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UNDER LEDELSE AF LAUGE KOCH

ON THE *PRE*-PERMIAN BASEMENT
OF THE GIESECKE MOUNTAINS (GAUSS
PENINSULA), NORTHERN
EAST GREENLAND

BY

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WITH 9 FIGURES IN THE TEXT

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PREFACE

It is the purpose of the present report to contribute to the stratigraphical knowledge of the *pre*-Permian basement in the complex built region of the Giesecke Mountains, Gauss Peninsula, and to put forward the main new data established by the writer in the spring of 1938 (2nd year of the Danish Geological Expedition to East Greenland under the leadership of Dr. LAUGE KOCH, Copenhagen).

In 1936 Dr. LAUGE KOCH had asked me to undertake a stratigraphical investigation of the *post*-Devonian deposits exposed north of Gael Hamkes Bugt, *viz.* between 74° and 75° North latitude. It had been planned that I should be relieved after one year's stay in East Greenland in order to work out the results in Europe. Owing to the bad ice-conditions in the summer of 1937, however, the expedition's ship the "Gustav Holm" failed to call at our base on Clavering Island and I was thus forced to stay for another year in East Greenland. On that account my stratigraphical-facial studies were carried on and extended as far south as Franz Josephs Fjord.

Several reports on the stratigraphy as borne out by the recent explorations have already been published (MAYNC 1938, 1939, 1940, 1942, 1947), and a detailed memoir on the Cretaceous stratigraphy of East Greenland has also been sent to press.

The investigation of the Giesecke Mountains, Gauss Peninsula, resulted in the discovery of some new facts and *inter alia* revealed the existence of doubtless Devonian deposits cropping out in the socle of that mountain range. Although a study covering the *pre*-Permian fundament did not lie within the scope of my task and though it was realized quite early that, of course, many a problem would remain unsolved after my few days' reconnaissance, I have nevertheless tried to clear up the interrelationship of the different Upper Palaeozoic formations there.

Actually, the Giesecke Mountains and, first and foremost, their southern part, hold great importance for the understanding of the *post*-Caledonian history of East Greenland, and this is the reason why I

conceived the idea of reporting briefly on the *pre*-Permian stratigraphy, basing upon my own survey.

This short account on those beds which beyond all doubt will also arouse the interest of future East Greenland geologists may—I hope—stimulate discussion and urge further exploration. If it should even turn out to serve as a basis for future work it will entirely have fulfilled its purpose.

It is a sincere pleasure to thank Dr. LAUGE KOCH, the leader of the Geological Survey of Greenland, for the extraordinary interest he has shown time and again in my investigations and who has done everything in his power to further my work.

I gratefully add cordial thanks to Dr. H. BÜTLER, Schaffhausen (Switzerland), to whom our present knowledge of the Devonian stratigraphy of East Greenland is largely due, for having had the kindness to read through the manuscript of this account.

Grindelwald (Switzerland).

April 1947.

Wolf Maync.

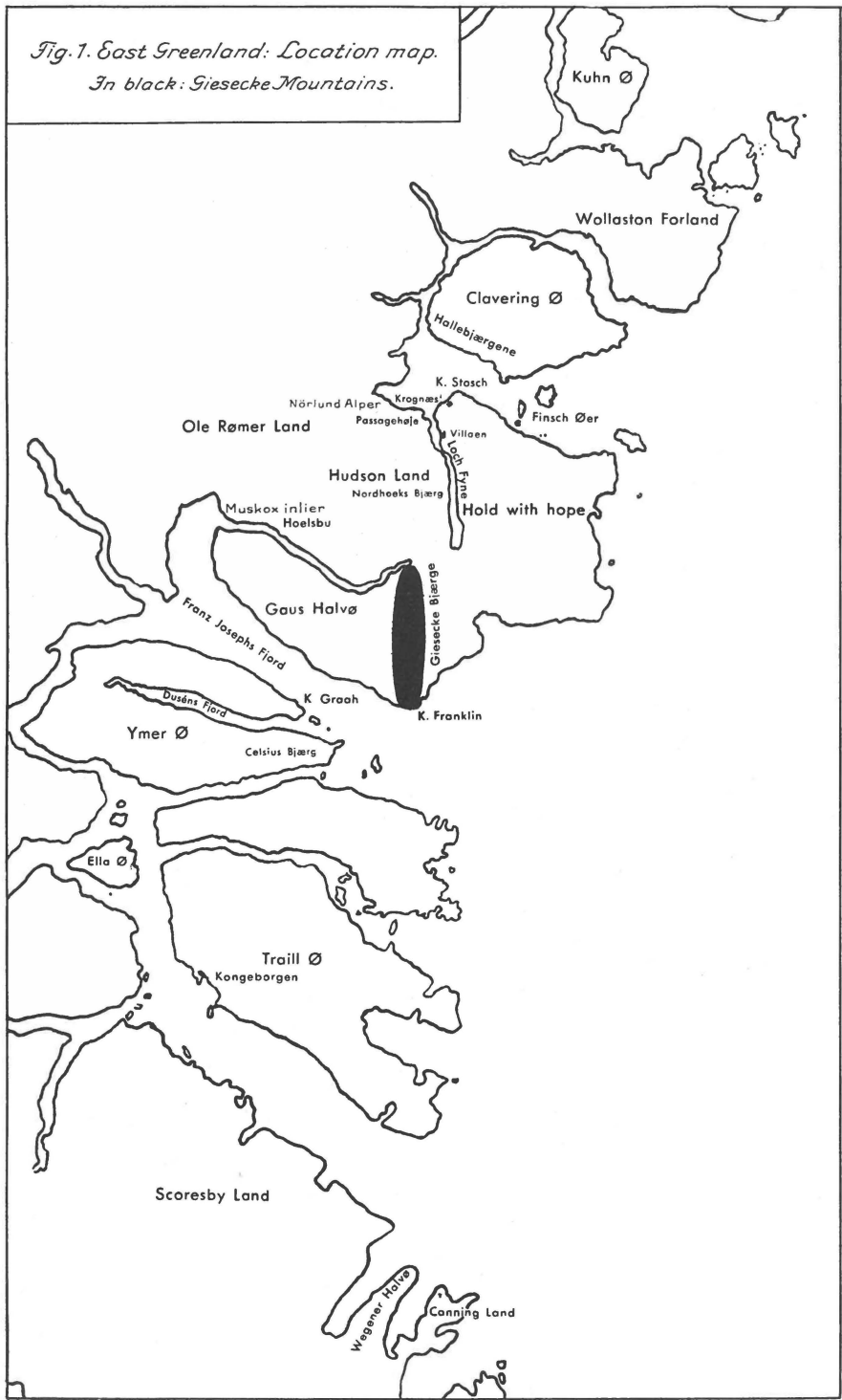


Fig. 1.

I. PRINCIPAL FEATURES AND STRUCTURE

With the exception of its northern- and southernmost ends, *viz.* the area of Ladderbjærg-La Cours Bjærg and the region of Cape Franklin, the Giesecke Mountains had geologically been a *terra incognita* prior to the reconnaissance surveys of A. VISCHER and the author in 1938.

In the light of the new finds they may to-day be considered as the crux of the geological problems bearing upon the *post*-Caledonian/*pre*-Permian history of northern East Greenland.

The NNE-SSW trending Giesecke Mountains occupy the area between Cape Franklin and the head of Moskusoksefjord, in other words, cover a distance, as the crow flies, of 42 km (*vid.* Figs. 1, 2).

The mountain range in question represents the eroded edge of the so-called "Giesecke Block", a tectonic element of the step-faulted continental border of East Greenland (cf. MAYNE 1948). This "Giesecke Block" has suffered a tilting towards the west-northwest and is bounded by the "Main *post*-Devonian Fault" (A. VISCHER 1939, 1940) from the more western "Gauss Block". Accordingly, the depression near this obvious fault contact is occupied by the youngest deposits whereas the older basement crops out in the uplifted outer edge of the "Giesecke Block". The latter, on the other hand, represents a tectonically higher unit than the downfaulted block to the east (Hold-with-Hope). The separating fault line runs along the eastern foot of the mountain range, and the fault contact ("Giesecke Fault") with the lowered "Hold-with-Hope Block" is marked by a sharp break in the topographical surface between the rugged western rock wall and the alluvial plains of Badlanddal and Vestersletten.

In the northernmost part of the Giesecke Mountains, namely west of Ladderbjærg, the "Giesecke Fault" dies away, being replaced and continued by the "Hudsonland Fault" that marks the boundary between Hudson Land and Hold-with-Hope.

On either side of Moskusoksefjord A. VISCHER's "Main *post*-Devonian Fault" is clearly exposed. The fault depression is filled up with deposits of the continental Carboniferous which, however, has been downfaulted as a *graben* in *pre*-Permian time. This fault wedge dies away already

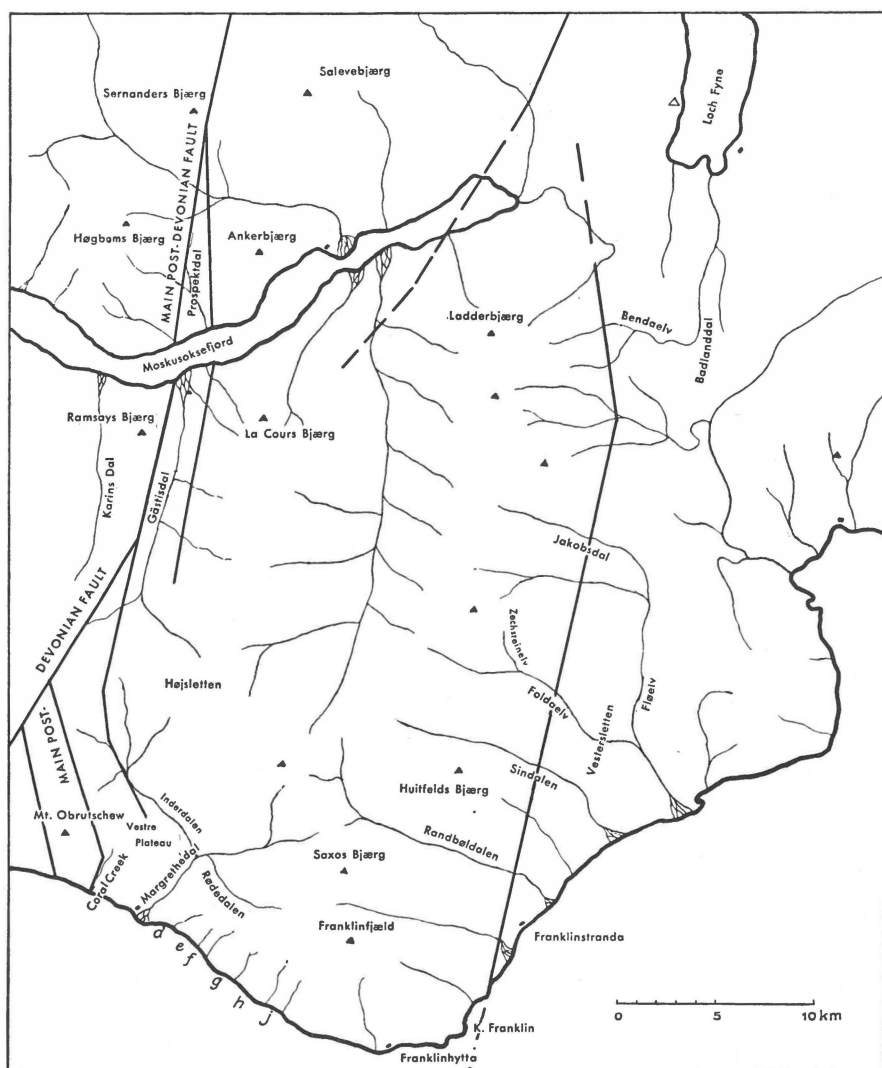


Fig. 2. Sketch-map of the Giesecke Mountains, Gauss Peninsula (tectonics after A. VISCHER).

in southern Hudson Land so that the "Main post-Devonian Fault" farther to the north is represented by the straight-running fault between the crystalline Nørlund Alps to the west and the Passagehøje with their Namurian sediments to the east (*vid.* BÜTLER 1939, 1940).

II. STRATIGRAPHY AND OCCURRENCE OF THE *PRE*-PERMIAN ROCKS

On dealing with the stratigraphy of the *pre*-Permian sediments and with the igneous rocks that have either intruded into or pierced through them we prefer to begin with the Devonian beds of southern Gauss Peninsula (area of Margrethedal). For, first and foremost, these deposits are exposed here over a rather large region and have not been invaded by intrusives and lava flows such as is the case in the Giesecke Mountains proper.

Unfortunately, I am not yet in a position to give an account on the geology of the *pre*-Permian socle in a chronological order, *viz.* beginning for instance with the lowermost exposed rocks and terminating with the *sub*-Permian formations, because there are still some doubts as to the age of certain beds and igneous rocks. By reason hereof it is of advantage to report progressively on the geological structure of the *pre*-Permian complex and to discuss the exposures in their location order from the south (Margrethedal-Cape Franklin) to the north (area of Moskusoksefjord).

In Coral Creek, west of Margrethedal, steeply inclined greenish-gray and strongly red marly-shaly, partly sericitic sandstones are exposed at a height of 60 m which are unconformably overlain by the marine Permian (*vid.* KOCH 1931, SÄVE-SÖDERBERGH 1934, MAYNC 1942). The same west-dipping rocks also occur higher up in the creek e. g. below the Permian gypsum at 280 m and 290 m, and beneath the Zechstein dolomite at 420 m (MAYNC 1942).

These beds are referred by L. KOCH to the uppermost member (8) of the Devonian (KOCH 1931) while G. SÄVE-SÖDERBERGH assigned them partially to the so-called "Upper Sandstone Complex" (Carboniferous), partly to the "*Phyllolepis* series" and "*Remigolepis* series" of the Upper Devonian (SÄVE-SÖDERBERGH 1934).

Margrethedal.

On his map LAUGE KOCH has indicated *pre*-Carboniferous "Fresh water Beds" cropping out in Margrethedal (KOCH 1929a). These deposits are reported to be bounded by a fault line from the *pre*-Devonian ("Caledonian?") granitic rocks which were supposed to make up the whole area of the Giesecke Mountains as well as the interior part of Moskusoksefjord (*op. cit.*).

According to A. K. ORVIN's map (ORVIN 1930) the coastal mountains of southeastern Gauss Peninsula (Franz Josephs Fjord) are built up of Devonian sediments (A. K. ORVIN's "Upper Red Sandstone series") which are indicated to be also exposed both in Margrethedal and on Cape Franklin.

H. G. BACKLUND, on the other hand, has referred a dark-gray series forming the coast cliff between Margrethedal and Cape Franklin to the continental Carboniferous (BACKLUND 1930). The acidic igneous rocks (liparite¹), liparite-tuff, quartz porphyry) of Cape Franklin were taken for outflows of Tertiary lavas on a rather young erosion surface (*vid. inf.*).

In the summer of 1930 L. KOCH undertook the geological mapping of the region between Margrethedal and Cape Franklin (KOCH 1931). The Devonian beds exposed in Margrethedal and in River d were correlated with O. KULLING's "Uppermost Red Sandstone series" (1929) of the Devonian formations (= member (8) of L. KOCH's subdivision) which is characterized by L. KOCH as follows: "Brick-red, very coarse, sometimes almost conglomeratic sandstone, in several places cross-bedded. It may also, for instance near the rivers e and f, pass into deep red or green micaceous shales, which, when not disintegrated, are very hard. They easily disintegrate, however, when they form light-green or reddish clay beds, in several places mixed with sand. These clay beds are very soft and rather plastic, and all transitions from soft to hard micaceous shales are represented" (KOCH 1931, p. 63). L. KOCH pointed out that there are no outcrops of Devonian beds east of River f: The coastal cliff between the rivers f and g was found to consist of variegated acidic eruptive rocks, mainly liparite¹), which have invaded the Devonian formations. Also basalts were found to occur here (*op. cit.*).

According to G. SÄVE-SÖDERBERGH there is no proof at hand that the sediments exposed in Margrethedal are Devonian in age (SÄVE-SÖDERBERGH 1932) nor is the sedimentary sequence established. On this account further investigations were carried out by G. SÄVE-SÖDERBERGH in 1933 (SÄVE-SÖDERBERGH 1934).

¹) Since the acidic rocks hitherto known to occur at Cape Franklin lack femic minerals and are, moreover, rich in potassium, the term "liparite" had better be replaced by the designation "rhyolite" (*vid. MALMQVIST 1935*).

In the uppermost part of Margrethedal, *viz.* north and east of Mt. Obrutchev, G. SÄVE-SÖDERBERGH succeeded in recognizing his "*Phyllolepis* series", "*Remigolepis* series", "*Arthrodire* Sandstone", and "Upper Sandstone Complex". The whole central portion of Margrethedal as well as the valley's mouth is supposed by G. SÄVE-SÖDERBERGH to be exclusively occupied by *post*-Devonian deposits (SÄVE-SÖDERBERGH 1934).

At the southeastern foot of Vestreplateau, *viz.* at 20—40 m altitude¹⁾, more or less horizontal light-gray to greenish, soft sandy marls, rich in finely disseminated muscovite, are seen to alternate with thicker layers of greenish slightly recrystallized marly limestone. Moreover, a few subordinate horizons of conglomerate with polygenetic (crystalline) pebbles were observed. These rocks highly recall those exposed below the "Cape Graah conglomerate" west of Cape Franklin (*vid.* p. 17).

Higher up, where the valley broadens and an important affluent (Inderdalen) from Højsletten joins the main river in Margrethedal at about 80 m altitude¹⁾, strongly red-coloured Devonian rocks, namely conglomerates made up of crystalline pebbles, and stratified nodulous sandstones, are widely distributed, disclosing a gentle dip to the southwest.

In Inderdalen, at 160 m altitude¹⁾, the red-purplish Devonian beds show a gentle folding. Furthermore, local interformational unconformities were recognized within these exposures.

At a height of 180 m¹⁾ gray-reddish hard quartzitic sandstones with greenish streaks are disharmoniously folded and the overlying strata overstep the cut folds (antedating interval of erosion).

In its upper course the river occupying Margrethedal has cut deeply into the Devonian formations. At a height of 140 m¹⁾ intensively red and violet-purplish fine-grained, more or less calcareous sandstones with a high content of muscovite are exposed on either side of the river bed, with interbeds and partings of red clayish shale. A dip of about 10° to the northwest was measured here.

