

Remarks upon  
LAUGE KOCH: Geologie von Grönland. 1935.

After the many expeditions of recent years our knowledge of the geology of Greenland has been considerably increased. A complete and objective representation of facts old and new may therefore always count on being received with great interest, and it is therefore easy to understand why a new book on the geology of Greenland has now been published in the series »Geologie der Erde.« This book, LAUGE KOCH: »Geologie von Grönland« Berlin 1935, 159 pages (Gebrüder BORNTÄGER, printed by E. BUCHBINDER (H. DUSKE) in Neuruppin), is intended for international geological circles in conformity with the plan of the series.

LAUGE KOCH has during recent years acted as a leader of several expeditions to Greenland and has in this way had an opportunity of following the work there at close quarters. We appreciate the great initiative shown by Dr. LAUGE KOCH in the exploration of the geology of Greenland. One therefore opens his new book expecting to find in it a first hand representation of the results obtained during recent investigations in addition to those previously known.

It must however at once be stated that the book does not achieve this purpose, and we therefore feel bound to dissociate ourselves decidedly from LAUGE KOCH's book on account of its on the whole tendentious and incorrect statements. And one of our reasons is indeed that the book appears in a series of widely read manuals.

We shall confine ourselves to quoting only a few of the many examples to be found in the book in order to illustrate the way in which the material has been procured and treated and we have chosen to deal with them in different groups according to their nature. This will involve the necessity of occasionally touching on subjects outside the book. In this connection we must draw attention to the fact that LAUGE KOCH has frequently stressed to the public the great number (55) of geologists who have worked in East Greenland on his Three-Years-Expedition. However out of these 55 "geologists" 19 only were geologists.

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Working Methods. The reliability of the working methods is always of decisive importance, when an author's scientific work is to be judged. It appears from this book, as well as from earlier works by LAUGE KOCH, that the observations are by no means so exact as presented.

In 1934, H. W:SON AHLMANN wrote as follows concerning LAUGE KOCH's mapping work in North Greenland (p. 277): "Since the appearance of KOCH's book, the large atlas 'Map of North Greenland, Scale 1:300 000' has been published. Unfortunately no information is as yet given of the observation material except that the routes and the points of observation are centered in the map. Therefore many questions will demand a reply. How, for instance, is it possible to draw up coast contours and valleys with winding brooks on all sides of from 500 to 700 m. high islands and other land which, travelling on the sea ice, have been passed on one side only; and similarly, how can the shore contours of deep fiords and bays, the mouths of which only were crossed or passed at some distance be given in fulldrawn lines?"

We would put a similar question concerning the geological map of East Greenland published in 1929, which contains mapped areas where LAUGE KOCH, according to his own account of his travels, has never been. Some of the areas lie up to 200 km. outside his travelling route. It is therefore easy to understand that the said map contains very considerable mistakes. On the other hand while drawing the map KOCH has to a great extent made use of earlier maps by NATHORST, NORDENSKJÖLD, and others, but in spite of this fact the map was designated as "mapped by LAUGE KOCH" instead of "compiled by LAUGE KOCH."

In recent years LAUGE KOCH has made great use of geological observations made while flying in Greenland. We do not in any way underrate the value of the aeroplane for the purpose of exploring regions difficult of access—this point must be stressed—, but we find that LAUGE KOCH in his treatment of his observations has brought the method into discredit.

How is it possible to distinguish from the air between acid and basic eruptives (p. 11)?

As a further example of the results of LAUGE KOCH's flying activity it may be mentioned that on the map on p. 75 a very large area of Devonian and Carboniferous-Permian with adjoining Triassic is inserted in places where no field investigations have been made.

Another side of LAUGE KOCH's working methods is illustrated in his treatment of the results of other writers' examinations. On p. 21 it is for instance stated that USSING considered the Igaliko sandstone to be Devonian, and that BACKLUND has found certain similarities between this sandstone and the East Greenland Devonian; but LAUGE KOCH nevertheless, with reservation, but without stating any reason, ascribes the Igaliko sandstone to the pre-Cambrian (p. 3).

On p. 37 we read: "POULSEN faßt den Kalk mit *Isoteloides? polaris* und das Konglomerat mit *Phyllograptus angustifolius* zu einer Zone zusammen, die er *Angustifolius-Zone* nennt. Ich halte jedoch beide Zonen

getrennt aufrecht." Here is another case in which LAUGE KOCH gives his own view without any attempt at an explanation.

