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Under Ledelse af Lauge Koch

REPORT ON THE EXPEDITIONS TO CENTRAL EAST GREENLAND 1926–39 CONDUCTED BY LAUGE KOCH

PART I

NOTES ON SOME TOPOGRAPHICAL AND GEOLOGICAL MAPS OF EAST GREENLAND

BY

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WITH 7 PLATES

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Introduction.

During and immediately after the war I have been engaged in writing a report on the East Greenland expeditions under my leadership, which started in 1926 and were continued almost without interruption till 1939. A large part of the manuscript has for a couple of years been ready for press, but since my expeditions have for the last two years taken almost all my time, I have not yet been able to complete the manuscript.

The accompanying maps were printed in 1947—49 and have been used on the expeditions since then. As it is no good thing that maps should attain a fairly wide distribution before publication, I consider it desirable to publish them with a very brief text as Part I of the above-mentioned report. I hope, however, that the remaining parts of the report will be published before long, all the more so since, as far as the geological maps are concerned, they contain detailed accounts by the various geologists who prepared the maps, of their journeys and the observation material on which the maps are based and on the whole of the conditions under which the work was done.

Topographical Maps.

(Pls. 1 and 2).

The two topographical maps are based on all available information published up to the beginning of the Second World War, first of all, of course, the topographic maps issued before the war by the Geodetic Institute, Copenhagen (cf. Koch 1940, p. 275). As regards the topographic material the reader is referred to my book "Survey of North Greenland" (1940), in which the majority of the expeditions on which the map material was collected are mentioned.

As to pl. 1, the southern part as far as 76° N. lat. is based on the maps of the Geodetic Institute, while the topography of the regions north thereof is based on terrestrial and air observations made on various expeditions. I take the opportunity here to thank especially Dr. P. Gelting, who has assisted me in working out the altitudes

mainly for Germania Land, and has supplied various information about the regions north and south of it.

The map of the area between 80° and 82° N. lat. is chiefly based on air observations made in 1933 (cf. KOCH 1940, pp. 290—299). The heights in the region north of 82° N. lat. mainly represent observations made on sledge journeys in 1917 and 1921 and on a flight from Spitsbergen over Peary Land and back in 1938 (op. cit. pp. 300—329). In the paper cited I mention that we must, of course, reckon with various inaccuracies, especially as regards the observations from the air. If more accurate observations should be made at some future time, the maps will probably have to be revised on many points; still I think that the material published here will be of some interest, for it gives, no doubt, a fairly correct picture of the broad features of the topography of the region.

As to pl. 2, a far more copious material is available. Thus the topography of the region between 65° and 69° and north of 72° N. lat. is based exclusively on the topographic maps already published by the Geodetic Institute. The same is true of the region around Scoresbysund between 70° and 71° N. lat. (Geod. Inst. map sheet 70[1]). For the area between 69° and 72° N. lat., comprising the whole interior of Scoresby Sund and the regions north and south thereof, the material is very sparse. For the tracts south of Scoresby Sund I have given the topography in broad features on the basis of observations made on two flights in 1932 (cf. 1940, p. 289). The same applies to the regions north of Scoresby Sund, though I have not ventured to give height contours for the southern part of Staunings Alper. As for the northern part of Jameson Land, the map is based on topographic measurements made by the geologist H. STAUBER and Captain IB POULSEN. The material for the altitudinal conditions of the nunataks and the inland ice west of the numerous ramifications of Scoresby Sund is unfortunately very sparse; in 1933 I had planned some flights across these tracts, but owing to the circumstances they could not be carried out; about the land areas between the fjord ramifications I have received much valuable information from Professor H. G. BACKLUND, who in 1934 travelled by aircraft and motorboat in these fjords; still for these regions, also, the topography is rather primitive.