At 150 m altitude¹⁾ there occur red-purplish or grayish-red, fine-grained sericitic sandstones, sometimes showing greenish spots and patches, and at 170 m above sea level¹⁾ purplish-red slightly calcareous, fine-grained sandstones with ripple marks and with red clayish sun-cracked laminae covering the bedding planes are exposed. Locally the bedding may be interrupted by thin mud-breccias and red clay galls.

In Rødedalen²⁾, a tributary of Margrethedal (*vid.* map Fig. 2),

¹⁾ According to the writer's own surveys.

²⁾ Name proposed by the writer for the valley cut between Franklinsfjæld (P. 1201 m) and Saxos Bjærg (P. 1050 m) that joins Margrethedal at about 200 m altitude 4 (*vid.* MAYNC 1942).

the Devonian beds are represented by mostly red-coloured or purplish, fine-grained sandstones.

During my visit early in April, 1938, I found the creek's floor between 250—260 m altitude¹⁾ sprinkled with loose-lying huge boulders consisting of a very coarse polymictous conglomerate with rounded blocks of gneiss, granite, and, moreover, quartzites, black limestone, light-coloured "*Cryptozoon* limestone" (algal reefs with *Collenia*), etc. derived from the "Eleonore Bay Formation" L. KOCH 1927. These different rock fragments are embedded within a violet-purplish to red-brown arkose matrix. Most noticeable, however, are remanié blocks of red Devon sandstones and reddish porphyries. Apparently, this coarse psephitic rock must occur *in situ* higher up.

At a height of 310—360 m¹⁾ red and violet-purple, fine-grained, somewhat calcareous sandstones, inosculating with interlayers of red and purple shale, are unconformably overlain (uneven contact) by yellowish, dark-gray, or reddish-gray argillaceous fine-grained muscovite sandstones, with partings of black shale sometimes containing indeterminate carbonized plant-remains and locally pyritic nodules. Since a remnant of light-coloured dolomite was observed to occur not far away between the red Devonian series and this sandstone formation, we feel justified in referring the latter to the Eotriassic.

East of Margrethedal the sub-Permian socle of the "Giesecke Block" is stripped by erosion in a number of small creeks which LAUGE KOCH has called Rivers d, e, f, g, h, and j (KOCH 1931). Owing to the steady dip of the "Giesecke Block" to the west-northwest the post-Devonian beds rise continually from Margrethedal towards the east, and at the southeastern corner of the tectonic block, *viz.* in the region of Cape Franklin, the pre-Permian basement is laid bare on that account from sea level up to considerable altitudes.

While still red or greenish-gray sandy marls and fine-grained sandstones, such as were found in the lowermost part of Margrethedal (*vid.* p. 12), crop out in River d, quite different rocks were found to form the Permian substratum on the west side of River e: From 80 m up to about 120 m altitude¹⁾ a red-coloured coarse, closely packed conglomerate is exposed, the constituents of which may attain the size of a head. The largest boulders still display rather sharp angles and edges whereas the smaller ones are fairly rounded. Apart from a few scattered pebbles consisting of a gray-greenish fine-grained sandstone, such as is of common occurrence farther to the west (River d, Margrethedal, Coral Creek), the destructional components are exclusively recruited from a red quartz porphyry (rhyolite)²⁾. Macroscopically, the rock shows no differ-

¹⁾ According to the author's own surveys.

²⁾ This "porphyry conglomerate" had been referred by A. ROSENKRANTZ to the Tertiary (ROSENKRANTZ 1932).

ence at all from that found at Cape Franklin (*vid.* pp. 16—17). On the other hand, the Permian gypsum in River f is underlain at a height of 200 m¹⁾ by fine- to medium-grained red sandstones, and there is no trace of the rhyolite conglomerate.

In River g dark-grayish to reddish Devonian sediments with intrusive sheets of diabasic rocks crop out below the Permian dolomite at 200 m altitude¹⁾. These basic igneous rocks have wrongly been taken for Tertiary basalt (*vid.* KOCH 1931); if this were right, however, one should expect the dolomite to have been influenced to some extent by contact metamorphic action which does not hold true at all, though (*vid.* MAYNC 1940). Merely the *pre*-Permian red-grayish sediments, into which the diabasic magma has worked its way, show obvious signs of exomorphism²⁾. It may be pointed out that a red and greenish quartz porphyry (rhyolite) was found here, although not *in situ*, that apparently has some connection with the diabase.

East of L. KOCH's River j, *viz.* at the foot of the marked knoll built up of quartz porphyry (sanidine-bearing rhyolite)³⁾, greenish-gray and reddish, slightly metamorphic slates (phyllites) and quartzitic sandstones are exposed in the coast, which dip at rather steep angles to the southwest. However, the stratigraphical relation between these sediments and the rhyolitic rocks could not be made out here.

The area of Cape Franklin.

The geology of Cape Franklin and its vicinity is highly complex and is but beginning to be more thoroughly understood.

Except the occurrence of Devonian sediments west of the cape L. KOCH has mapped the whole region as *pre*-Devonian (KOCH 1929a). He reports to have found *in situ* black limestones belonging to the *pre*-Cambrian "Eleonore Bay Formation" L. KOCH 1927, in other words, sediments of the "Caledonian" cycle of orogeny⁴⁾. Furthermore, granitic rocks were recorded which, apparently, have intruded into the "Caledonian" sediments and which were supposed to be closely connected with the Caledonian folding. This granite is believed to be *pre*-Devonian in age. In addition acidic extrusives and pyroclastics were reported to occur as well as basalt (KOCH 1929a).

¹⁾ According to the writer's own surveys.

²⁾ Femic "pacific" extrusives (e. g. diabases, spilites) are recorded to mark the beginning of the late Paleozoic volcanism in Moskusoksefjord (*vid.* RITTMANN 1939, 1940).

³⁾ Mapped by L. KOCH (KOCH 1931).

⁴⁾ I did not succeed in finding any fixed sedimentary rocks referable to the characteristic "Eleonore Bay Formation" L. KOCH 1927 in the surroundings of Cape Franklin, though.

West of Cape Franklin A. K. ORVIN, too, indicates extensive intrusions of granite, capped by Tertiary basalt (ORVIN 1930).

H. G. BACKLUND, on the other hand, referred the igneous rocks of the Cape Franklin area to the Tertiary (BACKLUND 1930, 1932, 1935, 1944) because he took them partially to be extrusions on a Tertiary surface of erosion. The dark-gray sandy plant-bearing shales exposed beneath these outpourings of rhyolitic lavas were assigned to the continental Carboniferous since the fossil plant-remains according to H. G. BACKLUND bear a Carboniferous stamp (*op.cit.*). The sediments concerned are, moreover, reported to differ greatly from the typical Devonian beds farther to the west. Another argument advanced by H. G. BACKLUND to support the supposed Carboniferous age of the deposits in question is their superposition by the yellowish dolomite of the marine "Upper Carboniferous-Permian"¹).

D. MALMQVIST, who has undertaken a thorough petrological study on the acidites of Cape Franklin (BACKLUND & MALMQVIST 1935), discriminates 3 rock-types: Firstly a reddish-gray "quartz rhyolite" displaying phenocrysts of quartz and feldspar. According to H. G. BACKLUND this hypabyssal-intrusive rock occurs as a laccolith within the shaly Carboniferous sandstone (slightly hardened along the igneous contact). Secondly, there is a red or greenish sanidine-bearing rhyolite exhibiting a fluidal texture. H. G. BACKLUND is of opinion that this rock in a molten state has flowed down over an erosional slope (BACKLUND 1935). As this sanidine rhyolite is cut by dykes of the aforementioned "quartz rhyolite" or of closely allied rocks, it is obviously earlier in its *mise-en-place*. Finally, a spherulitic rhyolite is described which discloses yellowish-greenish or purplish colours and an evident effusive texture. Up to fist-sized spherulites are frozen into the porous hemi-amorphous to glassy groundmass. The relative age of this most conspicuous extrusive is determined because it is cut by dykes and veins of sanidine rhyolite (*vid. sup.*). Upon the whole these spherulitic rhyolites, therefore, represent the oldest rocks among the acidites of the Cape Franklin volcanism.

Both sanidine rhyolite and spherulitic rhyolite are crossed by basalt dykes (carrying xenoliths of the older acidic rocks). Owing to the mode of occurrence of these igneous rocks of Cape Franklin H. G. BACKLUND & D. MALMQVIST arrived at the following sequence of genesis: dolerite basalts- acidites- plagioclase (olivine) basalts (BACKLUND & MALMQVIST 1935).

Unfortunately, a brief summary on the results of my own surveys

¹) In a special stratigraphical paper the writer has brought forth that the supposed "Upper Carboniferous-Lower Permian" formations of East Greenland are decidedly Upper Permian (Zechstein) in age (MAYNC 1942, *vid.* also MAYNC 1938, 1939, 1940).

near Cape Franklin in the spring of 1938 was published with much delay (MAYNC 1940).

In his petrological study on the Devonian eruptives of Moskusoksefjord A. RITTMANN, too, arrived at the conclusion that the alkali rhyolites of Cape Franklin are identical with those occurring within the Devonian beds of Ramsays Bjærg, "Hoelsbu" etc. (RITTMANN 1939, 1940). Moreover, he found that—with regard to its chemical-mineralogical composition and texture—the youngest acidic rock among the Cape Franklin magmatics, *viz.* D. MALMQVIST's "quartz rhyolite" (*vid. sup.*), cannot be distinguished at all from the alkali rhyolite dykes which cut the Carboniferous sediments in Prospektal (*vid. p. 46*). In other words, A. RITTMANN has drawn the unexpected conclusion that D. MALMQVIST's "spherulitic rhyolite" and "sanidine rhyolite" of Cape Franklin are a result of *intra*-Devonian magmatic activity whilst the "quartz rhyolite" is due to a later (*post*-Devonian) extrusion (*op. cit.*).

East of the Norwegian hut "Franklinhytta", west of Cape Franklin, red often dark-purplish to violet or greenish-gray marly, argillaceous fine-grained sandstones with shaly layers, rich in muscovite, partly red calcareous and flaggy sandstones showing greenish spots, are exposed from about sea level up to the *sub*-Permian boundary at 320—340 m altitude (*vid. MAYNC 1940, 1942*). At 200 m altitude a complex of greenish-gray calcareous flaggy muscovite sandstones, bearing carbonaceous matter (bedding planes) and plant-remains, was found within the red-coloured Devonian series; still farther below red rhyolitic extrusives occur.

These Devonian beds, which may be correlated with those exposed near the delta of Margrethedal (*vid. p. 12*), are gently folded and have partly been reworked during the transgression of the Upper Permian sea, for angular fragments of such red sandstones were discovered in the basal portion of the overlapping dolomite (*vid. MAYNC 1942*).

West of "Franklinhytta" the writer found a coarse block-conglomerate containing only boulders of red and reddish-gray sandstone. On top of this psephite follows a set of folded greenish-gray fine-grained sandstones. Obviously, the block-conglomerate cannot be correlated with the "Cape Graah conglomerate" occurring slightly farther to the east (*vid. inf.*) as the latter carries chiefly boulders of red quartz porphyry (rhyolite). Hence the conglomerate with the sedimentary constituents must be referred to another level than the "Cape Graah conglomerate".

Nearby a large exogeneous inclusion of a dark-coloured sediment, considerably altered by contact metamorphism, is frozen into the exposed mass of reddish quartz porphyry (rhyolite).

Slightly to the east of the river that debouches into Franz Josephs Fjord, about $4\frac{1}{2}$ km west of the basalt nose of Cape Franklin, a dark greenish (and reddish) argillaceous, fine-grained muscovite-bearing sandstone, with hard and flaggy interlayers, is exposed at sea level. These

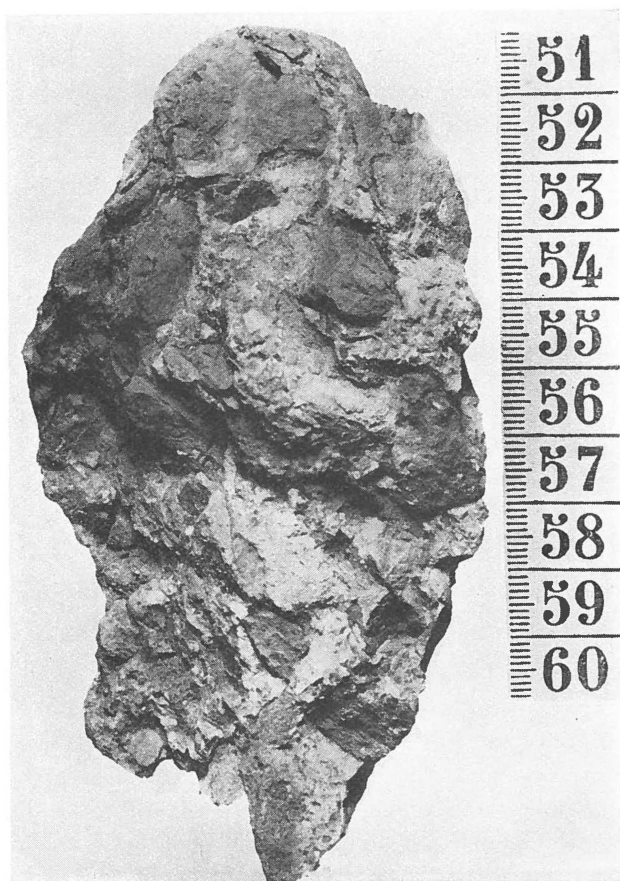


Fig. 3. Reworked slabs of red Devonian sandstone embedded within a grayish sandstone matrix. Basal conglomerate of the "Cape Graah series", west of Cape Franklin (lot 2703 coll. W. MAYNC).

beds, dipping at an angle of about 30° to the northwest, are overlain by a transgressive coarse conglomerate which I had proposed to name "Cape Franklin conglomerate" (MAYNC 1940) but which is evidently identical with the "Cape Graah conglomerate" (*vid.* p. 53). A sharp jagged angular unconformity marks the boundary between these formations (see Fig. 4).

This conglomerate is characterized by large angular blocks, boulders (attaining up to 1 m in length), and pebbles of red-coloured rhyolite and, moreover, of red-purplish or greenish, argillaceous muscovite sandstone, closely packed upon another. There is not the slightest mechanical

sorting recognizable, at least in the lowermost portion of this remarkable conglomerate. Its sparse matrix consists of purplish-violet micaceous sand.

Immediately west of this interesting exposure a conglomeratic inter-layer was stated to occur within the lower series of greenish muscovite sandstones. It is worthy of record that this conglomerate, which attains a mere thickness of 0.2 m, does not contain one single pebble of red Devonian sandstone nor any fragments of rhyolite, but all the components are of Caledonian origin, *viz.* quartzite, black limestone, "*Cryptozoon* limestone" *et cetera* derived from the "Eleonore Bay Formation" L. KOCH 1927.

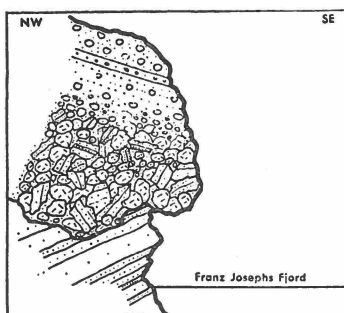


Fig. 4. The exposure west of Cape Franklin showing the angular unconformity between the overlapping conglomerate of the "Cape Graah series" and the underlying Devonian series (field-sketch).

The basal conglomerate displays closely packed pebbles of rhyolite (dashed pattern) and Devonian sandstone (stippled).

On the whole the geology of the *pre*-Permian socle in the surroundings of Cape Franklin is evidently rather intricate, and the numerous problems can only be solved by submitting the southern end of the Giesecke Mountains to a closer investigation. The present data at hand are still exceedingly scanty and will never suffice for the understanding of more than the mere essentials of their geological features.

Between River g and Cape Franklin typical Devonian sediments are thus seen to be invaded by bodies and sheets of variegated acidic rocks disclosing a porphyritic texture which near the bounding surfaces of the igneous bodies often turns into a spherulitic or felsitic one. Dykes and sills ramify from the main often laccolithic stocks into the enclosing formations, as well as apophyses (bright aplitic veins). However, younger outflows of basaltic lava frequently mask the geological relations of the *pre*-Permian extrusive rocks.

Among the predominantly red-coloured quartz porphyries (alkali rhyolites) different rock-types may be distinguished, which, however, seem to be derived from the same "pacific" aplitgranitic magma¹). A

¹) Where the *f*_m-value is rather high as e. g. in the spherulitic rhyolite the magmatic chemism is spoken of as engadinitic-granitic.

reddish-gray quartz rhyolite (alkali rhyolite with corroded phenocrysts of quartz) displays large individuals of a brick-red potassium feldspar (sanidine) within a micropoikilitic to hyalopilitic-spilitic groundmass. Large sanidine phenocrysts (in a felsitic matrix) are also characteristic of a brown-red to salmon-coloured, or greenish rhyolite with a well-pronounced fluidal texture. However, the most conspicuous rock is a light-gray to green spherulitic rhyolite bearing out a felsitic-microgranular groundmass with large spherulites, lithophysae, and phenocrysts of quartz and feldspar. Pyroclastic materials e. g. rhyolitic tuffs, tuff-breccias *et cetera* were observed locally.

These extrusive rocks are visibly cut by dykes of the Tertiary plagioclase basalt which sometimes carries frozen foreign inclusions of rhyolite as well as partially dissolved xenoliths of Devonian sandstone (*vid.* also BACKLUND & MALMQVIST 1935).

It is, of course, not pertinent to the present paper to describe these acidic igneous rocks at great length which would crave a man thoroughly familiar with the methods of modern petrology. Moreover, the main types have been masterly dealt with already by D. MALMQVIST (MALMQVIST 1935).

H. B. BACKLUND, who in 1929 carried out a cursory survey of the area west of Cape Franklin, has referred the said acidites to the young (Tertiary) volcanism (BACKLUND 1930, 1932, 1935, 1944) since he assumed them to have been welled out over a surface of erosion that is reported almost to coincide with the present-day slope. A couple of data recently accumulated, however, prove beyond a doubt that the igneous rocks concerned are due to an *intra*-Devonian (?and Carboniferous) phase of volcanic activity, (MAYNC 1940, VISCHER 1940).

The plainly visible denudation plane at the floor of the marine Zechstein series, which cuts obliquely both the old sediments and the intimately penetrating acidites, clearly bears out their *pre*-Permian age (*op. cit.*).

The brown-gray or reddish arkoses, mica-bearing sandstones, and sandy shales exposed near Cape Franklin are considered by H. G. BACKLUND to be of Carboniferous, *viz.* Namurian, age on account of their content in fossil, though indeterminable, plant-remains and their superposition by the marine "Carboniferous-Permian" formations (BACKLUND 1935).