A third example is the following: in 1929 LAUGE KOCH comprised the Grammysia sandstone, with some other finds, under the name "Depot Island Formation" which on the basis of ROSENKRANTZ's determinations he ascribed to the Lower Permian. FREBOLD has at a later time shown that the Ammonites that were mentioned by LAUGE KOCH as Lower Permian, belonged to the Eotriassic genus *Ophiceras*. With regard to the Grammysia sandstone ROSENKRANTZ (KOCH, 1929, No. 1, p. 107) was of opinion that it possibly was Lower Permian, whereas FREBOLD (1931) considered it probable that the Grammysia sandstone was Eotriassic. Thus neither of these two scientists who have studied the fossils of the Grammysia sandstone closely has been able to determine its age with certainty. It is therefore surprising, that LAUGE KOCH in the table on p. 77 ascribes the Grammysia sandstone to the Upper Zechstein without giving any reason whatever in the text. The Grammysia sandstone is used in this way as the sole proof of the presence of Upper Zechstein in East Greenland.

On the basis of some fragmentary observations by J. P. KOCH and ALFRED WEGENER, LAUGE KOCH in 1929 (No. 1, p. 55) expressed his opinion about a pre-Cambrian eruptive activity in Dronning Louise Land as follows: "However desultory these observations may be, it seems highly probable that the pre-Cambrian eruptive activity ... can also be traced ... to and including Dronning Louise Land..." Though no new investigations have been made in the meantime, KOCH now presents as an established fact (p. 125): "Auf Königin Louise-Land, namentlich im westlichen Teil, fand eine kräftige Eruption statt."

With regard to the pre-Cambrian eruptive activity in North Greenland LAUGE KOCH writes after mentioning the dikes in the western Inglefield Land (p. 123): "... weiter östlich kommen in den grönländischen Bildungen, wo diese bloß liegen, keine Eruptive vor. Jedoch findet man in den unterkambrischen Konglomeraten viele kleine Diabaskörner, die anzeigen, daß sich unter dem Inlandeis nach Südosten zu Eruptivgebiete finden müssen." It is obvious that this is an erroneous conclusion. The diabase from which these "Diabaskörner" originate may of course very well have occurred in another place. Moreover these "Diabaskörner" in a Lower Cambrian conglomerate cannot be regarded as a proof of the presence of an area of diabase existing at the present time.

Below we shall deal with another of KOCH's methods of representation, i.e. his suppression of the investigation results of other authors.

**Subjects Omitted or Incompletely Treated.** It is rather staggering at first glance to observe that large and very important parts of the geology of Greenland are not dealt with at all in the book. Thus in the stratigraphic section the Archæan is not mentioned at all in spite of the fact that the whole of Greenland's west coast, and not a small part of the east coast, are built up of this formation. There are numerous papers dealing with this formation by EBERLIN, HEIM, KNUT-

SEN, NORDENSKJÖLD, STEENSTRUP, and WAGER. LAUGE KOCH himself considers the whole of Greenland as an independent shield, and the book contains a chapter: "Der grönländische Schild," so we might have expected an account of the geology of the oldest formation; but in the chapter mentioned we find only (p. 121) 11 lines on the Archæan of Greenland, in which the names of some formations are mentioned without any further comments or references to the literature.

USSING's classical investigations of the geology of the Julianehaab district (Julianehaab Granite, Nepheline Syenites, etc.) are not mentioned at all. The only place in the book, where the word Nepheline Syenite appears, is on the map on p. 116 representing an area south of Scoresby Sound, which, with the exception of the coast, has only been observed from the air.

In the same way a "Kap-Fletcher-Serie" is to be found on the map on p. 75 only, but is not mentioned in the text.

It is also a remarkable fact, that the Quaternary is not mentioned at all, the more so as several of the members of LAUGE KOCH's own expeditions have contributed to the elucidation of questions of Quaternary geology (BACKLUND, GELTING, NOE-NYGAARD, POSER), not to mention the great number of other investigations, earlier as well as more recent.

Moreover no mention of valuable mineral resources such as cryolite, copper-ore, graphite, and marble is made, and the coals are dealt with from a stratigraphic point of view only.

Last but not least one misses a geological map of Greenland as well as an index. It is impossible for the reader to find out the geographic position of many important localities.

Misunderstandings and Statements that have not been Proved. Part of the contents of the book can be explained only on the basis of the assumption that LAUGE KOCH has misunderstood or is not acquainted with earlier publications, or that he makes his completely unproved or incompletely supported statements in the face of existing results. Besides the cases quoted above some more examples will be given below as they appear in the book.