My stratigraphical investigation in 1938 led me to refer these deposits to the Devonian, however (MAYNC 1940), as the Devonian series are exposed almost continuously from Margrethedal onwards to Cape Franklin. As the interformational conglomerate near Cape Franklin (= "Cape Graah conglomerate") carries boulders and fragments of red-purplish sandstones and, furthermore, of red rhyolites which are petro-

logically identical with those occurring *in situ* near by, the *intra*-Devonian age of those acidites is evident, after all.

Besides, rhyolitic masses are also exposed at higher levels than the "Cape Graah conglomerate" on the coast, i. e. at an altitude of 80—100 m west of Cape Franklin. This might be due to a younger rhyolite extrusion. On the other hand, it must be borne in mind that the lower surface of the "Cape Graah conglomerate" apparently slopes rather steeply to the south (*vid.* p. 55), in other words, the overstepping conglomerate on the coast is but a relic that has escaped erosion.

Closely allied and identical igneous rocks are of common occurrence within the Devonian "Cape Kolthoff series" between Ymer Island and Hudson Land (*vid.* ORVIN 1930, BÜTLER 1935a, 1935b, 1939, RITTMANN 1939, 1940).

The Giesecke Mountains.

Prior to our reconnaissance survey in 1938 there were hardly any information available with respect to the geology and stratigraphy of this mountain range. Only its northernmost part (Ladderbjærg, *vid. inf.*) and the region of Cape Franklin had been roughly mapped (KOCH 1929a, BACKLUND 1930, 1932, 1935).

On the regional geological map of East Greenland surveyed 1926—1927 by LAUGE KOCH the Giesecke Mountains are designed as being built up of "Caledonian?" granite and Tertiary basalts (KOCH 1929a).

A. K. ORVIN, too, depicts the whole mountain range as consisting of granite (ORVIN 1930).

As to the occurrence of Permian and Mesozoic sediments in the Giesecke Mountains the reader may be referred to other papers of the author (MAYNC 1940, 1942, 1947, 1949).

The Giesecke Mountains, in particular, have turned out to be of outstanding interest for the *post*-Caledonian/*pre*-Permian history of East Greenland. Of special importance are the acidic rocks which have intruded into the sedimentary *pre*-Permian basement. While an obvious extrusive facies is characteristic of the acidites near Cape Franklin (*vid. sup.*) we find hypabyssal intrusive stocks (granitoporphry) in the Devonian deposits farther to the north, *viz.* in the southern and central portions of the Giesecke Mountains. These high-level intrusives grade into bodies of granite and granitogneiss still farther to the north, namely in the region of Ladderbjærg and La Cours Bjærg. Thus these igneous rocks which play a main rôle in the composition of the mountain range seem to differ only texturally, their abyssal (intrusive) northern facies being replaced southwards by a more nearsurface facies that is represented near Cape Franklin by real effusives (surface flows). Their age is *intra*-Devonian (and in part Carboniferous?).

Huitfelds Bjærg (P. 1197 m).

Remarkable coarse-clastic deposits of an evidently synorogenic character were discovered on climbing the southeastern face of Huitfelds Bjærg from Randbøldalen (*vid.* map Fig. 2).

In the lower part of the *débris*-filled Randbøldalen outcrops of greenish-gray and red, often banded fine-grained muscovite sandstones and sandy shales, often turned slightly contact metamorphic as a consequence of the intruded stocks of reddish granitoporphry, were encountered (Devonian).

From an altitude of about 300 m¹) (southeastern slope of Huitfelds Bjærg) upwards a coarse conglomeratic series is exposed, but only part of it was studied during my investigation of the younger strata.

410 m¹) Coarse grayish-brown gritty arkose matrix containing up to head-sized, well rounded boulders of a whitish granite and angular fragments of red-purplish to violet muscovite sandstones such as are most characteristic of the Devonian. Moreover, blocks of acidic rocks are represented, which—judging by their sharp edges—cannot have been transported over any long distance.

Passing into

thick-bedded arkosic sandstone carrying smaller poorly rounded constituents (up to fist-size), chiefly made up of strongly red-coloured to violet-purplish shaly sandstone. Slightly higher very big fairly rounded crystalline boulders, huge angular blocks of augengneiss as well as large complexes of remanié red sandstones etc. are embedded topsy-turvy within this formation which displays a gentle dip to the southwest and is crosscut by basic (basaltic or diabasic) dykes.

Higher up

a hard gray-brownish stratified sandstone with pebble-bearing pockets is interbedded. On the whole there is no sorting at all in the coarser layers where the pebbles usually are closely heaped upon another. The less psephitic members composed of sandstone or arkose very often show a pinkish to red-purple colour which is evidently due to small splinters of the reworked red Devonian sandstones.

At 425 m altitude¹) the series is intruded by a

15 m thick sheet of a diabasic-basaltic rock; the sediments show a yellowish discoloration (exomorphism) and the normal bedding has become disrupted along the magmatic contact.

On top of this sill lies a

coarse hard breccia consisting of numerous red-purplish sandstone blocks embedded within a slightly calcareous sandstone cement. In the lowermost portion (8 m) the destructional fragments are tightly packed so that they touch one another. Thin partings of a purplish-grayish sandstone are rare.

These psephites grade into a

¹) According to the writer's own surveys.

3 m layer of a gray coarse-grained cross-bedded sandstone, bearing now and then a single pebble (quartzite, granitogneiss); after a 0.1 m bed of a very fine-grained sandstone another sedimentary cycle sets in, beginning with a coarse boulder bed that carries large detached rock fragments of red or greenish (streaked), fine-grained sandstones (as below) *et cetera*. Obviously, there is a repetition of the sequence (rhythmic sedimentation).

From a height of 460 m¹) upwards the succession was largely snowed up and only the ledges made up of basalt sills were left bare. However, at an altitude of about 600 m¹) much débris of Permian and Triassic rocks was strewn on the slopes, *viz.* formations that are stated by A. VISCHER to occur *in situ* on the other side of Randbøldalen.

In a more western ridge leading down to the valley a

thin-bedded banded shaly sandstone, disclosing cross-bedding, with buff-coloured clay galls, is exposed at a height of 410 m¹), alternating with greenish weakly metamorphic quartzitic sandstone. A subordinate conglomeratic interlayer with pebbles of porphyry is noteworthy.

This series lies in igneous contact with a basic sill (diabase or basalt) which also cuts across the intrusive stock of granitoporphry that crops out in either wall of Randbøldalen. This mass in turn visibly cuts the conglomeratic series at steep angles as well as the still lower greenish or reddish-gray shaly or marly mica-bearing sandstones of Devonian age. Xenoliths consisting of red Devonian sandstone that are frozen into the granitoporphry are rather common.

Besides, exposures of the boulder series were met with in this ridge even as far down as 270 m altitude¹).

The age of this remarkable psephitic formation, which I prefer to term "Randbøl conglomerate" until a definite age assignment is possible, cannot yet be fixed with certainty. Being overlain by marine beds of the Permian, its Paleozoic age is, of course, established. As the conglomerate series *inter alia* carries remanié blocks of Devonian sediments and porphyry, its deposition must have taken place in *intra-* or *post-*Devonian times. The presence of porphyritic pebbles might suggest a correlation with the "Cape Graah conglomerate". Dr. H. BÜTLER was so kind as to inform me that a very similar conglomerate carrying Caledonian pebbles occurs north of Ramsays Bjærg, Gauss Peninsula, where it is also underlain by greenish sandy shales with intruded rhyolitic rocks. This conglomerate is correlated with the psephites of the "Cape Bull series" and, though with reservation, with H. BÜTLER's "Conglomerate 2." of the "Muskox-inlier" (*vid.* table pp. 42—43).

¹) According to the writer's own surveys.

In the valley north of Randbøldalen, namely in Sindalen (*vid.* map Fig. 2) a block-conglomerate with still huger boulders (up to 3 m in diameter) was discovered by A. VISCHER in 1938. Its constituents are chiefly derived from the granitic stock cropping out in the more northern Foldaelv (*vid. inf.*) but fragments of red Devonian sandstone *etc.* are by no means rare. The coarseness of this psephite, which in all probability corresponds to the "Randbøl conglomerate", was reported to decrease rapidly towards the south. Its thickness was estimated by A. VISCHER to amount to about 300 m.

In Foldaelv coarse-granular and porphyritic granites with foreign inclusions of red-coloured Devonian sandstones form a stock with a circular-oval ground plan while farther up the valley a coarse conglomeratic series is exposed. West of the tributary named Zechsteinelv by the writer (MAYNC 1942) I observed the following sequence (*vid.* also MAYNC 1948).

Up to 440 m altitude¹⁾ banded gneiss and metamorphic rocks with granitoporphyratic intrusives occur which are overlain by a

440 m polygenetic conglomerate displaying up to fist-sized subrounded pebbles of Caledonian provenience, *viz.* quartzite, black limestone *etc.* derived from the "Eleonore Bay Formation" L. KOCH 1927, embedded within a sandy or gritty cement. A general dip of 12–15° to the north was observed higher up.

At a height of 450 m¹⁾ the unsorted conglomerate shows traces of exomorphism (hardening, baking) due to the superjacent basalt sill of considerable thickness (about 150 m) that has forced its way near the sub-Mesozoic unconformity (*vid.* MAYNC 1948).

In Zechsteinelv the succession is as follows.

- 200 m¹⁾ Confluence with Foldaelv.
- 210–240 m Granite and porphyritic granite, with basic ?inclusions or segregations.
- 240–305 m Basalt sill.
- 305–360 m Coarse block-conglomerate carrying both boulders of the subjacent granitoporphry, which may attain a diameter of 0.5 m, and large angular slabs of coarse brownish arkose sandstone, closely packed upon another.
- 360 m 4–5 m yellowish weathering conglomerate bearing well-rounded pebbles of quartzite only, = basal conglomerate of the complex Zechstein series (*vid.* MAYNC 1940, 1942).

The coarse psephites beneath the Permian are presumably of Devonian age and may be correlated with the "Randbøl conglomerate"

¹⁾ Determined by the writer with a "PAULIN" altimeter.

that is exposed in the more southern valleys to a considerable thickness (*vid. sup.*).

Jakobsdal¹).

North of Foldaelv Valley (*vid. map Fig. 2*) large portions of the eastern rock wall of the Giesecke Mountains are made up of granite and granitoporphyrries which had hitherto been taken to belong to the "Caledonian" crystalline (*vid. KOCH 1929a*) but which I hold to be *intra-Devonian/pre-Permian* intrusives (*vid. MAYNC 1940, 1949*).

Where both the rivers occupying Jakobsdal and Gustavsdal leave the mountain range, *viz.* the fault scarp of the "Giesecke Block", to flow slowly onwards across the vast alluvial plain of Vestersletten (Fløelv, *vid. map Fig. 2*) they have cut deeply into the crystalline *pre-Permian* core.

On the north side of Jakobsdal (from about 80 m altitude upwards) beautiful exposures of pinkish and whitish-gray granites, aplites, and above all of reddish-gray granitoporphyrries (with feldspar phenocrysts attaining the size of a head) were met with which are intruded by a 30—40 m thick sheet of basalt. This femic sill, which frequently carries immersed blocks and large flags of the bed-rock, discloses jagged contact surfaces, *viz.* short apophyses of basalt extend into the acidites. Besides, the basalt sheet was observed to be obliquely cut by veins of a dark rock exhibiting fine-grained or vesicular-amygdaloidal texture.

Near the igneous contact wall the granitoporphyrries, granites *etc.* have sometimes turned yellow and crumbling, and concentrations of feldspar ("Augen" texture) occur rather often.

The coarse reddish-gray granitoporphry is now and then cut by whitish-gray veins of a medium-grained aplite, and schliers of the pink granite within the porphyritic rock were observed time and again which proves that there is no difference in age worth mentioning between either the granite or the granitoporphry.

While these acidites are visibly overlain by the marine Permian deposits on the south side of the valley, this superposition could not be observed *in situ* in the other wall (*débris*, tundra, snow). However, xenoliths of Permian dolomite and coral limestone, swimming within the basalt sill, give proofs that these sediments must actually occur close by.

On the south side of Jakobsdal banded (biotite-bearing linings), microfolded and contorted gneisses and granitogneisses crop out, which are intruded by a red to pink granite. Also pegmatitic streaks were observed. Moreover, a fine light-gray granite was recognized here, yet

¹) Name given by the author (MAYNC 1942).

its mode of occurrence could not be made out since there was no time for further investigations, unfortunately.

At a height of 300 m¹⁾ these acidic igneous rocks are cut by the above-mentioned basalt sill which contains detached blocks of granite and granitoporphry.

Ladderbjærg (P. 1181 m).

The granite cropping out below the basalt-capped sediments in Ladderbjærg has been put into connection with the Caledonian orogeny, *viz.* it is assumed to have intruded *pari passu* with the folding (KOCH 1929a, BACKLUND 1930, 1932).

H. G. BACKLUND found the crystalline rocks in the socle of Ladderbjærg to consist chiefly of granite which in places may exhibit a gneissose texture and is cut by basalt dykes. The mode of occurrence of a white porphyritic (trondhjemitic) granite shows that it is somewhat later in its *mise-en-place* (BACKLUND 1930). Furthermore, he recorded a gray-white porphyritic granite with amphibolite schliers that passes gradually into banded "Flaser" gneiss or granitogneiss (BACKLUND 1932).

This "Caledonian" crystalline is reported to slope gently southwards from Ladderbjærg so that it disappears beneath the Devonian and Carboniferous formations (BACKLUND 1930).

On A. K. ORVIN's map Ladderbjærg is marked as an area of Tertiary basalt (ORVIN 1930).

In the eastern foot of Ladderbjærg, the northernmost summit of the Giesecke Mountains, the crystalline basement (hitherto referred to as "Caledonian") is laid bare to a considerable extent beneath the overstepping Permian formations (*vid.* KOCH 1929a, BACKLUND 1930, 1932, MAYNC 1940, 1942).

In the upper course of the southern Bendaelv (comp. map Fig. 2) the crystalline socle is exposed up to 320—340 m altitude¹⁾ where it is cut by the *sub*-Permian denudation plane (*vid.* MAYNC 1942).

At a height of 160 m a reddish-gray fine-grained granite occurs which is straightly cut by several basalt dykes. The granite very often exhibits a real porphyritic texture (with panidiomorphic feldspar phenocrysts of up to 1 cm in length) and should then rather be spoken of as granitoporphry (compare also the outcrops in the central and southern portion of the Giesecke Mountains). Locally it shows beautiful red to pink colours, e. g. at 230 m altitude. Such a reddish frequently porphyritic granite was also found at a height of 270 m where it contains veins and schliers rich in biotite ("Flaser" texture). In some places these segregations even predominate to such an extent that the rock specimens

¹⁾ All the heights are based upon the writer's own surveys.

under consideration display a banded parallel-textured habitus with microfolds and may thus safely be held for a gneiss.

Between 310—320 m altitude the granitic rocks are strongly weathered and kaolinized and have turned whitish-crumbling. Locally there is a striking intense purple-violet discoloration, but still more remarkable are numerous large blocks of a purplish-violet or greenish re-crystallized sandstone being frozen as foreign inclusions in the granitic matter. As quite identical rocks occur *in situ* everywhere within the pile of Devonian deposits (*vid. sup.*), these xenoliths are obviously Devonian sedimentary fragments that were detached from the rock wall during the *mise-en-place* of the granite and granitoporphry and in this way were frozen into the igneous rock. It stands to reason, therefore, that the intrusion of the acidic magma must be younger than the country rock, in other words, of *intra-* (or *post-*) Devonian age. To be sure, this phenomenon of disrupted blocks of Devonian sediments immersed in the granitic intrusives could be observed elsewhere in the investigated area (*vid. sup.*). In Bryozoen Ryg (= ridge located between the southern and northern branch of Bendaelv, *vid.* MAYNC 1942), for instance, quite a number of large slabs consisting of a red-purplish or grayish, muscovite-bearing stratified sandstone, of red fine-grained calcareous or marly sandstone, and of violet and gray banded argillaceous muscovite sandstone, were found enclosed in the granite. In one single spot this crystalline rock contains a few small rounded off pebbles of the same Devonian rocks which, evidently, must have been carried away by the intruding magma.

La Cours Bjærg (P. 1042 m).

This mountain, too, was mapped by L. KOCH as being built up of "Caledonian?" granite and Tertiary basalts (KOCH 1929a, ORVIN 1930).

H. G. BACKLUND's petrological investigations during the summers of 1929 and 1930 revealed many new facts (BACKLUND 1930, 1932). Black slates of Caledonian age were observed to be invaded by a pink granite that is replaced to the southwest by a gray coarse-granular granite the emplacement of which is reported to be older (BACKLUND 1932). Otherwise granitogneiss and biotite-bearing garnetiferous gneiss are of common occurrence. These granitic rocks are attributed to the Caledonian complex, in other words, they represent partially *pre-Cambrian* sediments which have turned into metamorphic rocks (Caledonian orogeny), partly they are taken to be intrusives that have invaded the folded beds (syntectonic granites). The former conjecture is evidenced by the occurrence of less metamorphic sediments such as quartzite and sericitic slates on the west face of the mountain (*op. cit.*).

On the western slope of La Cours Bjærg, too, H. G. BACKLUND discovered a brick-red to salmon-coloured hybridic granophry of hypabyssal habitus (phenocrysts of albite, often twinning according to

the Albite Law). Obviously this rock cannot be matched with any granitic one derived from the "Caledonian" (in *loc. cit.*). As its relative age is reported to be older than the above-mentioned granites, H. G. BACKLUND brought it into connection with a nearsurface intrusion during the evolution phase of the Caledonian geosyncline (BACKLUND 1932).

Besides, mention is made of relics of a white coarse-grained quartz sandstone on the northern face of La Cours Bjærg which reminds one of the Carboniferous psammities occurring in Prospektal (BACKLUND 1935). Resting directly on the crystalline socle with a basal conglomerate, a thin sedimentary series was moreover encountered, with dark-gray to red-brown sandstones and purplish tuffogeneous layers, which H. G. BACKLUND with all reservation assigned to the ?Devonian (*op. cit.*).

"On the slopes of Mt. La Cour conditions must be more complicated, as appears from BACKLUND's map. In addition to Caledonian crystalline rocks there probably occur Devonian eruptives in company with folded post-Caledonian sediments" (quotation *ex* BÜTLER 1935a, p. 18).

In the summer of 1936 H. BÜTLER carried out an investigation of the *pre*-Permian rocks in the area of La Cours Bjærg-Gästisdal (BÜTLER 1938, 1939, 1940).