On p. 3 the name "Grönlandium" is used for the late pre-Cambrian sediments in Greenland, and on p. 152 it is stated that "Grönlandium" is to be regarded as a new geological period, as also appears from the table on p. 25, where "Grönlandium" is inserted between "Algonkium" and "Kambrium". Moreover on p. 127 "Grönlandium" is correlated with late pre-Cambrian strata in Spitsbergen, in Scotland, and in Fennoscandia. To this it must be observed that the latter series are by most authors ascribed to the Algonkian system, but on the other hand A. W. GRABAU for instance has as early as 1922 (p. 82—83) treated these series on a much broader basis; he comprised these and similar late pre-Cambrian formations under the name of "the Sinian System." If therefore with LAUGE KOCH one regards the said late pre-Cambrian sediments as a special formation which is to be distinguished from the Algonkian System, then a new name for this formation must at any rate be considered superfluous and confusing.

On p. 30 a correlation table of the Cambrian is found which, owing to its incompleteness (omission of several hiatus and formations) is altogether misleading, and therefore useless.

On pp. 36 and 152 CHR. POULSEN's find of Lower Ordovician graptolites in the Cass Fiord formation is mentioned, a deposit which according to POULSEN (1927 and 1930) may be correlated with the Upper Ozarkian of North America. The graptolite find thus causes one to reflect on the stratigraphical position of the Upper Ozarkian, but does not permit of such far-reaching conclusions with regard to the Middle and Lower Ozarkian as those which LAUGE KOCH here ascribes to POULSEN.

On p. 43 POULSEN's views on the correlation of the Cape Weber formation with the Upper Canadian are accepted, but nevertheless on the same page KOCH writes that according to the most recent finds this formation belongs to the Middle Canadian. In this connection it must be noted that no recent finds exist. Attention is also drawn to the correlation table on p. 131, where LAUGE KOCH has expressed a definite opinion by referring the Cape Weber formation to the Middle Canadian.

On p. 48 the Valentian is incorrectly classified in the American formation series.

On the map p. 79 the area west of the present region of the Mesozoic formations in East Greenland is designated as "Vorübergehende Verfestigung im Mesozoikum." This must evidently mean that this area has become labile in more recent times. But this is in direct conflict with the facts. No explanation is however given in the text.

In the treatment of the Mesozoic formations it is stated on p. 80 that the bay in Wollaston Foreland is a labile area. "Die anderen Gebiete erweisen sich als sehr wenig labil, da es sich überall um Flachwasserbildungen handelt . . ."; KOCH's view is not expressed very clearly but the passage quoted must presumably be taken to mean that he considers the sediments in Wollaston Foreland to be deep-sea formations. In reality the sediments in Wollaston Foreland are shallow water formations (FREBOLD 1932, No. 1), partly developed as delta formations and coarse conglomerates.

On p. 100 it is stated that Kimmeridge is found in the Shannon Island; this has however never been proved.

On pp. 120 and 153 LAUGE KOCH mentions the history of the development of the Canadian and the Greenland shields, and emphasizes that the Greenland shield, in contrast to the Canadian, has had a marked positive tendency (rising tendency) since pre-Cambrian time. At the same time he correlates the Canadian shield with "die russische Tafel." But as is well known the Canadian as well as the "Greenland" shield were partly covered by epicontinental seas in early Paleozoic time. Since Silurian time both areas have shown prevailing positive tendency, and the sedimentation has taken place in the border zones only. Signs of a separation of Greenland from the major part of the Canadian shield are not observed prior to the Cretaceous and Tertiary. A correlation between the Canadian shield and "die russische Tafel" is impossible, because "die russische Tafel" is a large sedimentation area of very varying composition ("Osteuropäischer Schollenkomplex,"

BUBNOFF 1926), while the Canadian shield is one of the most typical stable rising areas of the world.

On p. 122 while comparing the East Greenland geosyncline with the Scandinavian one L. KOCH discusses the possibility, "daß die ostgrönländische Geosynklinale infolge ihrer weit größeren Breite bedeutend labiler war." There is no reason whatever for expressing an opinion on this question, as the width of both of these geosynclines is unknown. In the same discussion further erroneous statements are to be found.

On p. 131 it is emphasized "daß in Ostgrönland ebenso wie in Nordgrönland unteres Canadian fehlen, hier besteht eine ausgeprägte Winkel-diskordanz." POULSEN, of whose researches L. KOCH is presumably thinking, writes on this question (1930, p. 313) as follows: "The Cape Weber formation has been deposited disconformably on the slightly eroded surface of the Cass Fjord formation." According to the generally accepted geological terminology this means however that these formations are separated by a parallel unconformity, not by an angular unconformity, which indeed suits better the unfounded views which KOCH sets forth in the same part of the book.

On p. 135 it is pointed out by the author: "Es besteht kein Zweifel darüber, daß wir hier kräftige takonische Bewegungen vor uns haben, die also mit der Monograptus sedgwicki-Zone altersmäßig zusammenfallen." Here it must be noted that among geologists the term "takonisch" is applied to movements that took place before the beginning of the Silurian, i.e. long before the time here mentioned. It is thus obvious that in the above quotation the author contradicts himself.

On p. 152 it is stated in the Résumé that the pre-Cambrian "schloss mit einer tektonischen Phase, die hier den Namen 'skandisch' erhalten hat." In geological usage it is only an orogenesis that is called "Tektonische Phase," but in Greenland according to LAUGE KOCH's own accounts no orogenic movements have ever taken place between the pre-Cambrian and the Cambrian. In the fuller account of the "Scandic Phase" in the preceding text volcanic activity only is mentioned.

**Misleading Argumentation.** It is quite misleading, to follow the finally revised lists on pp. 29 and 31 of the faunas from the Bastion formation and the Ella Island formation, that are given *in extenso* after POULSEN (1932), by a discussion on the basis of POULSEN's preliminary determinations (POULSEN 1930) of the same faunas. Among other things this involves the use of some specific names which were withdrawn by POULSEN in his final description, which is of course the only valid one.

With regard to the geological age of the Polaris Harbour Formation the following account is found on page 49: "Der Sandstein ist im allgemeinen fossilfrei, in situ hat man keine Fossilien gefunden. Dagegen liegt von dieser Serie ein loser Block mit Versteinerungen vor, der nach POULSEN zum jüngeren Ludlow<sup>1)</sup> gestellt werden kann." POULSEN however writes as follows (1934, p. 43): "Fossils have not been found

<sup>1)</sup> Italicised by us.

*in situ*, but an erratic boulder, containing a few species of brachiopods and one trilobite, possibly originates from this formation. Judging from these fossils, the formation should probably<sup>1)</sup> be referred to the Ludlow,..." A further study of this chapter of LAUGE KOCH's book makes it obvious that the remarkable change from "probably Ludlow" into "jüngeres Ludlow" is to serve the purpose of making the presence of the formation following the Ludlow in the North Greenland formation series, viz. the Downtonian, seem probable. It seems quite a parody, when the author enters into a discussion of the age of the North Greenland folding chain on this sparse and specially prepared basis.

In this as in his earlier publications LAUGE KOCH tries to give the reader the impression, that the question as to the origin and age of the North Greenland mountain chain has been finally settled by his investigations. But this is not at all the case. A scientific valuation of the existing material shows on the contrary that a basis for determining the age is still lacking.

A determination of the age of a folding is done by:

1. Stating the age of the folded strata,
2. Proving that younger strata of a known age rest unconformably on the folded strata.

It is impossible to make any statement about these conditions in North Greenland on the basis of existing observations.

It is therefore surprising that KOCH in his book not only maintains that the folding is of the Caledonian age, as previously assumed by him, without answering the criticism set forth by FREBOLD in 1934, but that he furthermore enters into a discussion of the question, whether this mountain folding represents the Ardennian or the Erian subphase of the Caledonian folding. Not one single fossil is yet known from the area of the North Greenland geosyncline here mentioned. Nevertheless L. KOCH writes (p. 151): "Die nordgrönländische Geosynklinale mit einem von Sedimenten bedeckten breiten Vorland südlich davon hat bedeutende Faunen des Kambriums, Ordoviziums und Gotlandiums geliefert." But these faunas originate without any exception from the foreland south of the supposed geosyncline.

In this connection it is tempting to refer to the preface of the book in which KOCH writes: "Der Stoff bezüglich Nordgrönland ist im Augenblick das klarste."

Suppressions and Incorrect Quotations. The book is in many places disfigured by corrupted quotations and incorrect statements.

With regard to the tectonic conditions in the area of the Eleonore Bay formation in East Greenland between 73° and 74° n. lat. KOCH writes (p. 20): "TEICHERT war sich damals nicht klar darüber, was WEGMANN später gefunden hat, daß die tektonischen Erscheinungen in den letztgenannten Gebieten auf variszischen<sup>2)</sup> Störungen beruhen ..." On the

<sup>1)</sup> Italicised by us.