H. BÜTLER stated that the crystalline of western La Cours Bjærg is faulted *en échelon* towards the Gästisdal *graben* and that Carboniferous sediments here directly overlie the crystalline basement (BÜTLER 1938). Owing to the downfaulting of the said trough these Carboniferous beds, too, underwent mechanical deformation (flexures, fractures).

South of the summit of La Cours Bjærg, however, H. BÜTLER ascertained a zone of mylonitized rocks and contorted shales of Devonian age on top of a white-gray granite. This Devonian belt, which broadens considerably towards the southwest, is interpreted as the "root" of the upthrust Devonian complex ("Cape Kolthoff series") of Ramsays-Högboms Bjærg (*op. cit.*).

An instructive section was set down on climbing the mountain along its northwestern face up to the small kar glacier (ravine debouching east of the Gästisdal delta).

40 m to
about 200 m¹⁾ Outcrops of banded folded gneiss with intruded bodies of a pink-coloured partly porphyritic granite that is visibly cut by a greenish fine-textured effusive rock (spilitic diabase).

In a neighbouring gully this pink or brick-coloured granite has
100-120 m¹⁾ penetrated into a steeply inclined sedimentary series (*vid.* Fig. 5): These greenish and red sandy beds of ?Devonian age dipping at an angle of about 60° to the east-northeast are irregularly cut by the granitic stock and their apophyses. In consequence hereof, those sediments have partially turned slightly contact metamorphic.

¹⁾ According to the writer's surveys.

From a height of about 200 m¹⁾ upwards the following succession of well-exposed sediments was measured (*vid.* Fig. 6)²⁾:

200 m Coarse polygenetic conglomerate (1).

Mostly subrounded up to fist-sized pebbles of light- or rosy-coloured quartzite, cemented together by a white-grayish fine kaolinized matrix with purple infiltrations. Alternate layers (1—2 cm) of medium- to fine-grained whitish or pink-reddish quartz sandstone bearing scattered small crystalline pebbles. Passing both vertically and laterally into the psephitic rock (1).

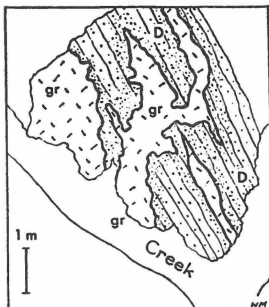


Fig. 5. Exposed rock-spur (largely snowed up) in la Cours Bjærg, showing the injection of a pink porphyritic granite (gr) into tilted ?Devonian sediments (D). Field-sketch.

A dip of 18° to the southwest was stated in this member, the thickness of which amounts to about 6 m.

Intraformational unconformity.

2 m bed of a purplish-red weathering, dark red or violet-coloured, fine grained gently folded micaceous sandstone (a) which is transgressively overlain by a light-coloured polymictous conglomerate (b) of quite the same type as (1).

Surmounted by a whitish-gray fine-grained quartz sandstone showing red-purplish bedding planes (Rock as below (a)).

(2) Alternation between whitish conglomeratic beds, partially disclosing violet and red-coloured infiltrations, and of intensively red, purple, and violet-coloured, fine-grained thin-bedded muscovite sandstone layers. The whole sedimentation is evidently a cyclic one as the whitish conglomerates gradually pass upwards (minute alternations) into the stained sandstone member the lowermost portions of which may still contain some singular quartzitic pebbles. The purple muscovite-bearing quartz sandstone is often grading into an argillaceous and shaly one.

The contrast in colour of this alternate series is highly conspicuous. Dips ranging between 16° and 28° to the southwest were measured here.

¹⁾ According to the writer's surveys.

²⁾ Owing to the unfavourable conditions during the author's inspection of La Cours Bjærg (May, 1938) the very contact of this clastic sedimentary series of Lower Carboniferous age with the subjacent rocks could nowhere be observed.

The top bed consisting of 0.5 m hard banded gray-purplish partly argillaceous sandstone (3), rich in muscovite, is overlain by 2.5 m of a whitish coarse-clastic conglomerate (4) with densely crowded polymictous pebbles (embedded in a fine psephitic cement with ferruginous matter). Intercalations of obliquely-bedded sandstone. Passing upwards into a streaked sandstone (as (3)) which still bears polygenetic pebbles in its lowermost part.

After a set (5) of alternate light-coloured conglomerate and thin beds of whitish and purplish banded sandstone follows a layer of thin-bedded to shaly violet-purple quartz sandstone, rich in muscovite. This bed (6) grades downwards into a light-coloured conglomerate (as (1)) and passes upwards into an alternation (7) between red-purple fine-grained quartz sandstone (as (2a)) and whitish or light-gray psephite (as (1)).

The conglomeratic layers frequently carry flags of the underlying purple-violet coloured sandstone (Fig. 7) and, moreover, subordinate oval flat pebbles of fluvial origin as well as sharp-edged fragments of metamorphic rocks.

Interbeds and lenses of a brown-gray sandstone. Cross-bedding. Numerous cyclic repetitions of conglomeratic layers passing gradually into purple-coloured sandstone and (marked by a sharp boundary) again light-gray psephites etc.; the uppermost levels of the strongly coloured psammites may already contain pebbly nests.

The exposed thickness of this series, which is correlated with G. SÄVE-SÖDERBERGH'S "Upper Sandstone Complex" (Lower Carboniferous), here amounts to about 50 m (*vid.* Fig. 6).

From about 225 m altitude upwards this sedimentary sequence was still concealed beneath snow during the writer's survey, but slightly higher up the only exposures to be met with were those of crystalline rocks either *in situ* or in the large talus cones of La Cours Bjærg. Both banded amphibole-bearing gneiss disclosing beautiful gneissose parallel-texture and pink porphyritic granite build up the higher portion of this mountain.

However, in the ravine immediately to the west (joining the main river in the Gästisdal delta, *vid.* map Fig. 2) the conglomeratic series is still exposed between 290 m and 350 m altitude, having escaped erosion; for below as well as from 350 m height up to P. 840 m there are outcrops of gneiss and granite. The clastic beds show a dip of about 15° to the northwest and, consequently, abut against the crystalline rock wall of La Cours Bjærg. This, indeed, must lead to the conjecture of a fault contact.

Outcrops of a pink-coloured porphyritic granite were observed at a height of 280 m. At 300 m altitude a light-gray to whitish conglomerate with Caledonian pebbles (corresponding to member (1) in the foregoing

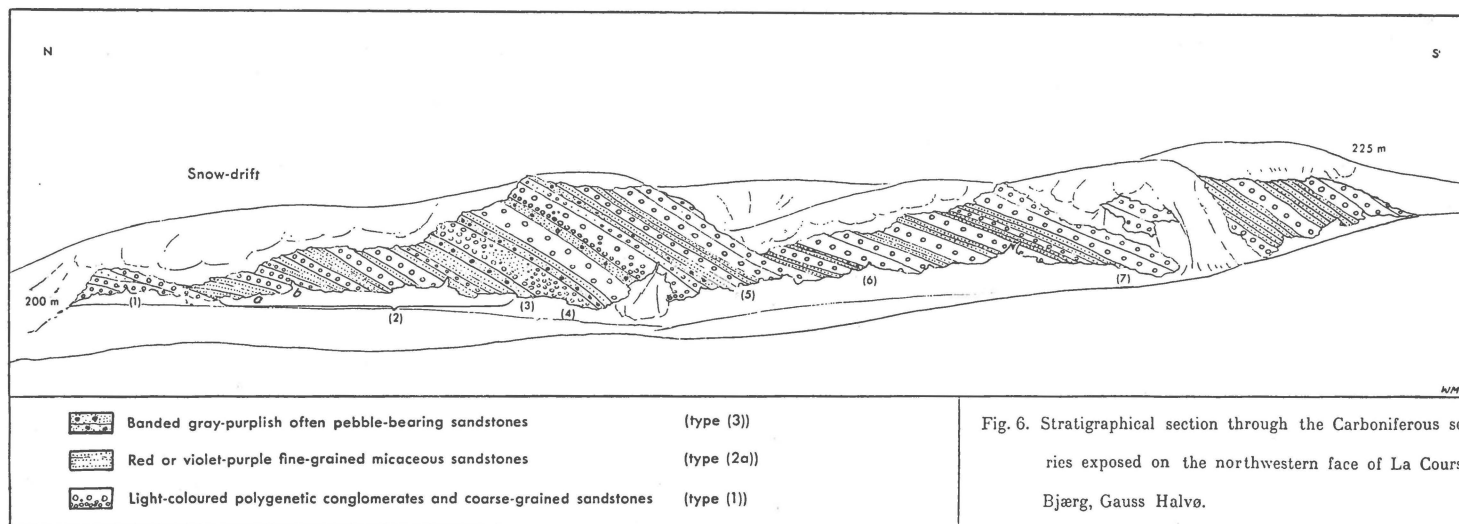


Fig. 6. Stratigraphical section through the Carboniferous series exposed on the northwestern face of La Cours Bjærg, Gauss Halvø.

Fig. 6.

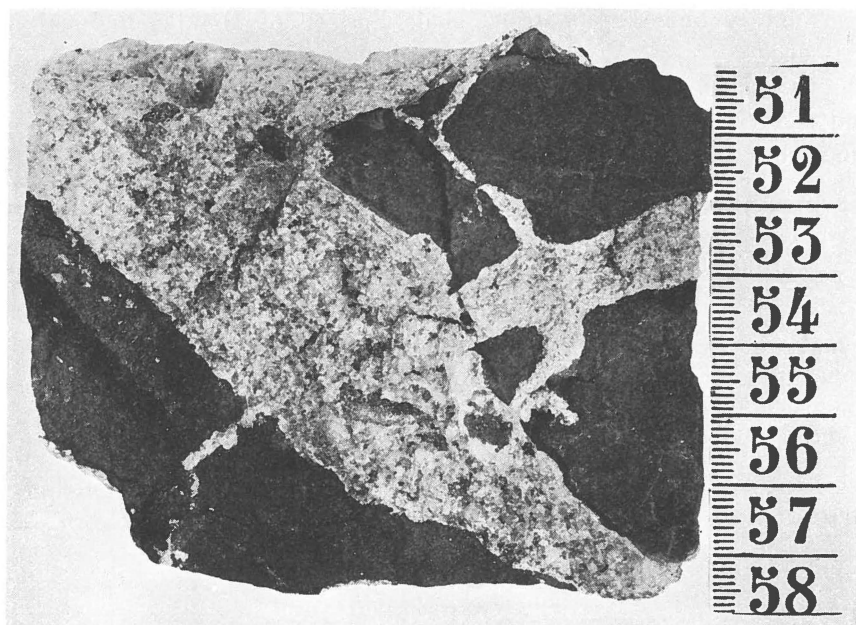


Fig. 7. Reworked slabs of purple sandstone in a whitish-gray quartz sandstone. Carboniferous La Cours Bjærg, Gauss Peninsula (lot 3031 coll. W. MAYNC).

section) was observed, which displays a dip of 12° to the northeast. Farther up follows the alternate series of light-coloured conglomerate and purple muscovite-bearing, partly argillaceous sandstone showing inconstant dips; the psephites with purple-coloured sandstone interbeds at 335 m altitude even disclose an almost horizontal position. In places the sedimentary series exhibits smaller fractures, faults, and flexures.

Gästisdal.

Since in the summer of 1936 H. BÜTLER had undertaken the study of the *pre*-Permian rocks in Gästisdal, I did not spend much time investigating the Gästisdal *graben* with its Carboniferous deposits.

From the delta of Gästis River (30 m) upwards outcrops of the cyclic Carboniferous series such as is exposed on the other side of Moskusoksefjord, *viz.* in Prospektal (*vid.* p. 34), are found up to the base of the transgressive marine Permian (MAYNC 1940, 1942).

A small anticline of these continental Carboniferous beds was observed in the valley at a height of 130 m. The lowermost exposed rock then projecting from the snow was a gray or yellowish rather fine-grained muscovite sandstone with a thin interbed of black-grayish carbonaceous sandy shale, rich in mica, which, however, rapidly wedges out between the sandstone members.

Slightly higher up another shale horizon of about 2 m in thickness occurs.

On following the creek cut in between Agassiz Bjærg (P. 1340 m) and the ice- and basalt-capped mountain north of Højsletten the Carboniferous formations were found to occur up to 740 m altitude¹⁾.

At 680 m¹⁾ light-coloured fine- to medium-grained sandstones with *Stigmara sp.*, *Sigillaria sp.* etc. alternate with thin horizons of black coaly shale and, furthermore, with layers of a pink or greenish-gray thin-bedded very sandy limestone.

These beds were measured to dip 24° to the southwest.

From 710 m a red-purplish fine-grained sandstone of Devonian aspect was met to 720 m¹⁾ with which is in turn overlain by 10 m of yellowish-gray sandstones (as below.)

At a height of 740 m the Carboniferous series is unconformably overlain (sharp jagged contact) by the overstepping basal conglomerate of the Upper Permian formations (*vid.* MAYNC 1940, 1942).

Prospektdal.

The whole sediment series exposed between Ankerbjærg and Høgboms Bjærg was referred by A. K. ORVIN, though with some reservation, to the Devonian, *viz.* to his "Middle Gray Sandstone series" and "Upper Red Sandstone series" (ORVIN 1930). The whitish-gray coarse sandstone occupying Prospektdal, with interbeds of black shale and coal, carrying plant-remains *i. a.* *Stigmara sp.*, was at first rightly correlated with the "Culm" (continental Carboniferous); however, as a red-coloured sandstone series was observed by A. K. ORVIN to overlie these formations²⁾ a parallelization with the Devonian was held inevitable (*op. cit.*).

The *post*-Devonian *graben* of Prospektdal-Gästisdal with its filling of continental Carboniferous deposits was mapped by H. G. BACKLUND (BACKLUND 1932).

According to H. BÜTLER a basal conglomerate of the Carboniferous series only occurs in the centre of the *graben* whilst younger Carboniferous beds overlap the western margin of the trough (BÜTLER 1938).

The Prospektdal *graben* was found to wedge out to the north between Salèvebjærg and Sernanders Bjærg (BÜTLER 1940).

The Carboniferous floras that were brought back by H. G. BACKLUND in 1930 from Prospektdal are referred to the Lower Carboniferous

¹⁾ According to the writer's surveys.

²⁾ In later years, however, H. BÜTLER recognized that the Devonian deposits east of Høgboms Bjærg do not normally succeed the Carboniferous sandstone series of Prospektdal; both formations are bounded by a set of faults en échelon (*vid.* BACKLUND 1932, BÜTLER 1935a, 1938).

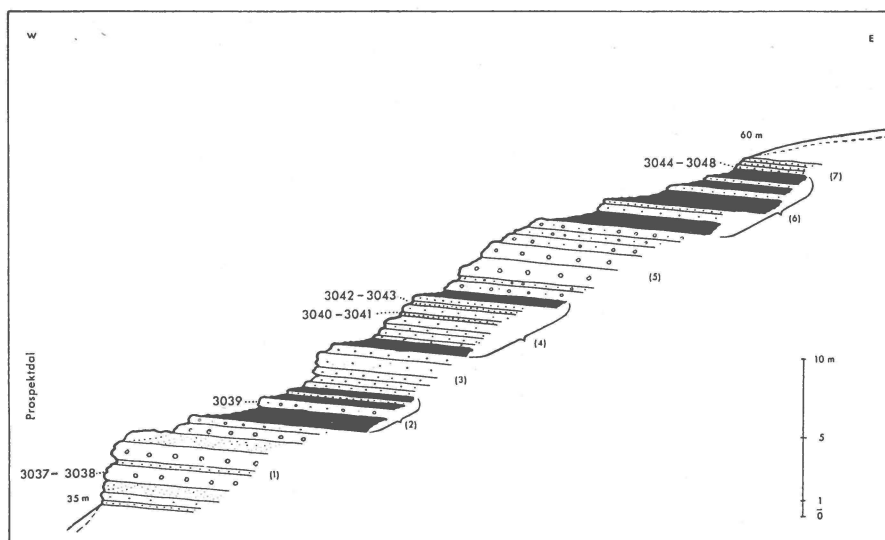


Fig. 8. Stratigraphical section through the Carboniferous formations in Prospektal, Hudson Land.

(Dinantian) and are stated by T. G. HALLE to be the best dated ones derived from East Greenland (HALLE 1931). The following forms are cited by T. G. HALLE:

Asterocalamites? sp.
Telangium bifidum (LINDL. & HUTT.) BENS.
Adiantites cf. bellidulus HEER
Lepidophyllum sp.
Stigmaria ficoides BRNGN.
 (HALLE 1931).

It is all the more remarkable, therefore, to learn through Professor T. G. HALLE himself¹⁾, that the plants collected in 1938 by the writer in one single section in Prospektal partly belong to the usual Dinantian ("Culm") flora of East Greenland but, on the other hand, contain genuine Namurian forms. Evidently, it is not altogether easy to make out on a mere phytopaleontological basis whether Dinantian or Namurian is represented.

As shown in the measured stratigraphical section (Fig. 8) there occur several horizons of gray or blackish carbonaceous shales and shaly sandstones (in black) containing the Namurian plant-remains. The intermediate light-coloured sandstones and conglomerates carry the "Culm" floras with, *inter alia*, *Stigmaria*, *Lepidodendron*, *Lepidophloios* and so on. Accordingly, we must assign the entire floras to the Namurian.

¹⁾ Communication of Professor, Dr. T. G. HALLE, Stockholm.

The following section was measured in Prospektal:

Débris and alluvial deposits.