<sup>2)</sup> Variszisch is the German expression for Hercynian.

contrary in his publication on this subject WEGMANN (1935, pp. 28—29), in perfect agreement with TEICHERT, looked upon the said disturbances as Caledonian and not as Hercynian. On the other hand in 1934 SCHUCHERT published an account of a letter from LAUGE KOCH in which in reference to TEICHERT's investigations it is stated (SCHUCHERT 1934, p. 308): "KOCH believes that the deformation is essentially Hercynian and not Caledonian."

On the same page TEICHERT's discovery of a sediment area in Nörlund Land is mentioned in an extremely misleading way, which is best shown by printing the quotation along with the original:

KOCH 1935, p. 20.

»Im nördlichen Gebiet hatte TEICHERT auf Nörlund-Land Gelegenheit, alle Übergänge zwischen schwach metamorphosierten Sedimenten und ausgeprägten Gneisen zu sehen. Er zieht den Schluß, daß in diesem nördlichen Gebiet, d. h. auf Nörlund-Land und der Koldewey-Insel, ein anderer präkambrischer Sedimentzyklus, der älter als die Eleonore-Bay-Formation ist, auftritt«.

TEICHERT 1933, p. 107.

»Vorläufig läßt sich nur soviel darüber aussagen, daß diese Gesteine wahrscheinlich präkambrisch sind, daß aber darüber hinaus ihr Alter nicht näher zu fixieren ist. Sie können möglicherweise der Eleonore-Bay-Formation zuzurechnen sein, was sich leicht durch eine nähere Untersuchung der Koldewey-Insel feststellen lassen müßte, sie können aber auch mit derselben Wahrscheinlichkeit erheblich älter sein...«.

In continuation of this KOCH writes that he can see no reason to enter more closely into TEICHERT's tectonical considerations as BACKLUND and MALMQVIST have found that the sediments in this northern area really are Eleonore Bay formation. But it is obvious that this supposition in no way is antagonistic to TEICHERT's statements, as the disagreement arises through KOCH's incorrect quotation only.

On p. 49 NATHORST's knowledge of the distribution of the Devonian in East Greenland is dismissed with the following words: "Über die geographische Verbreitung der Schichten war sich NATHORST noch nicht im klaren..." And below on the same page KOCH continues: "1926—27 legte KOCH (1929) die Grenzen genauer fest..." But in reality the most important additions to NATHORST's map (NATHORST 1901, plate 5) as regards the distribution of the Devonian have already been introduced by NORDENSKJÖLD (1907), not by KOCH.

Another example of a highly inexact statement is the following: KOCH in 1929 (No. 2, p. 245) assumed that the greater part of Canning Land consists of continental Lower Carboniferous. NOE-NYGAARD writes (1934, p. 26): "During the present investigation Carboniferous strata of continental character, besides in Calamites River, have only been met with in three exceedingly small localities on the Wegener Peninsula;" thus continental Carboniferous is not at all found on Canning Land. Nevertheless KOCH now states (p. 62): "Zufolge NOE-NYGAARD ist kontinentales Kar-

bon auch auf der Wegener-Halbinsel und auf Canning-Land weit verbreitet."

On p. 67 KOCH referring to his work published in 1929 writes: "Außerdem werden von KOCH Schichten mit *Posidomya* und Fischresten von der Küste östlich von Kap Stosch und von Kap Franklin erwähnt, die mit einigem Zweifel zum oberen Karbon<sup>1)</sup> gestellt werden." This is not correct. KOCH actually wrote (1929, No. 2, p. 244): "The fossils tell nothing about the age of the formation. I have provisionally referred the beds to the lowermost Carboniferous<sup>1)</sup>, but they may belong to the uppermost Devonian<sup>1)</sup>."

In not a few cases LAUGE KOCH quotes his own previously stated opinions in an erroneous way. In most of such cases he quotes results of newer investigations as if they were views of his own already expressed. But it also happens that he ascribes erroneous opinions to himself, whereas his original opinions were actually correct.

In 1929 (No. 2) KOCH used the name "Eleonore Bay Formation" exclusively for late pre-Cambrian sediments. The expression is used in the same way in "Geology of East Greenland" (1929, No. 1) with the one exception, however, that on p. 56 KOCH uses the name to cover the whole pre-Devonian series of strata. In spite of that KOCH now writes (p. 13): "In beiden Publikationen von 1929 nennt KOCH die ganze Schichtserie, einschließlich der paläozoischen Schichten, Eleonore-Bay-Formation..."

On p. 69 we read: "Wie bereits angedeutet, liegen von 1932 und 1933, also nach<sup>1)</sup> FREBOLD'S Untersuchungen, neue umfangreiche Materialien vor, u. a. auch von *Medlicottia*, die zeigen, daß die mannigfachen Schichten Faziesäquivalente ein und derselben Serie, die den Schwagerinhorizont und das Artinsk umfaßt, darstellen, ohne daß man mit Sicherheit eine genaue Grenze zwischen den beiden Horizonten ziehen kann." This view however is not a result of new collections; it had already been expressed by FREBOLD in 1932 (No. 2) in a diagram (p. 44) and a table (p. 54) which clearly show that the view now set forth by KOCH as new is simply derived from this paper. KOCH'S behaviour is here so much the more remarkable in that he himself in his book reproduces the said diagram from FREBOLD'S paper on page 69 and FREBOLD'S table on page 70.

On p. 85 LAUGE KOCH writes: "Im Nathorstfjord fand KOCH 1926 *Ophiceras* und *Glyptophiceras* über<sup>1)</sup> der sogenannten Depot-Insel-Formation." This is wrong in so far as the fossils in question were ascribed directly to the Depot Island formation by KOCH in his work of 1929 (No. 2) and this formation he did not regard as Triassic, but as Lower Permian. In 1929 (No. 2) KOCH thus wrote (p. 247): "There is some probability that the fauna is related to that of the Russian Arta beds, and consequently is of lower Permian age."

As far as it is possible to determine the cephalopods they were ascribed to *Ophiceras* and *Glyptophiceras* by FREBOLD (1931) and accordingly this

<sup>1)</sup> Italicised by us.

part of the Depot Island formation to the Eotriassic. KOCH's quotation must therefore be characterized as misleading.

On page 74 KOCH writes: "Im Jahre 1927 brachte KOCH (1929) einige weiße, sehr fossilführende Kalkblöcke vom Kap Stosch mit. Die Fauna wurde von ROSENKRANTZ (KOCH 1929) als Zechstein (?) bestimmt." There is no foundation at all for doubting ROSENKRANTZ's determination, for in 1929 (No. 1, p. 116) KOCH himself quotes ROSENKRANTZ in the following way: "ROSENKRANTZ describes the fauna as follows:

"The fauna mentioned above is of Permian Age and of a decidedly West European aspect. It permits me to establish a direct comparison with the Zechstein of England and Germany (Lower Zechstein)."

In the chapter on the Eotriassic on p. 82 we read: "1931 nahm KOCH hier eine Einteilung in 5 Hauptzonen vor." From this the reader naturally gets the impression that it was KOCH's investigations that first gave rise to a subdivision of the series of strata into various horizons, while as a matter of fact all the main divisions had already been shown by WORDIE and ROSENKRANTZ. The latter's find (1930, p. 360) of a rich fish layer characterized by the presence of the ammonite genus *Oloceras* has also been suppressed.

It has become apparent that one of the Upper Neocomain formations, the Aptian, has a wide distribution in East Greenland, and the discovery of this part of the Cretaceous is important in various respects. We therefore think that it would have been correct if LAUGE KOCH had mentioned that it was only on the basis of R. BØGVAD's collections that the presence of these deposits could be ascertained.

The chapter "Tertiäre Bewegungen in Ostgrönland" (p. 149) begins thus: "De Geer (1911) forderte eine allgemeine tertiäre Landhebung in allen Gebieten rings um den Skandik. 1921<sup>1)</sup> glaubte KOCH, das dies für Grönland sehr übertrieben sein müsse und rechnete damals nicht mit einer sonderlich starken Hebung in tertiärer Zeit. Spätere Untersuchungen ergaben jedoch, daß innerhalb dieses Zeitraumes sehr mächtige Hebungen in Verbindung mit starkem Vulkanismus und außerordentlich starken Verwerfungen stattgefunden haben müssen."

Attention must however be drawn to the fact that already in 1929 ROSENKRANTZ (1929, No. 1) mentions the possibility of Tertiary movements in Jameson Land. The reader moreover looks in vain for an account of the new investigations that led to a change in KOCH's view of 1929. At any rate these new investigations were not undertaken by KOCH himself. We shall here refer particularly to papers by BACKLUND, KULLING, and FREBOLD from the years 1930—33, in which the questions of the age, extent, and character of the younger movements have been discussed. The latter papers further deal with the possible importance of the late tectonics in determining the origin of the fiords in East Greenland. It is indeed surprising that this important question is not mentioned at all, although the large fiords are a conspicuous feature in the picture of the coast of East Greenland, and in spite of the fact that

<sup>1)</sup> 1921 is a misprint for 1929.

the said investigations were carried out during KOCH's own expeditions. Besides we have also some earlier contributions (WORDIE, 1927).