- | | |
|-------------------------|---|
| 35 m above
sea-level | $\left\{ \begin{array}{l} \text{6 m white-yellowish coarse-grained, often cross-bedded sandstone,} \\ \text{with interlayers of light-gray conglomerate (often showing infil-} \\ \text{trations of red-coloured matter) the pebbles of which exclusively} \\ (1) \text{ consist of quartzites (diameter on an average 1 cm). Dip: } 10^{\circ} \text{ to} \\ \text{the southeast. } Stigmara ficoides \text{ BRNGN., } Sigillaria \text{ sp., } Calamites \\ \text{(?} Asterocalamites \text{) sp., } Lepidodendron \text{ sp. et cetera, often in large logs.} \\ \text{1 m interbed of black coaly sandy shale (a), and dark-gray mica-} \\ \text{ceous shaly sandstone.} \\ \text{0.8 m white fine-grained muscovite sandstone (b) with a few scattered} \\ (2) \text{ small-sized quartzite pebbles. Contains seams and flags of coal and} \\ \text{carbonized plant-remains.} \\ \text{1 m black sandy mica-bearing shale (c) with a 0.1 m thick interlayer} \\ \text{of light-coloured muscovite sandstone. Dip: } 8^{\circ} \text{ to the southeast.} \\ (3) \text{ 3 m white muscovite-bearing sandstone with carbonaceous matter} \\ \text{and plant-remains.} \\ \text{0.3 m dark-gray sandy shale (a) (as below).} \\ \text{0.1 m layer of reddish-brown streaked quartzitic sandstone (b).} \\ \text{3 m yellow-gray fine-grained micaceous calcareous sandstone (c)} \\ \text{with limonitic nodules (weathered pyrite). Carries an abundance of} \\ (4) \text{ fossil plant-remains.} \\ \text{Several thin interbeds of pink-gray sandstone and purplish-red} \\ \text{arkose sandstone carrying large muscovite flakes and carbonized} \\ \text{plant-remains.} \\ \text{0.5 m black sandy shale (d).} \\ (5) \text{ 5 m light-coloured coarse-grained sandstone or microconglomerate} \\ \text{with pea-sized quartzite pebbles.} \\ \text{0.8 m black or dark-gray sandy shale (a), rich in mica.} \\ \text{0.6 m well-stratified greenish-gray micaceous sandstone (b) with} \\ \text{inosculations of yellowish calcareous muscovite sandstone (as (4c)).} \\ (6) \text{ 2.7 m black-grayish slightly carbonaceous crumbling shale (c), rich} \\ \text{in muscovite, with interlayers (à 0.1 to 0.3 m) of light-coloured fine-} \\ \text{grained micaceous sandstone with fossil plant remains (as 4c)).} \\ 60 \text{ m} \\ (7) \text{ 1 m yellowish fine-grained sandstone, rich in mica, with numerous} \\ \text{plant-remains e. g. } Telangium bifidum \text{ (L. \& H.) BENS., } Adiantites \\ \text{sp., } Lepidodendron \text{ sp., } Stigmara cf. ficoides \text{ BRNGN. et cetera.} \end{array} \right.$ |
|-------------------------|---|

Covered with débris.

Slightly higher up in the valley, viz. at a height of 70 m (own surveys),

black, sometimes marly shales with polished carbonaceous bedding planes are exposed which alternate with yellow or whitish sandstones (psephitic interlayers).

The series is gently undulated.

Still farther up, near the river-fork at an altitude of 160 m,

greenish-gray quartzitic sandstones and light-green or pinkish sandstones with sparse coal crop out the dips of which vary greatly.

Sometimes the rock is torn and even displays mylonitization (fractures healed up with calcite).

At 180 m height

white or sometimes slightly pinkish sandstones were observed.

From 200 m upwards numerous outcrops of rocks were found which may be referred to the *pre*-Carboniferous basement: Red-purplish shales and sandstones, hard varicoloured breccias (buff-coloured angular fragments of limestone embedded within a red silty matrix), greenish shales, sandstones and so forth.

This formation of ?Devonian age has undergone considerable foldings whilst the Carboniferous series merely discloses weak undulations.

The Carboniferous sediments exposed in the coastal cliff between Loch Fyne and Cape Stosch.

In 1927 LAUGE KOCH discovered a small exposure of *pre*-Cambrian "Eleonore Bay Formation" L. KOCH 1927 at the mouth of Loch Fyne (eastern shore), which he found to be overlain by red, green, and yellow, partly cross-bedded sandstone with intraformational conglomerates. These northeast or east dipping sediments were referred by L. KOCH to the Devonian and correlated with the conglomeratic formation exposed between Cape Stosch and Finsch Islands¹⁾ (KOCH 1929a).

According to O. KULLING these dark red series bears a great resemblance to the Devonian "Upper Red Sandstone series" (member (6) of O. KULLING's standard section, *vid.* KULLING 1929). The conglomerate¹⁾, which he recorded to overlie unconformably the Devonian series, is compared by O. KULLING to the psephitic formation building up the Hallebjærgene, western portion of Clavering Island²⁾ (KULLING 1929), whereas A. ROSENKRANTZ refers it to the "Mt. Pictet Formation" (NATHORST 1911) L. KOCH 1929 of the Lower Carboniferous (ROSENKRANTZ 1930).

According to A. K. ORVIN the beds cropping out along the shore between Cape Stosch and Loch Fyne would correspond to his Devonian "Lower Gray Sandstone series" which is e. g. exposed on either side of Moskusoksefjord and in Cape Graah (= H. BÜTLER's "Cape Kolthoff

¹⁾ This conspicuous conglomerate that rests upon the gneissic basement on Stille Island (Finsch Islands) was, however, proved by the writer to be the basal conglomerate of the transgressive Upper Permian (Zechstein) beds (*vid.* MAYNC 1939, 1940, 1942).

²⁾ This "Halle Mountains Formation" (SÄVE-SÖDERBERGH 1934) of western Clavering Island, however, is presumably of Namurian age (*vid.* KULLING 1929, HALLE 1931, MALMQVIST 1932).

and Cape Bull series"). The red sandstone formation of the Passagehøje, Hudson Land, on the other hand, is referred by A. K. ORVIN to his "Lower Red Sandstone series", which is more or less identical with the "Cape Graah series" of H. BÜTLER (ORVIN 1930).

The investigations of L. KOCH in 1930—1931 proved that this brick-red Devonian series composing the coastal cliff is bounded by a fault which separates it from the Carboniferous-Permian deposits (KOCH 1931). These red coarse-grained sandstones, displaying cross-bedding, ripple marks, and sun-cracks, with thin conglomeratic interbeds is now stated by L. KOCH (*ibid.*) to closely resemble his Devonian member (8) of the Margrethedal area.

There is, however, no doubt that the red sandstone formation between Cape Stosch and Loch Fyne corresponds to the continental Carboniferous series of the Passagehøje¹) (Hudson Land) on the other side of Loch Fyne, the fossil floras of which most probably point to a Namurian age (*vid.* HALLE 1931, BACKLUND 1932, SÄVE-SÖDERBERGH 1934, BACKLUND & MALMQVIST 1935, VISCHER 1943).

West of the Norwegian hut "Krognæs" the fault contact between the red-coloured Namurian beds and the basal conglomerate of the Permian (olim Carboniferous) is exposed (*vid.* VISCHER 1939, 1943).

These Carboniferous deposits, which had hitherto been taken to be Devonian, are represented here by strongly red-coloured friable, micaceous, often cross-bedded sandstones, sometimes bearing red clay galls and scattered small crystalline pebbles. Locally interbedded layers of coarse psephites occur. Interbeds and lenses of light-coloured harder sandstone give rise to the banded character of the exposed series.

Near "Krognæs" a gentle general dip to the north-northeast was observed but also horizontal beds as well as dips to the west were recognized. The disturbed sedimentation, evidenced by the frequent facial changes is, moreover, enhanced by *pre*-diagenetic slidings and local foldings which may be obliquely cut by the overlapping formations.

Near the cape to the north of the Norwegian hut "Villaen", Loch Fyne, red-coloured arkoses and sandstones crop out which contain interlayers of black or dark-brown crumbling sandy shales and, furthermore, thin interbeds of a grayish or pink to brick-red, breccious-nodulous marl and limestone with singular red or green clay galls.

Immediately north of the hut "Villaen" the series shows an obvious cyclic character: Red-coloured shales and shaly sandstones are here overlain by a coarse polymictous conglomerate (with boulders attaining the size of a head) that grades upwards into arkoses and sandstones;

¹) Formerly referred to the Devonian Old Red molasse (KOCH 1929a, BACKLUND 1930).

these in turn pass again into red thin-bedded argillaceous sandstones and brick-red or purplish sandy shales (as below) and so on.

Confessedly, these beds might easily be taken to be Devonian were it not for the fact that the Carboniferous series building up the Passagehøje, west of Loch Fyne, shows the greatest resemblance. Also the Namurian formations occupying the western portion of Clavering Island (*vid.* KULLING 1929, MALMQVIST 1932) closely recall the beds exposed on the east side of the mouth of Loch Fyne.

The pinkish limestone nodules observed within the cliff's series immediately north of "Villaen" may be supposed to have been laid down as some limy ooze, i. e. as nearshore marine or lacustrine deposits. It is not out of place to assume that fossil fish-remains may be found here such as have been discovered in the Carboniferous sediments (limestone concretions, marls) on Traill Island, Scoresby Land, and western Jameson Land (STAUBER 1938, 1939, 1940, BIERTHER 1939, 1941). However, since it was my task to study chiefly the Permian and Mesozoic formations of this region, not much time was devoted to search for fossils here.

III. OUTLINE OF THE GEOLOGY AT THE HEAD OF MOSKUSOKSEFJORD

Although my own investigations in 1938 were not extended across the fjord into Hudson Land (with the exception of a rough survey of the Carboniferous series in Prospektal) it is quite impossible to dispense with a brief statement of the geological features of this region. To be sure, there is not even the slightest doubt that the abundance of new important criteria that have been advanced by the pioneer researches of H. BÜTLER during the past years have furnished the very clue for the understanding of the *post*-Caledonian/Devonian history of East Greenland.

Another key position with regard to the Devonian stratigraphy is held by Ymer Island with the classical locality of Cape Graah.

Since the Giesecke Mountains are situated just between these two paradigmatical areas occupied by both sediments and igneous rocks of Devonian age, a detailed investigation would be thoroughly justified. At present, however, we have to content ourselves with the deficient data at hand which, none the less, permit to point out some similarity or other as well as certain tentative correlations.

According to LAUGE KOCH's geological map the head of Moskusoksefjord is occupied on either side by "Caledonian?" granite and Tertiary basalts (KOCH 1929a). The former was at first held to be "*post*-Devonian batholites and laccolites, possibly of Tertiary, but most likely of Carboniferous age" (*ibid.*, p. 73). However, L. KOCH subsequently recognized a gradual transition from certain gneisses in Moskusoksefjord into hardly metamorphic sediments of the "Eleonore Bay Formation" L. KOCH 1927 and on account hereof assigned those granitogneisses to the Caledonian complex. L. KOCH also rightly interpreted the metamorphic rocks cropping out in the core of the so-called "Muskox inlier" (WORDIE 1927), near the fjord's mouth, as belonging to the Caledonian cycle (*op. cit.*).

It would take us too far, indeed, to compile here a summary digest of H. G. BACKLUND's eminent researches in the East Greenland Cale-

donides (BACKLUND 1930, 1932). Suffice it to point out the main features.

The Caledonian crystalline, composed of more or less migmatitized sediments of the "Eleonore Bay Formation" L. KOCH 1927 and of syntectonically intruded granites and granitogneisses, crops out in Ladderbjærg, La Cours Bjærg, Ankerbjærg, Nordhoeks Bjærg *et cetera*¹).

Owing to hybridization there is, obviously enough, a great diversity in the rocks resulting from palingenesis and migmatitization: Banded amphibole-bearing gneiss, garnetiferous gneiss *etc.* which may gradually pass into pink-white granite or porphyritic granite. However, mention is also made of younger granitic intrusions which, too, are brought into relationship with the Caledonian orogeny ("*post-kinematic intrusions*").

In Nordhoeks Bjærg e. g. H. G. BACKLUND reports the quartzites and phyllites of the "Eleonore Bay Formation" L. KOCH 1927 to be cut by granitoporphyrific and quartzporphyritic veins and dykes. In the southern part of the mountain where the Caledonian sediments have partly turned into garnet-bearing gneiss a pinkish to white granite has intruded into the country rock (BACKLUND 1930, 1932). This granite is considered by H. G. BACKLUND to be an abyssal facies of the porphyritic granite occurring farther to the north. Intrusions of granite and porphyritic veins, carrying xenoliths of the country rock, also cut the steeply tilted Caledonian sediments in Ankerbjærg (*op. cit.*).

H. G. BACKLUND, moreover, recorded extrusive rocks in Högboms Bjærg, namely "brick-red and bright yellow, somewhere white, highly variegated liparitic lavas and quartz porphyries together with their volcanoclastics" (BACKLUND 1930, p. 264). Mentioned are e. g. red to purplish felsitic quartz porphyries with phenocrysts of anorthoclase-albite and quartz; pinkish spherulitic quartz porphyries and so on. Similar rocks, which are designated by H. G. BACKLUND as "quartz keratophyries" and which he takes to be "effusives of the Caledonian evolution phase", occur also in Sederholms Bjærg, Gauss Peninsula (BACKLUND 1932). Apart from these acidic outflows and hypabyssal magmatics H. G. BACKLUND described basic, namely spilitic, rocks from Högboms Bjærg (*op. cit.*).

It was A. K. ORVIN who first suggested a Devonian age for the granitic rocks (or at least part of them) in Moskusoksefjord as he observed quartzitic sandstones, presumably of Devonian age²) ("*Middle*

¹) The exposures of supposed Caledonian rocks (*vide* H. G. BACKLUND) e. g. in Ramsays Bjærg, Högboms Bjærg, Sernanders Bjærg *etc.* have later on turned out to be *intra-Devonian* magmatics (*vid.* BÜTLER 1935, 1938, 1939, 1940).

²) The broad valley west of Ankerbjærg, where A. K. ORVIN found a whitish-gray sandstone with partings of black shale and coal seams, has later been named Prospektal. This series is not of Devonian age as assumed by the Norwegian

Gray Sandstone series" of A. K. ORVIN), which in Högboms Bjærg had been invaded by a granite (ORVIN 1930). In addition he encountered several granitic veins cutting the sandstone formations west of Ankerbjærg. Because of the obvious igneous contacts with exomorphic influences A. K. ORVIN assigned those acidites to the Devonian, consequently. H. G. BACKLUND, on the other hand, is unwilling to accept such an age assignment with all its consequences (BACKLUND 1932).

The exhaustive survey of the Devonian between Traill Island and Ole Rømer Land/Hudson Land carried out in a masterly way by H. BÜTLER since 1933 has proved *i. a.* that a large portion of the acidic rocks occurring in Moskusoksefjord is, indeed, of Devonian age (BÜTLER 1935a, 1935b, 1938, 1939, 1940).

As the *sub*-Devonian (Caledonian) basement rises steadily from Franz Josephs Fjord to the north, the oldest series of the Devonian molasse crop out in the area of Moskusoksefjord and Hudson Land (BÜTLER *op. cit.*). The lowermost Devonian deposits have been laid down upon an erosion surface of the worn down Caledonian mountain range (*vid.* KOCH 1929a, KULLING 1929, BÜTLER 1935, WEGMANN 1935). Great thicknesses of psammitic material accumulated and the bottom of the Devonian molasse basin underwent a considerable subsidence. This sinking tendency, however, was not a continuous regular one but was periodically interrupted by orogenetic movements. The Devonian is, consequently, a typical synorogenetic formation which attains a thickness of 8000—9000 m (BÜTLER 1935b). H. BÜTLER has shown that the pile of Devonian deposits in Moskusoksefjord may be subdivided into different orogenetic cycles in such a manner that each younger series overlies unconformably the denuded folds of the lower one; the basal conglomerate of the following transgressing series carries pebbles arisen from the subjacent Devonian series. H. BÜTLER thus arrived at the following stratigraphical subdivision of the Devonian into 5 orogenetic cycles (see table on pp. 42—43, extreme right).

Furthermore, H. BÜTLER's researches clearly showed that the dykes of quartz porphyries (rhyolites) and spilites in the region of Högboms Bjærg-Ramsays Bjærg, which H. G. BACKLUND had designed as "quartz porphyries" of *pre*-Cambrian age (*vid. sup.*), are *intra*-Devonian (BÜTLER 1935a). These extrusive sheets occurring within the sandstone formation

explorer, but must be referred to the Carboniferous (*vid.* p. 32 ff.). By the way, A. K. ORVIN himself has laid emphasis upon its striking resemblance to the "Culm" beds of Spitsbergen (in *loc. cit.*). However, the white-gray sandstone which is stated to have undergone contact metamorphism (*vid. sup.*) occurs slightly farther to the west and may, accordingly, well be of Devonian age. On the other hand, the detailed investigations of H. BÜTLER have brought in evidence of rhyolitic rocks which, indeed, cut the Carboniferous formations in Prospektal and which are thus, in other words, *post*-Devonian (BÜTLER 1939, RITTMANN 1940).

("Cape Kolthoff series") are visibly cut by the basal conglomerate¹⁾ of the "Cape Graah series" of H. BÜTLER that rests unconformably upon the steeply inclined lower Devonian series. This overstepping conglomerate carries reworked pebbles of the subjacent rhyolitic rocks (*op. cit.*). That the magmatic activity in Moskusoksefjord did not come to a standstill locally is proved by the occurrence of a quartz porphyry dyke in Sederholms Bjærg which also cuts the folded red, tuff-bearing "Cape Graah series". In Prospektal and in La Cours Bjærg even *intra*-Carboniferous (*pre*-Permian) rhyolites were ascertained by H. BÜTLER (BÜTLER 1939)²⁾.

It has turned out that not merely the Devonian sediments and their magmatics were laid bare and eroded because of the *intra*-Devonian orogenetic movements ("Hudsonland phases I—IV") but locally even the Caledonian bed-rock became stripped and could, accordingly, supply pebbles for the succeeding conglomerates. Owing to the persisting tectonic movements the Caledonian socle did not remain a rigid dead-folded mass but became mobilized and compressed to some extent. Warpings and upthrusts of Caledonian "tumours" led to a piercing and disruption of the Devonian roof³⁾. The protruding Caledonian wedges thus became subjected to erosion and could furnish pebbles to the younger Devonian series (BÜTLER 1935, 1937, 1939). According to H. BÜTLER Nordhoeks Bjærg, Ankerbjærg, La Cours Bjærg, Ladderbjærg *etc.* represent such *intra*-Devonian uplifts and thrusts. As a consequence of those movements of the Caledonian basement also parts of the Devonian mantle became disturbed as is for instance borne out by the upthrust of the "Högbom series" over the younger "Cape Graah series" during the Hudsonland phase IV (BÜTLER 1938, 1939, 1940). On the other hand, the *mise-en-place* of the crystalline of the Nørlund Alps, Hudson Land, is shown by H. BÜTLER to fall into his "Hudsonland phase III"; for both the "Cape Bull series" and the "Cape Kolthoff

¹⁾ Referred by H. G. BACKLUND with all reserve to the *sub*-Cambrian "tillite series" (BACKLUND 1932).

²⁾ In 1932 C. TEICHERT had discovered a porphyritic breccia (fragments of a reddish porphyry embedded within a greenish tuffaceous groundmass) near the Norwegian hut "Hoelsbu", east of the "Muskox inlier" in Moskusoksefjord. As this igneous rock was observed to cut the exposed Devonian sandstone formations C. TEICHERT classed it as *post*-Devonian. Slightly to the east greenish tuffs were moreover recorded being covered by flows of fluidal glassy porphyries (TEICHERT 1933). However, H. BÜTLER later proved that these extrusive rocks near "Hoelsbu" clearly occur below his "Cape Graah series" and must, therefore, be equivalents of the *intra*-Devonian quartz porphyries (rhyolites) exposed in the region of Högboms Bjærg (*vid. inf.*).

³⁾ These Caledonian "nuclei", squeezed by the Devonian foldings into the core of *intra*-Devonian anticlines (e.g. the "Muskox inlier"), fully correspond to E. ARGAND'S "*pli de fond*" (comp. BÜTLER 1935a).

Stratigraphical subdivisions of the Devonian

		O. KULLING 1929	A. K. ORVIN 1930
(? Middle) Upper Devonian	Carboniferous		
	~~~~ Ymer Ø phase ~~~~~		Upper Gray Sandstone series
		Upper Red Sandstone series	Upper Red Sandstone series
		Greenish-gray Sandstone series	Middle Gray Sandstone series
	~~~~ Hudsonland phase IV ~~~~~		
		Midmost Red Sandstone series	Lower Red Sandstone series
	~~~~ Hudsonland phase III ~~~~~		
	Main phase of volcanic activity	Gray Sandstone series	
	~~~~ Hudsonland phase II ~~~~~		Lower Gray Sandstone series
	~~~~ Hudsonland phase I ~~~~~	Lower Red Sandstone series	
		Basal conglomerate	
Stratigraphical gap comprising Ordovician ("Narhval Sound			
Caledonian			

series" (which here succeed one another conformably) were folded because of the upthrust of the Nørlund crystalline and are unconformably overstepped by H. BÜTLER's "Cape Graah series" (BÜTLER 1940). The steep tilting of the lowermost Devonian series near the mouth of Moskusoksefjord is due to the displacement of the so-called "Muskox inlier" and would correspond to the "Hudsonland phases I and II" (BÜTLER 1939).



“Old Red” molasse in East Greenland.

G. SÄVE-SÖDERBERGH 1934	H. BÜTLER 1935	Thickness
Upper Sandstone Complex <i>Arthrodire</i> Sandstone	Continental Carboniferous	about 2000 m
	Mont Celsius series (gray sandstones and conglomerates)	about 1500 m
<i>Remigolepis</i> series		
<i>Phyllolepis</i> series (“Lower Sandstone Complex”)	Cape Graah series (red sandstones and tuffs; basal conglomerate)	max. 1400 m
	Cape Kolthoff series (gray and red sandstones; conglomerate 3. east of “Muskox inlier”)	Up to 5000 m
	Cape Bull series (gray sandstones) conglomerate 2. at “Muskox inlier”)	
	Basis series (gray and red sandstones) conglomerate 1. at “Muskoxinlier”)	
Basal conglomerate (“Björne Ø conglomerate” C. TEICHERT 1933)		more than 1000 m

Formation” CH. POULSEN 1930) to Lower (or Middle) Devonian

basement

On the basis of the paleontological facts evidenced by the prominent work of E. STENSIÖ and G. SÄVE-SÖDERBERGH the four lower Devonian cycles of H. BÜTLER would entirely correspond to the “*Phyllolepis* series” of the ?Upper Devonian. G. SÄVE-SÖDERBERGH’s “*Remigolepis* series”, “*Arthrodire* Sandstone”¹⁾, and “Upper Sandstone Complex¹⁾

¹⁾ The “*Arthrodire* Sandstone” is overlain e. g. in Celsius Bjærg by the unfossiliferous brick-red or mottled sandstones of G. SÄVE-SÖDERBERGH’s “Upper

which are included into H. BÜTLER's "Mont Celsius series" would thus be younger than any known deposits of the Devonian "Old Red" (*vid.* SÄVE-SÖDERBERGH 1934, BÜTLER 1935b). It must be borne in mind, however, that only the upper portion of the "*Phyllolepis* series" is proved by vertebrate fossils to be Upper Devonian in age whereas in its lower part, *viz.* in H. BÜTLER's "Cape Kolthoff series", "Cape Bull series", and "Basis series", no determinable fossils have hitherto been found (*vid.* ORVIN 1930, SÄVE-SÖDERBERGH 1934, BÜTLER 1935b, 1939). There is even reason to assume that these lower series may be of Middle Devonian age (*vid.* BÜTLER 1935a, 1939) and that the embedded eruptive rocks not only in their chemical-mineralogical composition but also with regard to their age correspond to those of the "Cape Fletcher series" of Canning Land and Wegener Peninsula (BÜTLER 1935a, 1937, 1939).

The great petrological resemblance between the Devonian acidites in Moskusoksefjord and those of the "Cape Fletcher series" occurring below the Middle Devonian sediments (G. SÄVE-SÖDERBERGH) is also pointed out by A. RITTMANN who has devoted a special paper to the Devonian igneous rocks in Moskusoksefjord (RITTMANN 1939, 1940, *vid. inf.*). With regard to the facies both the lower portion of the "*Phyllolepis* series" in the north and the Middle Devonian formation of Canning Land in the south also show a striking similarity (BÜTLER 1939, 1940). It is much to be hoped that the fish-remains found by TH. HEINRICHSON in the Devonian basal conglomerate on Ella Island will allow a definite age assignment of this lowermost portion of the Devonian molasse. According to a recent communication of Dr. H. BÜTLER the Devonian basal conglomerate is to-day dated by the invertebrate-paleontologists as Upper Devonian, however.

In the following pages A. RITTMANN's thorough study on the Devonian eruptive rocks in Moskusoksefjord (= "Mont Högbom series" of H. BÜTLER 1937) will be epitomized, which will prove necessary for a comparison with the acidites occurring at Cape Franklin and in the Giesecke Mountains.

Högboms Bjærg which H. G. BACKLUND had interpreted as an up-thrust Caledonian element (BACKLUND 1932) was proved by H. BÜTLER to be composed of a Devonian sandstone series (BÜTLER 1935a). This

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Sandstone Complex" (SÄVE-SÖDERBERGH 1934). According to T. G. HALLE the plant-remains derived from the "*Arthrodire* Sandstone" already bear a "Culm" stamp. If this conjecture holds good, both "*Arthrodire* Sandstone" and "Upper Sandstone Complex" are of Carboniferous age. H. BÜTLER, on the other hand, still refers these series to the Upper Devonian because they occur well beneath the marked unconformity at the base of the Carboniferous system (BÜTLER 1935b).

gray series, which in the stratigraphical sequence established by H. BÜTLER occurs beneath the "Cape Graah series", is invaded by eruptive rocks such as granophyries, quartz porphyries, and diabases (*op. cit.*); most probably it corresponds to the "Cape Kolthoff series", however, and it is not at all improbable that it may turn out homotaxial with the Middle Devonian "Cape Fletcher series" known from Canning Land and Wegener Peninsula (*vid. sup.*).

The hypabyssal plutonite which has intruded into the gray Devonian series of Högboms Bjærg (compare also A. K. ORVIN 1930) is represented by a brick-red fine- to medium-grained aplitic granite, sometimes disclosing a porphyritic texture (idiomorphic orthoclase and albite frozen into a runitically intergrown feldspar-quartz matrix). Both the red alkali granite that was found to have intruded into the quartzites of the "Eleonore Bay Formation" L. KOCH 1927 in Parkinsons Bjærg, Hudson Land, and the red-salmon aplitic alkali granite cutting the crystalline rocks slightly farther north in Granite Valley¹⁾ or Dybendal²⁾ belong to the laccolithic granite body of Högboms Bjærg. Also the thick dyke of aplitic granite which has cut the Devonian sandstones on the northeastern slope of Sederholms Bjærg is considered part of the Högbom plutonite (RITTMANN 1940). Whether or not the coarse-granular alkali granitoporphyry (with large phenocrysts of reddish microcline and orthoclase), which forms an intrusive sheet of considerable thickness within the Caledonian quartzites of Salèvebjærg³⁾, is genetically related to that granite intrusion has not yet been established with certainty.

In dykes and apophyses and near its contacts with the country rock the Högbom granite displays a marginal-hypabyssal facies, *viz.* grades into a red to salmon-coloured alkali rhyolite that often shows a spherulitic texture and in this case is completely identical with the spherulitic quartz rhyolite of Cape Franklin (*vid. p. 14 ff.*). It may be stressed that quite indistinguishable pebbles of that spherulitic alkali rhyolite were found by H. BÜTLER in the basal conglomerate of the "Cape Graah series", west of Högboms Bjærg and in Sederholms Bjærg (*vid. RITTMANN 1940*).

East of Högboms Bjærg H. BÜTLER found another *intra*-Devonian granite with ramifying sills. This rock which has intruded into the same Devonian series as the Högbom plutonite (*vid. sup.*) is characterized as a red-gray rather fine-grained granite with xenoliths. However, its chemical-mineralogical composition obviously differs from that of the Högbom granite as the former is more basic and must be derived from

¹⁾ Name given by H. G. BACKLUND (BACKLUND 1932).

²⁾ Nomenclature of H. BÜTLER (BÜTLER 1940).

³⁾ Salèvebjærg is the name given to the mountain situated between Ankerbjærg and Parkinsons Bjærg, east of Sernanders Bjærg, Hudson Land (BÜTLER 1940).

a more "pacific" engadinitic-granitic magma. Its marginal facies is marked by alkali rhyolites such as occur in Ramsays Bjærg, Sederholms Bjærg, and Karins Dal, Gauss Peninsula, in other words, by the extrusive rocks which H. G. BACKLUND had formerly described as quartz keratophyries¹⁾ of *pre-Cambrian* age (BACKLUND 1930, 1932). Their mode of occurrence, however, clearly shows that they represent *intra-Devonian* effusives. Such an alkali rhyolite derived from Ramsays Bjærg is e. g. characterized by small phenocrysts of quartz and sanidine frozen into a brick-red dense extra-telluric fraction (porphyritic texture). A. RITTMANN's study has shown that also the sheets of alkali rhyolite and the obsidian-like surface flows occurring in the surroundings of the Norwegian hut "Hoelsbu", near the mouth of Moskusoksefjord (*vid.* footnote 2 on p. 41) belong to that group of extrusive rocks. As pebbles of these very same alkali rhyolites are stated by H. BÜTLER to be represented in the "Cape Graah conglomerate", the relative age of both these rhyolites and the enclosing Devonian sandstone series is therefore fixed to a certain extent: They are older than the "Cape Graah series", of course, and may be referred in all probability to the "Cape Kolthoff series" which, to be sure, is proved to be largely invaded by hypabyssal magmatics, lava flows, and pyroclastics. According to A. RITTMANN's statement the granitic rocks occurring east of Högboms Bjærg display an almost identical composition to the acidic eruptives of the "Cape Fletcher series" (RITTMANN 1940).

In the region of Moskusoksefjord there occur, besides, rhyolitic rocks evidently of *post-Devonian* age (BÜTLER 1939, 1940, RITTMANN 1940). The Carboniferous deposits filling up the *graben* in Prospektal are cut by a dyke of alkali rhyolite which petrologically greatly resembles the brick-red felsitic alkali rhyolite (D. MALMQVIST's "Quartz rhyolite") that was found to cut the "Cape Graah series" in Sederholms Bjærg (BÜTLER 1935a). The rhyolite in Prospektal, moreover, is distinctly similar to the alkali rhyolite with phenocrysts of quartz and sanidine that has invaded the crystalline of La Cours Bjærg, Gauss Peninsula. It should, however, be borne in mind that already H. G. BACKLUND described a "red granite" from La Cours Bjærg which was supposed to be older than the Caledonian intrusive acidites (BACKLUND 1932). This aplitic alkali granite with its rather high content of silica and magnesium clearly differs from the average composition of the *intra-Devonian* hypabyssal magmatics. Evidently, it has undergone considerable mechanical deformations. It is most probable that this rock was originally a younger alkali rhyolite ("quartz rhyolite") of the previous type (RITTMANN 1940).

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¹⁾ As the effusives concerned are lacking in sodium A. RITTMANN prefers the term "alkali rhyolite" instead of "quartz keratophyry" (RITTMANN 1940).

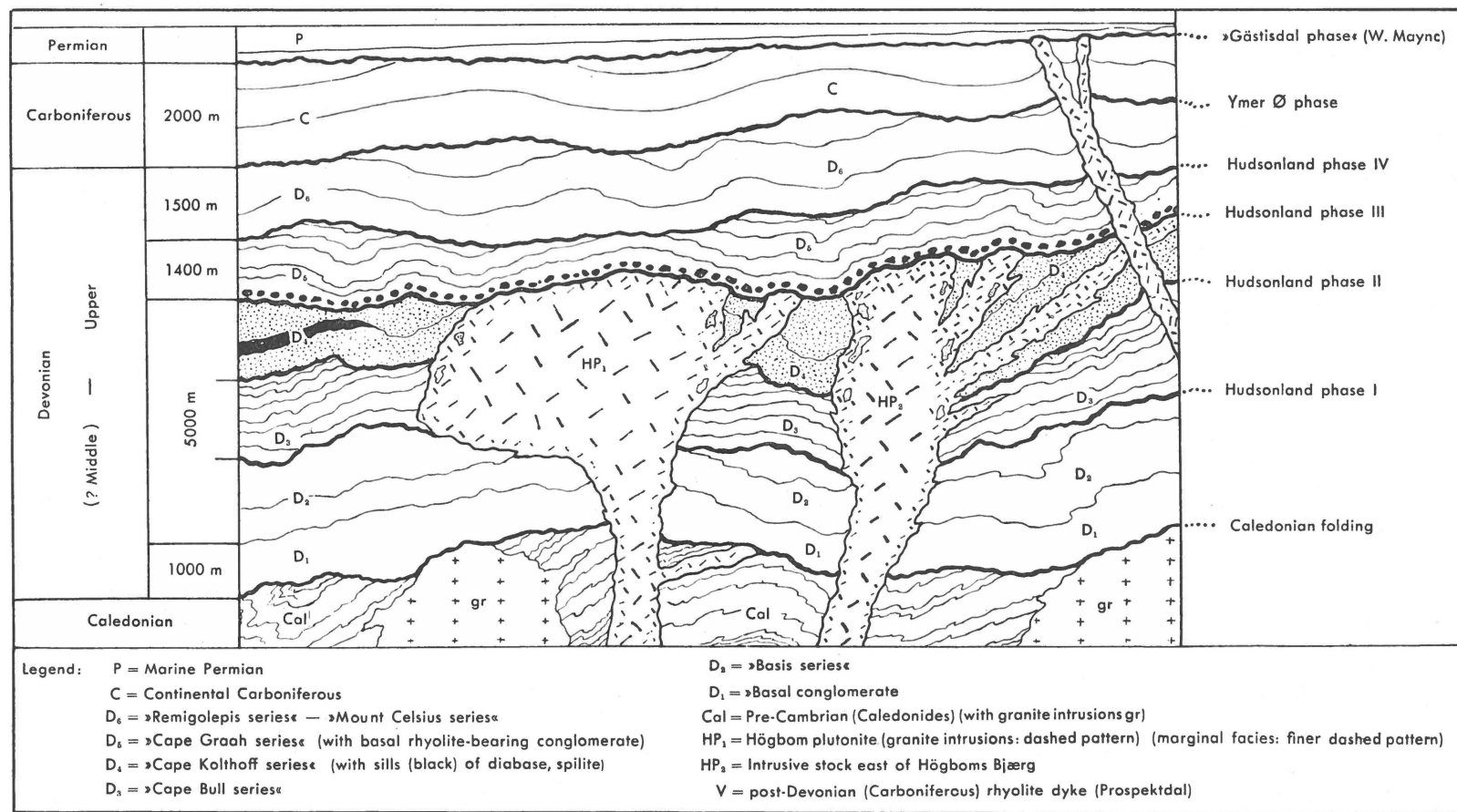


Fig. 9. Diagram illustrating the mode of occurrence of the intra-Devonian (and Carboniferous) igneous rocks, and their relations to the enclosing sedimentary series (orogenic cycles) in the region of Moskusoksefjord, East Greenland. (After H. BÜTLER and A. RITTMANN).

#### IV. REMARKS ON THE GEOLOGY OF YMER ISLAND (CAPE GRAAH)

The stratigraphical section set down by L. KOCH at Cape Graah¹), northeast corner of Ymer Island, displays a set of gray and pink sandstones which is followed by a thick dark-red conglomerate that passes upwards into gray-green and red sandstones (KOCH 1929a). The conspicuous red-coloured conglomerate is reported to carry well-rounded boulders (up to 0.1 m in diameter) derived from the subjacent Devonian formations; also Caledonian quartzites are represented (*op. cit.*).

In 1929 A. K. ORVIN made his successful investigation in the Devonian beds of Ymer Island and Moskusoksefjord (ORVIN 1930). About 10 km northwest of Cape Graah remains of *Placodermi*²) were discovered. From the very cape a gray plant-bearing sandstone is mentioned (= "Lower Gray Sandstone series") which is overlain by the "Lower Red Sandstone series"; the Upper Devonian age of the latter could be definitively proved by the finding of scales belonging to *Holoptychius nobilissimus* AGASS. (A. SMITH WOODWARD).

L. KOCH's red conglomerate (*vid. sup.*) occurs beneath this fossil-bearing red sandstone series, and A. K. ORVIN suggested the possibility that a stratigraphical hiatus and unconformity might mark the boundary between these "Lower Gray Sandstone series" and "Lower Red Sandstone series".

According to A. K. ORVIN the Devonian beds at Cape Graah are decidedly lower in the stratigraphical sequence than those cropping out in the eastern part of Gauss Peninsula and at Cape Franklin (in *loc. cit.*). On the other hand, the "Lower Gray Sandstone series" of Cape Graah is indicated on his map to occur along the coasts of Moskusoksefjord where it is also succeeded by the "Lower Red Sandstone series" (ORVIN 1930).

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¹) Type locality for the now abandoned term "Cape Graah Formation" (NATHORST 1899) L. KOCH 1929 for the deposits of the whole Devonian system (KOCH 1929b).

²) *Phyllolepis orvini* HTZ., *Bothriolepis groenlandica* HTZ., *Holoptychiidae* (ORVIN 1930, HEINTZ 1930).

In the same summer O. KULLING, too, carried out *i. a.* a survey of the Devonian strata on Ymer and Traill Islands (KULLING 1929). The beds exposed slightly to the west of Cape Graah were designated as the "Midmost Red Sandstone series" (= "Lower Red Sandstone series" of A. K. ORVIN), and conglomeratic layers are reported to occur both at the base (arkoses) and at higher levels of this series. While feldspar fragments and granitic pebbles chiefly compose the lower psephites, quartzites and gneisses derived from the "Eleonore Bay Formation" L. KOCH 1927 are represented within the upper conglomerates. In the top beds of the series, which attains a thickness of more than 1000 m, fine-grained red sandstones exhibiting cross-bedding, mud-cracks etc. are typical (KULLING 1929).

H. BÜTLER's investigations resulted in the discovery that the gray sandstone formation at Cape Graah is interstratified with red quartz porphyries (rhyolites) and pyroclastics (tuffs, explosive breccias, lapilli, volcanic bombs). The overlying red conglomeratic and psammitic beds (*vid. sup.*) which were designated by H. BÜTLER as "Cape Graah series" turned out to show, indeed, transgressive features, as had previously been suggested by A. K. ORVIN: its basal conglomerate was proved to carry destructional fragments and pebbles of the subjacent rhyolite. Whilst thus the "Cape Graah series" occupying large areas between Traill Island and Hudson Land rests with a sharp angular unconformity upon the lower series in the region of Moskusoksefjord, no such discordances of bedding are disclosed at its floor farther to the south (BÜTLER 1935a, 1939). Either did this folding (H. BÜTLER's "Hudsonland phase III") not at all manifest itself in more southern parts of East Greenland or we must assume that the recorded conformity is but an apparent one (discontinuity or penaccordance).

In his paper on some eruptive rocks from East Greenland A. RITTMANN also deals with the Devonian volcanites of Ymer Island (RITTMANN 1940).

About 10 km northwest of Cape Graah, at the north coast of the island, H. BÜTLER found the Devonian sandstones to be conformably overlain by arkoses and rhyolitic tuffs which contain ejectamenta and lapilli of gray sanidine-bearing alkali rhyolite. These strata are followed by a 200—300 m thick hummocky lava flow of rhyolite. According to A. RITTMANN (*op. cit.*) this extrusive is represented by a red-gray alkali rhyolite showing phenocrysts of red sanidine and quartz, in other words, it is quite identical with D. MALMQVIST's "sanidine rhyolite" of Cape Franklin and may, moreover, be compared with certain alkali rhyolites from "Hoelsbu", Moskusoksefjord (*vid. p.* 46). At the base of the outpouring the brownish rhyolite displays an excellent fluidal texture.

West of Celsius Bjærg, southern portion of Ymer Island, there occurs a closely resembling alkali rhyolite (neck), and a similar rock was found by H. BÜTLER in stratified tuffs with volcanic agglomerates, bombs, and fragments of rhyolite, which are sequentially overlain by the gray Devonian sandstone.