In "Geologie von Grönland" we further miss an information of the find of "Upper Carboniferous" which KOCH himself, according to this paper in 1929 (No. 1), made in Peary Land, and which is of such great importance on account of its geographical position.

On p. 129 KOCH writes: "Die Pemmican River-Formation ... wird von POULSEN mit einigem Zweifel zum Oberkambrium gerechnet, jedoch den oberen Teil dieser Formation und die folgende Kap Frederik-VII-Formation wurde von POULSEN zum Unterozarkium gestellt. ... Nach POULSEN's neuesten Untersuchungen handelt es sich vermutlich um Oberkambrium." The truth is, however, that POULSEN (1927, p. 244) with reservations ascribes both of the said formations to the Lower Ozarkian. The remark concerning POULSEN's new investigations with regard to this matter must be due to a misunderstanding, for such investigations have been neither undertaken nor planned.

Appropriation of the Results of other Explorers. The chapter, "Die Basaltformation in Grönland" (p. 115) opens in this way: "1920 wies KOCH nach (Chicago 1920), daß die grönländischen Basalte ihre Hauptverbreitung sowohl an der Ost- wie an der Westküste bei etwa 70° n. Br. haben. ..." This piece of information seems very strange as the presence and the distribution of the basalt in Greenland had been known for a long time in 1920 (see BØGGILD, 1917).

In 1934 FIEBOLD has erroneously ascribed to LAUGE KOCH the honour of having discovered the great folding zone in North Greenland. KOCH however commits the same error when (p. 119) he writes: "1917 wies KOCH längs der ganzen Nordküste Grönlands eine Faltungszone nach, die er weiter westlich bis Ellesmere-Land und Grant-Land verfolgen konnte." We shall only recall the fact that on the basis of earlier investigations BØGGILD wrote as follows as early as 1917 (p. 18): "das einzige sichere Faltungsgebiet liegt im allernördlichsten Teil des Landes," and after having mentioned the folded and metamorphosed sediments on Grant Land (Cape Rawson Series) he states (p. 9): "Zusammen mit diesen gehören wohl auch die von der Danmark-Expedition untersuchten Gegenden im westlichen und nördlichen Teile von Peary-Land, wo auch stark umgewandelte Sedimente gesammelt worden sind." On Ellesmere Land and Grant Land the folding has been known since 1878 (FEILDEN & DE RANCE).

Misleading Headings. We must draw attention to the fact that not a few chapters show a remarkable discrepancy between the contents and the headings. Besides the examples quoted elsewhere we shall here confine ourselves to the following cases:

Under the heading "Vergletscherung" (p. 126) only non-glaciated areas and conglomerates of non-glacial origin from North Greenland are mentioned.

In the chapter "Tertiär" one looks in vain for any real treatment of the West Greenland Tertiary, and with regard to the East Greenland Tertiary no mention is made of ORVIN's and HØEG's investigations.

Under the heading "Die Basaltformation in Grönland" the only investigations from East Greenland mentioned are some of BACKLUND's and MALMQVIST's which deal not only with basalts, but also with a number of other eruptive rocks, whereas any reference to the other literature on the basalt in Greenland is missing.

Furthermore it must be characterized as highly misleading that the heading "Mitteldevon" (p. 50) is used for a chapter that covers all three Devonian areas in the region around the Nathorst Fiord, as NOE-NYGAARD, the only geologist who has undertaken investigations in this place, explicitly states that middle Devonian fossils are known in the Ravnefjeld District only, and further writes: "Even if the sediments of Cape Brown and Canning Land belong to the Devonian, they may as well represent other horizons than those encountered in the Ravnefjeld." (NOE-NYGAARD 1934, p. 25).

**Absurdities and Self-Contradictions.** Under the heading "Unterperm" KOCH mentions on pp. 66—67 two faunas from the Mallemukfjeld which were described by GRÖNWALL in 1917<sup>1)</sup>. In contradiction to the heading KOCH ascribes these two faunas originating from different horizons to the Upper Carboniferous. The younger of the faunas mentioned nevertheless belongs to the Lower Permian in the sense in which this term is generally used by KOCH in his book.