Slightly southwest of Cape Graah, at the shore of Duséns Fjord, the Devonian sandstone also carries volcanic bombs and other ejectamenta consisting of a red felsitic-vesicular rhyolite exhibiting a distinct fluidal texture. Below the sandstone H. BÜTLER ascertained arkoses and tuffs containing sanidine and splinters of pumice (RITTMANN 1940).

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## V. CORRELATION OF THE *PRE*-PERMIAN ROCKS OF THE GIESECKE MOUNTAINS

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Bearing in mind the geological features established in the region of Moskusoksefjord and at Cape Graah, which have been briefly summarized in the foregoing, I feel altogether justified in advancing a tentative correlation between the Devonian rocks of both the Moskusoksefjord area and Ymer Island with those known from the Giesecke Mountains. In spite of the scanty information hitherto available, there are, nevertheless, some new criteria at hand now which provide unexpected support for a stratigraphical comparison. To be sure, it is not to be wondered at that this mountain range, reconnoitred in 1938 by A. VISCHER and the writer, has turned out to display some close relations with the adjacent areas both to the north and the south, at least with respect to the Devonian stratigraphy, in view of its intermediary location.

As shown by H. BÜTLER's brilliant studies the Devonian molasse deposits of East Greenland may be subdivided into five orogenetic cycles, each comprising a set of sediments of about 1500 m in thickness (*vid.* table on pp. 42—43, and schema Fig. 9). From the Devonian basis upwards the following series are recognized in Moskusoksefjord and Hudson Land: "Basis series", "Cape Bull series", "Cape Kolthoff series", "Cape Graah series", and "Mont Celsius series". Each of these series represents a closed cycle and is marked at its floor by an evident unconformity that corresponds to different *intra*-Devonian folding phases for which H. BÜTLER has coined the terms "Hudsonland phases I—IV".

It is beyond a doubt that the most conspicuous stratigraphical boundary within the Devonian pile runs along the foot of the "Cape Graah series" (*vid.* Fig. 9). There exists, on the one hand, a strikingly sharp angular unconformity between the "Cape Graah series" and the underlying "Cape Kolthoff series" which, in addition, is emphasized by the contrast in colour between the lower, chiefly gray beds and the overstepping red series. On the other hand, the steeply folded sandstones of the "Cape Kolthoff series" (+ "Cape Bull series") are mainly characterized by the presence of intrusive granitic rocks and the interstratification with rhyolitic lava flows, tuffs carrying lapilli,

volcanic bombs etc. (*vid.* Fig. 9). These igneous rocks are *intra*-Devonian in age: None of the granitic or porphyritic hypabyssal stocks, laccoliths etc. with ramifying sills, dykes and apophyses of alkali rhyolite (quartz porphyry), partly exhibiting a glassy-felsitic extrusive facies and an indubitable fluidal texture, do range into the superjacent "Cape Graah series". All the igneous bodies—with the exception of a few dykes of quartz rhyolite, *vid. sup.*—are visibly cut by the transgressing conglomerate of the "Cape Graah series" which, moreover, carries blocks and pebbles of these acidites in a remanié state.

On Ymer Island, *viz.* in the surroundings of Cape Graah, conditions are quite the same. Here, too, occur gray tilted sandstones with interbedded flows of red sanidine-bearing rhyolite, agglomerates with lapilli, tuffs etc. of identical mineralogical and textural composition to those exposed in Moskusoksefjord. There is no doubt whatsoever that this formation corresponds in all details to H. BÜTLER's "Cape Kolthoff-Cape Bull series". This gray sandstone series being invaded by extrusive rocks is transgressively overlain by the red conglomeratic "Cape Graah series", which—as in the Moskusoksefjord area—bears pebbles derived from the subjacent *intra*-Devonian magmatics. No unconformable resting of the "Cape Graah series" could be proved here, however.

It may be pointed out that still more importance must be attached to the obvious limit at the base of the "Cape Graah series"; for the geological data gathered in Moskusoksefjord suggest, indeed, that the "Cape Kolthoff series" together with the lower ones might possibly be correlated with the Middle Devonian¹⁾ beds of Canning Land and Wegener Peninsula ("Ravnefjæld Formation" A. NOE-NYGAARD 1934), while the age of the "Cape Graah series" is definitively fixed as Upper Devonian. The identity between the igneous hypabyssal rocks occurring within the "Cape Kolthoff series" and the porphyritic bodies, extrusive sheets with pyroclastics etc. of the Middle Devonian "Cape Fletcher series" in Canning Land would strongly support such a parallelisation, after all (RITTMANN 1940). Besides, a slight unconformity between those beds and the overlying transgressive series is recorded; this younger formation, which doubtless resembles the "Cape Graah series", is supposed to be Upper Devonian in age (*vid.* NOE-NYGAARD 1934, BÜTLER 1937).

Accordingly, it has become obvious that rhyolitic lava flows and their abyssal and hypabyssal equivalents (granite, granitoporphyries) are of the utmost weight for a correlation of the Devonian beds in East Greenland. On account of the sharp regional boundary at the floor of

¹⁾ The finding of fossil plant-remains which T. G. HALLE is inclined to refer to *Arthrostigma*, a form cited from the Lower and Middle Devonian, would also speak in favour of such a correlation (*vid.* footnote 2) on p. 54).

the "Cape Graah series" even remote outcrops of Devonian deposits may thus safely be linked up with one another.

The foremost criterion to fix this limit is the occurrence of granitic and porphyritic intrusions and the accumulation of extruded rhyolitic lavas in the sedimentary series beneath the stratigraphical contact on the one hand, and of the presence of those igneous rocks as reworked pebbles in the basal conglomerate of the "Cape Graah series" on the other.

If we turn now to the *pre*-Permian rocks cropping out in the basement of the Giesecke Mountains, beds of indubitable Devonian age are recognized without any difficulty. Among the most conspicuous exposures are those displaying the red rhyolite-conglomerates characterizing the "Cape Graah series"; about  $4\frac{1}{2}$  km west of Cape Franklin, on the coast, even the jagged transgressive subface of that rhyolite-bearing "Cape Graah conglomerate" is exposed (*vid.* Fig. 4). This conglomerate with angular blocks and pebbles of rhyolite and reworked Devonian sediments has previously been designated as the "Cape Franklin conglomerate" (MAYNC 1940). However, since there is no objection against a correlation with that marking the base of the "Cape Graah series" this term may, of course, be dispensed with.

The subjacent tilted series composed of greenish and reddish argillaceous mica-bearing sandstones most likely corresponds to H. BÜTLER's "Cape Kolthoff series", accordingly.

A completely identical conglomerate carrying blocks and pebbles of red rhyolite and, subordinately, of reworked Devonian sediments occur at River e (*vid.* p. 13). Consequently, this psephite, too, is referable to the "Cape Graah conglomerate".

The coarse deuteroigneous conglomerate made up of rounded blocks of Caledonian rocks, Devonian sandstone, and reddish rhyolite which was found in Rødedalen (*vid.* p. 12) can hardly be identified with the "Cape Graah conglomerate"; for it chiefly consists of Caledonian components which are otherwise generally lacking in the basal conglomerate of the "Cape Graah series", though they are of common occurrence at higher conglomeratic levels of the formation e. g. west of Cape Graah (KULLING 1929). No doubt, also the underlying red and purplish fine-grained sandstones, shales etc. occurring in Rødedalen and Margrethedal should be referred to the "Cape Graah series".

As mentioned above, the greenish or reddish argillaceous mica-bearing sandstone series exposed at sea level beneath the "Cape Graah conglomerate" at "Franklinhytta" may be compared to the "Cape Kolthoff series". Slightly to the west a thin conglomeratic bed carrying exclusively pebbles of Caledonian provenience is intercalated

in this folded greenish sandstone series which is underlain by a coarse boulder bed with slabs of red and grayish Devonian sandstones. Still farther westwards the sediments are intimately penetrated by sanidine rhyolites and spherulitic rhyolites to such a degree that a stratigraphical survey is rendered quite impossible¹⁾.

East of "Franklinhytta", however, gently folded red-gray and greenish marls, argillaceous fine-grained sandstones, and greenish-gray muscovite sandstones, rich in plant-remains²⁾ and carbonaceous matter, occur up to the *sub*-Permian boundary at 320—340 m altitude. These beds, too, are referable to H. BÜTLER's "Cape Kolthoff series". Formerly this formation was designated by O. KULLING as "The Gray Sandstone series" (KULLING 1929). This author gives the following description of the sediments under consideration: . . . "A phenomenon common to the whole series is, in addition to the colour, the occurrence of plant fossils in several horizons. On Gauss Peninsula fossil plants³⁾ occur throughout the whole series, often rather large trunks up to 1.5 decimeter at least in diameter". . . . "Further, the sandstone series contain occasional conglomeratic boulders of hard quartzite, but real beds of conglomerate do not occur. Bits of coal, sometimes rounded, occur, not infrequently associated with the quartzitic boulders" (quotation ex KULLING 1929, p. 336).

Near the shore these beds are covered by a red rhyolitic flow.

Upon the whole the relationship between the Devonian series near Cape Franklin is difficult to make out. On the one hand, the folded greenish-gray or red sandstones, which we take to be an equivalent of the "Cape Kolthoff series", is exposed between Cape Franklin and "Franklinhytta" almost from sea level up to the *sub*-Permian transgression plane.

¹⁾ However, basing my view upon the knowledge of the Devonian in Moskusoksefjord and Ymer Island, I feel entitled to refer the rhyolitic flows and stocks of the Cape Franklin area still to the complex beneath the "Cape Graah series", although their lay with regard to the sedimentary formations could not be ascertained during my reconnaissance survey. In addition A. RITTMANN's studies have proved that the acidic rocks of Cape Franklin are almost identical with those known from Moskusoksefjord and from Cape Graah (*vid. sup.*) in the sediments occurring below the "Cape Graah series" (RITTMANN 1939, 1940). Sure enough, already D. MALMQVIST had stated that no difference could be made between the extrusives of Cape Franklin (held to be Tertiary in age) and the supposed "*pre*-Cambrian keratophyries" H. G. BACKLUND's from Moskusoksefjord (MALMQVIST 1935).

²⁾ On account of the abundance in fossil plants, though fragmentary, H. G. BACKLUND had been led to suppose a Carboniferous (Namurian) age for these beds (BACKLUND 1935).

³⁾ From Kongeborgen, Traill Island, O. KULLING mentions "*Arthro stigma*" (*det.* by T. G. HALLE), a form known from the Lower and Middle Devonian (KULLING 1929).

Near the hut, on the other hand, merely a few meters of that series crops out on the coast and is succeeded by the coarse overstepping "Cape Graah conglomerate". This peculiar resting is obviously due to a remarkable unevenness and a considerable sloping of the transgression plane of the "Cape Graah conglomerate", and it may, therefore, be conjectured that the entire "Cape Graah series" on the steep southern slope of the Giesecke Mountains has been stripped away by erosion, with the exception of the mere remnants at "Franklinhytta" and in River e. This inclination of the lower surface of the "Cape Graah series" is also evidenced by the distinct southeastern dip of the conglomerate in the exposure at "Franklinhytta" (*vid.* Fig. 4). It may be borne in mind that already H. G. BACKLUND arrived at the presumption that an erosional slope towards the south was preserved in the Cape Franklin area (BACKLUND 1935). However, he surmised that such a sloping surface had existed here prior to the outflows of rhyolitic lavas, in other words, that the acidic magma was poured out over this surface of erosion of supposed Tertiary age (*op. cit.*).

The geological analysis of the Cape Franklin area must evidently be left to future investigations. Doubtless much time will have to be devoted until the solution of the manifold stratigraphical and petrological problems. As A. RITTMANN's studies on the Devonian eruptives suggest, the extrusions of rhyolitic lavas might even turn out to be asynchronous ones: D. MALMQVIST's "sanidine rhyolite" and "spherulitic rhyolite", indeed, reveal the greatest resemblance to the *intra*-Devonian sanidine-bearing alkali rhyolites of Cape Graah whilst his "quartz rhyolite" completely corresponds to the *post*-Devonian (Carboniferous) alkali rhyolites in the region of Prospektal-La Cours Bjærg (RITTMANN 1940).

Be this as it may, the southern end of the Giesecke Mountains may well be said to stand in the very focus of geological interest in northern East Greenland.

As stated above, the coastal region west of "Franklinhytta" is almost entirely composed of *pre*-Permian rhyolitic extrusive rocks (*vid.* BACKLUND 1935) the study of which did not lie within the scope of my investigation.

Immediately east of River j (KOCH 1931), beneath the outstanding hill built up of red sanidine-bearing rhyolite, I found greenish-gray and reddish slates which display a dip of 30—40° to the southwest and may reasonably be referred to the "Cape Kolthoff series". A few kilometers farther to the west, *viz.* in River e, the remarkable red rhyolite-conglomerate crops out below the Permian (at 80—120 m altitude) which is considered the base of the "Cape Graah series" (*vid. sup.*). Here, too, a westerly though weaker dip was stated. Accordingly, a transgressive

resting of this younger series may, in analogy with the facts at Cape Franklin etc., safely be assumed. The red fine-grained sandstone exposed in River f at a height of 200 m shows a dip of about  $10^\circ$  to the west and, apparently, represents a slightly higher level of the "Cape Graah series". The exomorphic sediments occurring in River g, on the other hand, are referred to the lower Devonian series because they are closely associated with extrusive rocks (diabase, rhyolite).

The red or greenish-gray sandy marls and fine-grained micaceous sandstones exposed both in River d (above sea level) and slightly above the delta in Margrethedal are nearly horizontal. From a lithological point of view they strongly resemble those of the "Cape Kolthoff series" west of Cape Franklin (*vid. sup.*). If such a correlation holds true, one should expect to meet with the "Cape Graah conglomerate" somewhere in the lower portion of the flat Quaternary-filled valley. During my stay early in April, 1938, however, the whole region was still deeply buried beneath snow.

The red-purple fine-grained pelitic sediments and fine-grained calcareous sandstones (with several conglomeratic interlayers), partially exhibiting ripple marks, sun-cracks, mud-breccias, clay galls etc., that occupy the middle part of Margrethedal as well as Rødedalen, may doubtless be referred to the "Cape Graah series¹⁾).

In the following the new finds made during my reconnaissance in the Giesecke Bjærge will be briefly discussed.

The river occupying Randbøldalen has cut transversely through the mountain range and debouches into the sea about 8 km to the northeast of Cape Franklin (*vid. map Fig. 2*).

As described in chapter II, a conglomeratic series of 200—300 m thickness is exposed below the marine Permian in Randbøldalen (Huitfelds Bjærg) and Sindalen, respectively, for which the preliminary term "Randbøl conglomerate" will be used until its age and, consequently, a correlation with known beds of adjacent areas will be possible. This "Randbøl conglomerate" contains an unsorted mass of large rounded granite boulders, sharp-edged blocks of augengneiss, as well as angular slabs of red-purplish micaceous Devonian sandstone and fragments of porphyritic granite. This remarkable conglomerate is underlain by red or greenish-gray muscovite-bearing banded sandstones, sandy shales, and greenish quartzitic sandstones with rare psephitic interbeds (pebbles of granitoporphyry).

¹⁾ The adjacent area west of Margrethedal shows outcrops of the "Cape Graah series" along the coast (contrary to H. BÜTLER's map, 1935a) which is capped by the "Mont Celsius series" ("*Remigolepis* series" *in parte*) in the interior of Gauss Peninsula (SÄVE-SÖDERBERGH 1934, BÜTLER 1935b).

Both the conglomerate and the subjacent series are cut at steep angles by intrusive stocks of granitoporphry which contains numerous incorporated blocks of red Devonian sandstone along its contacts (xenoliths). Accordingly, these intruded bodies are later in their *mise-en-place*.