On p. 76 under the two headings "Unterer Zechstein" and "Mittlerer Zechstein" rocks of the said formations are dealt with. On p. 77 KOCH gives a table of the East Greenland Permian, but in this we miss the Middle Zechstein mentioned in the text. On the other hand the Upper Zechstein, which is not mentioned in the text, now suddenly appears in the table. Therefore, it is impossible to get an idea either of the actual conditions or of KOCH's opinion.

We think we are justified in asking what the author means by stating (p. 105): "An der Nordküste von Hold-with-Hope findet sich zwischen Kap James bis zum Mt. Diener eine mehrere 100 m mächtige Schichtserie roter, grauer und gelber, grober Sandsteine. Diese Lokalität wurde zum ersten Male 1930 von KOCH besucht, die Gesteine erwiesen sich aber als fossilieer. Man fand jedoch einen schlecht erhaltenen Echinodermen, der ein ziemlich junges Aussehen hat."

On p. 38 we find the following peculiar statement: "Die obengenannte Schichtenserie ... wird von zusammen 40 m hellgrauem Kalk<sup>2)</sup> mit zahlreichen Bändern von Kalkkonglomeraten<sup>2)</sup> überlagert. ... Die Schichten sind stark fossilführend und werden hier Ostracodensandstein<sup>2)</sup> genannt."

The tables on pp. 42 and 128 are both incorrect and are moreover contradictory to such an extent as to become quite useless.

<sup>1)</sup> This important paper is missing in the bibliography.

<sup>2)</sup> Italicised by us.

Frequently we meet sentences in which it is impossible to find any sense at all. We shall quote only a few examples:

(P. 122): "1921 bemerkte KOCH im südlichen Teil von Peary-Land am Brönlund-Fjord, daß in einem bestimmten Niveau alle die Ergußsteine, die die grönländischen Schichten durchsetzen, wegerodiert worden sind und von Konglomeraten und Kalken ... überlagert wurden."

On p. 133 KOCH states with reference to the hiatus that separates the Cape Schuchert formation from the overlying Offley Island formation: "Man muß sich daher vorstellen, daß diese Schichtlücke so umfassend war, daß große Schichtfolgen der Offley-Insel-Formation in der Nähe des Kap Constitution Bewegungen ausgesetzt gewesen sind, die die Kalke und Schiefer der Kap Schuchert-Formation gefaltet und gestört haben. Ich neige dazu, diese Faltungen als Resultate einer plötzlichen Hebung mit folgender horizontaler Verschiebung kurz vorher abgelagerter Sedimente zu erklären, und nicht als Zeichen einer wirklichen Faltung."

As to his application of STILLE's system LAUGE KOCH writes (p. 152): "Mit großem Vorbehalt hat der Verfasser die von STILLE geschaffenen Namen auf diese Bewegungen angewandt und hat davon abgesehen, andere Namen für tektonische Phasen aufzustellen, soweit man bereits Bezeichnungen dafür hatte. ..." We must be obliged to the author for his modesty!

On p. 134 we find an information about a breccia containing graptolite slates from the strata deposited after the formation of the breccia and now resting on top of it.

Between the chapters "Grönlandium" and "Kambrium" a section is found bearing the title: "Tillit." On p. 22 it is at once stated that the Tillite Series contains "Blöcke spätkambrischer Sedimente." This is certainly a misprint for "spätpräkambrischer Sedimente", but the reader at first receives the impression that the age of the tillites is post-Cambrian.

On p. 23 on the other hand we read as follows: "In dieser Arbeit soll die Grenze zwischen Spätpräkambrium und Kambrium über den Tilliten gezogen werden," which evidently can mean only that the tillites are pre-Cambrian. But in the next line LAUGE KOCH writes: "In Grönland sind unterkambrische<sup>1)</sup> Tillite an vielen Stellen ... gefunden worden."

We find one more determination of the age of the same tillites on p. 127 where KOCH points out that the East Greenland tillites are correlated with tillites in Spitsbergen and in Norway, and that these deposits are considered as "altersgleich, d. h. eokambrisch"<sup>1)</sup>.

In the above we have quoted but a small part of the material which calls for criticism, not to say protest; it will however presumably suffice to make it clear that we find it necessary to dissociate ourselves as strongly as possible from "Geologie von Grönland" as a presentation of our present knowledge of the geology of Greenland; we have therefore thought it desirable to advance this criticism here in Denmark as strongly as

<sup>1)</sup> *Italicised by us.*

we have done, in order to make it clear abroad also that we disapprove of Dr. LAUGE KOCH's methods.

November 9, 1935.

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(sign.) LAUGE KOCH.

København d. 17/1 1936.

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