The conglomeratic series may possibly be compared to the "Cape Graah conglomerate" whilst the underlying red and greenish-gray formations might be referable to the "Cape Kolthoff series". With respect to lithology and facies no strong objections could be raised against such a correlation except the obviously polygenetic composition of the "Randbøl conglomerate". This, however, merely depends upon the composition of the old bedrock and may not be taken for a throughout valid argument; for by far the main percentage of destructional constituents is derived from the underlying Devonian sediments (*vid.* p. 21 ff.)

Admittedly, there is one essential point bearing upon the occurrence of the granitoporphry. Up to now the intrusions of hypabyssal acidites (and rhyolitic extrusions) were generally accepted to be *intra*-Devonian in age, chiefly prior to the deposition of the "Cape Graah series" (*vid. sup.*). However, the intrusive body in Randbøldalen clearly pierces through the conglomeratic series and is only cut by the Permian transgression plane. It may, in other words, be of *post*-Devonian/Carboniferous age and would, therefore, represent a more abyssal facies of the alkali rhyolites that have invaded the Carboniferous series in Prospektal and the massif of La Cours Bjærg (*vid. sup.*). Furthermore, it might be linked up with the extrusion of the "quartz rhyolite" between Cape Franklin and Margrethedal (BACKLUND & MALMQVIST 1935, RITTMANN 1940). Until the pre-Permian igneous rocks brought back from the Giesecke Mountains will have been thoroughly examined, the question as to these possible relations must remain unanswered, unfortunately.

Another alternative would be to assign the sedimentary series discovered in Randbøldalen and Sindalen to one of H. BÜTLER's lower Devonian series.

The presumed Carboniferous age seems most unlikely since the beds of that age, which occur in La Cours Bjærg, Gästisdal, and Prospektal (*vid. inf.*), show a different lithological-facial habitus. Besides, the "Randbøl conglomerate" is reported by A. VISCHER to grade laterally into red Devonian sandstones (*vid.* MAYNC 1940).

Both in Foldaelv and Zechsteinelv there occur psephitic beds beneath the Permian that are referable to the Devonian "Randbøl conglomerate" which is here much reduced in thickness.

As the bosses and stocks of granite and granitoporphry in Foldaelv and farther north carry frozen-in xenoliths of red Devonian sandstone, their *mise-en-place* is fixed as *intra*- or *post*-Devonian/*pre*-

Permian (*vid.* MAYNC 1940, 1948). It is therefore not correct to include them into the collective noun "Caledonian"¹⁾ any longer as the Caledonian orogeny s. str., the foldings, metamorphosis, and granitization of which has transformed the *pre*-Cambrian-Silurian rocks into a unit, is *pre*-Devonian in age; these acidic rocks are not "synorogenic" but "*post-orogenic*" intrusions.

The same conclusion applies to the corresponding intrusives occurring in the central and northern Giesecke Mountains, in La Cours Bjærg, and maybe to other "Caledonian" massifs.

No *pre*-Permian sediments were encountered in Jakobsdal, the whole basement being here composed of igneous intrusive rocks. Except a banded microfolded biotite gneiss which is exposed on the south side of the valley, only granitoporphyries grading into granites were observed. The main rock is a coarse-granular reddish granitoporphyry, with large phenocrysts of feldspar, containing frequent schliers of a pink granite (transitions). A closely resembling red to pink granite was found to cut the above-mentioned gneiss. In several places the reddish granitoporphyry had been penetrated by veins of a whitish aplite granite (*vid.* p. 24).

In the socle of Ladderbjærg, the northernmost summit of the Giesecke Mountains, no *pre*-Permian sedimentary beds are present either.

There occurs a reddish granite often displaying a coarse porphyritic texture which completely agrees with that exposed farther south (*vid. sup.*). Locally it shows a "*Flaser*"- or even gneissose texture (concentrations and dark linings of biotite) and then it corresponds entirely to the gneiss cropping out in Jakobsdal. Near the *sub*-Permian transgression plane the granitic rocks disclose an intense weathering. Just as stated in Foldalv, Zechsteinelv, and Randbøldalen (*vid. sup.*) the granite or granitoporphyry frequently carries inclusions of red or purplish-violet Devonian sandstones near its contacts, in other words, blocks of those Devonian sediments were broken off and were immersed during the intrusion of the granitic magma. Accordingly, the same conclusion is here arrived at, that the *mise-en-place* of the granite and granitoporphyry is later than the deposition of those red Devonian beds.

Upon the whole, there is now every reason to believe that also the stocks of reddish granite or granitoporphyry of La

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¹⁾ Accordingly, I can neither fully support A. VISCHER's interpretation (VISCHER 1939) that the Devonian area of the southern Giesecke Mountains is overthrust upon the "Caledonian" basement cropping out farther to the north.



Cours Bjærg, Ankerbjærg, Nordhoeks Bjærg, of Clavering Island, Wollaston Foreland etc. might—at least in part—be *intra*- or *post*-Devonian in age and are not “syntectonic Caledonian” intrusions as was hitherto generally assumed (KOCH 1929a, BACKLUND 1930, 1932, BÜTLER 1935, 1938, 1939, 1940, MITTELHOLZER 1941, WEGMANN 1935).

In the northwestern face of La Cours Bjærg a banded gneiss and gneissic granites crop out which are very similar to those observed in Ladderbjærg and Jakobsdal (*vid. sup.*). A hypabyssal pink or salmon-coloured, often porphyritic granite has intruded into it which probably corresponds to H. G. BACKLUND's “red granite” and to A. RITTMANN's quartz-bearing alkali rhyolite (BACKLUND 1932, RITTMANN 1940). Due to the great petrological resemblance to the rhyolite that cuts the Carboniferous beds in Prospektal the rock of La Cours Bjærg, too, is considered to be of *post*-Devonian age. Such an assignment may be supported by the observation that the same characteristic hypabyssal granite has been injected into a series of steeply tilted green and red deposits of ?Devonian age (*vid. p. 27*). However, how large a portion of the crystalline *cupola* of La Cours Bjærg should be ascribed to younger i. e. *intra*- and *post*-Devonian intrusions cannot yet be stated,

The sedimentary series exposed at 200—225 m (*vid. Fig. 6*) had already previously been referred to the Carboniferous (BACKLUND 1935, BÜTLER 1938). Indeed, this psephitic formation resembles to some extent that exposed in Prospektal (*vid. p. 32*), especially its lower portion. It bears, however, the most striking resemblance to G. SÄVE-SÖDERBERGH's “Upper Sandstone Complex” which, together with the upper portion of the so-called “*Arthrodire* Sandstone”, is considered already to be of Lower Carboniferous age (SÄVE-SÖDERBERGH 1934). As the uppermost Devonian sequence normally passes into the “*Arthrodire* Sandstone” and “Upper Sandstone Complex”, the latter obviously represents the Lowermost Carboniferous whilst the series occurring in Gästisdal-Prospektal *graben* is slightly higher in the stratigraphical succession.

The identity of the deposits concerned in La Cours Bjærg with the “Upper Sandstone Complex” is clearly borne out. G. SÄVE-SÖDERBERGH gives the following characteristic of those beds exposed north of Mt. Obrutschew (uppermost portion of Inderdalen/Margrethedal): “Series of strongly brick-red, or red-white-mottled, hard sandstones ... intercalated with grey or white conglomerates, etc.” ... (quotation *ex* SÄVE-SÖDERBERGH 1934, p. 45). From the east side of the same mountain mention is made of coarse-grained whitish sandstones with cross-bedding,

conglomerates with quartzite pebbles, mud-cakes, arkoses, brick-red sandstones with white spots, and so forth (*op. cit.*).

As put forward in chapter II, those sediments in La Cours Bjærg have evidently been subject to slight *intra-* or *post-*Carboniferous tectonic movements of a faulting character.

The Dinantian age of the plant-bearing sediments in Gästisdal and Prospektdal has hitherto been generally accepted (HALLE 1931). However, my small collection brought together in 1938 from one single section in Prospektdal (*vid.* p. 32) contains both Dinantian and Namurian plants and, consequently, the entire series must be of Upper Carboniferous age.

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## VI. SUMMARY OF RESULTS

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The main points brought out in the present account may be summed up as follows:

- 1) The reconnaissance survey carried out in the spring of 1938 has proved that the *pre*-Permian basement of the Giesecke Mountains and the adjacent areas is chiefly composed of Devonian rocks.
- 2) Carboniferous sediments only occur in the *graben* of Gästisdal-Prospektdal and as remnants on the northwestern face of La Cours Bjærg.
- 3) The Devonian sediments exposed in the Cape Franklin area are referred to H. BÜTLER's "Cape Kolthoff series". The beds are intimately penetrated by alkali rhyolites of the same petrological composition as those known from the "Cape Kolthoff series" of (?Middle)-Upper Devonian age in Moskusoksefjord. Moreover, the magmatics of Cape Franklin bear a great resemblance to the eruptive rocks of the Middle Devonian "Cape Fletcher series" of Canning Land and Wegener Peninsula (A. RITTMANN).
- 4) The red alkali rhyolites of Cape Franklin are not Tertiary in age as was previously assumed but are due to *intra*-Devonian (and Carboniferous?) extrusions. Some of them occur as pebbles in the superjacent Devonian sediments and are cut by the *sub*-Permian transgression plane.
- 5) The rhyolite-bearing conglomerate which unconformably overlies the "Cape Kolthoff series" and its extrusives near Cape Franklin and southeast of Margrethedal is correlated with H. BÜTLER's "Cape Graah conglomerate" of the Upper Devonian. On this account the previous term "Cape Franklin conglomerate" (MAYNE 1940) is dropped. The red sediments occupying Margrethedal and Rødedalen are referred to the "Cape Graah series".
- 6) In the southern part of the Giesecke Mountains a thick conglomeratic formation ("Randbøl conglomerate") is found to crop out beneath the marine Permian which could not yet be correlated with any of H. BÜTLER's orogenetic cycles.

- 7) The intrusive stocks of granite and granitoporphry in the Giesecke Mountains cut the Devonian sediments and, moreover, carry frozen-in xenoliths of red Devonian deposits. Accordingly, their age is *intra-* or *post-*Devonian (Carboniferous). These granitic intrusives are looked upon as a more abyssal facies of the extrusive rhyolitic flows of Cape Franklin and Moskusoksefjord.
  - 8) Attention is drawn to the fact that a large portion of the so-called "Caledonian" crystalline socle (Ladderbjærg, La Cours Bjærg etc.) is actually made up of *intra-*Devonian or Carboniferous intrusive rocks.  
The term "Caledonian" should be restricted to rocks which, indeed, have undergone *pre-*Devonian foldings and metamorphosis.
  - 9) The relics of the sedimentary series exposed on the northwest face of La Cours Bjærg are correlated with G. SÄVE-SÖDERBERGH's "Upper Sandstone Complex" of the Lower Carboniferous.
  - 10) The common occurrence of fossil plants of both Dinantian and Namurian age in the sedimentary sequence of Prospektal permits us to refer the beds of the Gästisdal-Prospektal *graben* to lower levels of the Upper Carboniferous.
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## BIBLIOGRAPHY

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- 1) BACKLUND, H. G., 1930, Contributions to the geology of Northeast Greenland. Medd. om Gr., Vol. 74 (XI).
- 2) — 1932, Das Alter des "Metamorphen Komplexes" von Franz Josef Fjord in Ost-Grönland. Medd. om Gr., Vol. 87, Nr. 4.
- 3) — (& MALMQVIST, D.), 1935, Zur Geologie und Petrographie der nordostgrönländischen Basaltformation. II. Die sauren Ergussgesteine von Kap Franklin. Medd. om Gr., Vol. 95, Nr. 3.
- 4) — 1944, On the field position of some basalts intermediate between the northern and southern areas in North-East Greenland. Appendix to: KROKSTRÖM, T., 1944, Petrological studies on some basaltic rocks from East Greenland. Medd. om Gr., Vol. 103, Nr. 6.
- 5) BIERTHER, W., 1939, Zur Geologie des Scoresbylandes. Mitt. Natf. Gesellschaft Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (13).
- 6) — 1941, Vorläufige Mitteilung über die Geologie des östlichen Scoresbylandes in Nordostgrönland. Medd. om Gr., Vol. 114, Nr. 6.
- 7) BÜTLER, H., 1935a, Some new investigations of the Devonian stratigraphy and tectonics of East Greenland. Medd. om Gr., Vol. 103, Nr. 2.
- 8) — 1935b, Die Mächtigkeit der kaledonischen Molasse in Ostgrönland. Mitt. Natf. Gesellschaft Schaffhausen (Schweiz), Bd. XII, Nr. 3.
- 9) — 1937, Die geologische Position des Canninglandes in Ostgrönland. Vorläufige Mitteilung. Mitt. Natf. Gesellschaft Schaffhausen, Bd. XIII, Nr. 1.
- 10) — 1938, Die tektonischen Strukturelemente des östlichen Moschusochsenfjordes. Medd. om Gr., Vol. 103, Nr. 5.
- 11) — 1939, Übersicht der devonischen Bildungen nördlich des Davysundes in Ostgrönland. Mitt. Natf. Gesellschaft Schaffhausen, Bd. XVI, Jahrg. 1940 (5).
- 12) — 1940, Das devonische Faltungsgebiet nördlich des Moskusoksefjordes in Ostgrönland. Medd. om Gr., Vol. 114, Nr. 3.
- 13) HALLE, T. G., 1931, Younger Palaeozoic plants from East Greenland. Medd. om Gr., Vol. 85, Nr. 1.
- 14) HEINTZ, A., 1930, Oberdevonische Fischreste aus Ost-Grönland. Skrifter om Svalbard og Ishavet, Nr. 30. Oslo.
- 15) KOCH, L., 1929a, The Geology of East Greenland. Medd. om Gr., Vol. 73, Nr. 2.
- 16) — 1929b, Stratigraphy of Greenland. Ibid.
- 17) — 1931, Carboniferous and Triassic stratigraphy of East Greenland. Medd. om Gr., Vol. 83, Nr. 2.
- 18) KULLING, O., 1929, Stratigraphic studies of the geology of Northeast Greenland. Medd. om Gr., Vol. 74. 1930.

- 19) MALMQVIST, D., 1932, Zur Kenntnis der Oberkarbonischen Sedimente der westlichen Clavering Insel, Ostgrönland. Medd. om Gr., Vol. 94, Nr. 6.
- 20) — (& BACKLUND, H. G.), 1935, Zur Geologie und Petrographie der nordostgrönländischen Basaltformation. II. Die sauren Ergussgesteine von Kap Franklin. Medd. om Gr., Vol. 95, Nr. 3.
- 21) MAYNC, W., 1938, Stratigraphie der postdevonischen Ablagerungen der Clavering Insel und des Wollaston Vorlandes. Medd. om Gr., Vol. 114, Nr. 1.
- 22) — 1939, Übersicht über die postkarbonische Stratigraphie Ostgrönlands zwischen 73° und 75° Lat. N. Mitt. Natf. Gesellschaft Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (10).
- 23) — 1940, Stratigraphie des Küstengebietes von Ostgrönland zwischen 73°—75° Lat. N. Medd. om Gr., Vol. 114, Nr. 5.
- 24) — 1942, Stratigraphie und Faziesverhältnisse der oberpermischen Ablagerungen Ostgrönlands. Medd. om Gr., Vol. 115, Nr. 2.
- 25) — 1947, Stratigraphie der Jurabildungen Ostgrönlands zwischen Hochstetterbugten (75° N.) und dem Kejser Franz Joseph Fjord (73° N.). Medd. om Gr., Vol. 132, Nr. 2.
- 26) — 1949, The Cretaceous beds between Kuhn Island and Cape Franklin (Gauss Peninsula), northern East Greenland). Medd. om Gr., Vol. 133, Nr. 3.
- 27) MITTELHOLZER, A. E., 1941, Die Kristallgebiete von Clavering-Ø und Payer Land (Ostgrönland). Medd. om Gr., Vol. 114, Nr. 8.
- 28) NOE-NYGAARD, A., 1934, Stratigraphical outlines of the area round Fleming Inlet (East Greenland). Medd. om Gr., Vol. 103, Nr. 1.
- 29) ORVIN, A. K., 1930, Beiträge zur Kenntnis des Oberdevons Ost-Grönlands. Skrifter om Svalbard og Ishavet, Nr. 30, Oslo.
- 30) RITTMANN, A., 1939, Der jungpalaeozoische Vulkanismus in Ost-Grönland. Mitt. Natf. Gesellschaft Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (8).
- 31) — 1940, Studien an Eruptivgesteinen aus Ost-Grönland. Medd. om Gr., Vol. 115, Nr. 1.
- 32) ROSENKRANTZ, A., 1930, Summary of investigations of younger Palaeozoic and Mesozoic strata along the east coast of Greenland in 1929. Medd. om Gr., Vol. 74.
- 33) — 1932, Geologiske Undersøgelser i Østgrønland Sommeren 1929. København.
- 34) SÄVE-SÖDERBERGH, G., 1932, Notes on the Devonian stratigraphy of East Greenland. Medd. om Gr., Vol. 94, Nr. 4.
- 35) — 1934, Further contributions to the Devonian stratigraphy of East Greenland. Medd. om Gr., Vol. 96, Nr. 2.
- 36) STAUBER, H., 1938, Stratigraphische Untersuchungen postdevonischer Sedimente auf den Inseln Traill und Geographical Society. Medd. om Gr., Vol. 114, Nr. 1.
- 37) — 1939, Geologie des südlichen Teiles der postdevonischen Zone von Ostgrönland. Mitt. Natf. Gesellschaft Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (12).
- 38) — 1940, Stratigraphisch-Geologische Untersuchungen in der ostgrönländischen Senkungszone des nördlichen Jameson Landes. Medd. om Gr., Vol. 114, Nr. 7.
- 39) TEICHERT, C., 1933, Untersuchungen zum Bau des kaledonischen Gebirges in Ostgrönland. Medd. om Gr., Vol. 95, Nr. 1.
- 40) VISCHER, A., 1939, Ergebnisse von Studien über die postdevonische Tektonik zwischen Hochstetter Bucht und Franz Josefs Fjord während der Zwei-

jahresexpedition 1936—1938. Mitt. Natf. Gesellschaft Schaffhausen (Schweiz), Bd. XVI, Jahrg. 1940 (9).

- 41) VISCHER, A., 1940, Der postdevonische Bau Ostgrönlands zwischen 73° und 75° N. Br. Medd. om Gr., Vol. 114, Nr. 4.
- 42) — 1439, Die postdevonische Tektonik von Ostgrönland zwischen 74° und 75° N. Br. Medd. om Gr., Vol. 133, Nr. 1.
- 43) WEGMANN, C. E., 1935, Preliminary report on the Caledonian Orogeny in Christian X's Land (Northeast Greenland). Medd. om Gr., Vol. 103, Nr. 3.