The heights of the inland ice are taken in part from a relief map published by me in 1928 (KOCH 1928, fig. 140), altered in accordance with the observations made since then. Altogether the height contours of the present map are very similar to those of the map of the whole of Greenland on a scale of 1:5,000,000 published by the Geodetic Institute in 1947. That the contours must be accepted with some reservation, appears, however, from a note at the base of the latter map: "The re-

presentation of certain coast stretches and of the heights of the inland ice are not based on observations made by the Geodetic Institute." Practically all the height observations on the inland ice were made by means of aneroid barometers, and many of them on sledge journeys often lasting for weeks and at a time when changes of the atmospheric pressure could not be ascertained by radio. It may be pointed out that the map "Atlas of the Americas, sheet 1 D, 1948", published by the American Geographical Society, New York, corresponds in broad features to the map of the Geodetic Institute, though the contours on the inland ice have been somewhat revised; it is not stated, however, whether the corrections are based on observations made from the air or from the inland ice itself during the war.

Thus the two maps (pls. 1 and 2) are based on our knowledge of the altitudinal conditions up to and including 1939. The indication of levels from 0 to 200 m and of contours for every 500 m is meant to furnish as correct information as possible about the heights within this part of Greenland, as well as to give a general geographic picture and provide a map which may be useful for future flights in East Greenland.

That part of Greenland which is represented on the maps includes not only the highest part of the inland ice, but also those coastal tracts in which Greenland's highest mountains are located. Corresponding maps of South, West, and North Greenland cannot yet be prepared, but we are fairly certain that mountains exceeding 2000 m in height are very rarely met with in these parts of Greenland, and there can be no doubt that peaks exceeding 2,500 m do not occur. Mountains of this and greater heights are, however, found in several places within the areas comprised by the two accompanying maps; thus between 66° and 69° N. lat. a great many peaks rise above 2,500 m; some distance north of Angmagssalik there occurs, with Mont Forel as a centre, an area with peaks rising above 3,000 m—the height of Mont Forel has been found to be 3,360 m—and the highest mountains in Greenland are located a little south of 69° N. lat., many of them exceeding 3,000 m in height.

On the Geodetic Institute's map of Greenland (1947) the highest peak in Greenland (Gunnbjørns Fjeld) is stated to be 3,700 m high. As mentioned in my paper of 1940, on my flight over this peak I found (with four aneroid barometers) a somewhat greater altitude, namely a little over 4,000 m (cf. Koch 1940, p. 288). A similar result was arrived at by the British explorer M. Lindsay, who crossed the inland ice in 1934 (cf. Koch 1940, p. 274). The American, Major A. B. Sykes, who flew across these peaks during the war, takes Gunnbjørns Fjeld to be about 4,000 m high. That doubt has been expressed as to the height of Gunnbjørns

Fjeld, is probably due to the fact that it is very difficult to locate when approached from the south and east, while, when approached from the west and north, it is easily detected, standing out from the surroundings as a very marked peak.

Thus in central East Greenland, unlike other parts of Greenland, there are several areas with mountain peaks rising above 2,500 m, viz. the Mont Forel area (highest peak 3,360 m) and the Gunnbjørns Fjeld area (highest peak 3,700 m, possibly higher). These two areas rise considerably above the highest elevations of the inland ice, where the greatest height measured is, with reservation, 3,098 m. Furthermore Staunings Alper (highest peak measured 2,769 m) and the area about Petermanns Bjerg (highest peak measured 2,940 m). Finally, Dronning Louises Land, where, in Carlsbergfondets Land, we find the peaks Gefionstinder (2,785 m) and Revalstoppene (2,808 m) (cf. J. P. KOCH 1930, pp. 58—59 and pl. 1). North of the latter I observed from the air at least one mountain probably more than 2,500 m high. The latter three areas are located far from the 3,000 m contour line on the inland ice, and even during the maximum of the Ice Age several mountains within the five areas mentioned no doubt rose above the inland ice.

The land areas in central Northeast Greenland which are below 200 m are very extensive compared with Greenland as a whole. Direct comparisons with similar low-lying areas in other parts of Greenland must, however, be postponed till suitable material for comparison is available from these regions; but it is a fact that some of the most extensive areas of Greenland below 200 m are located within the tracts mapped in pls. 1 and 2. Thus vast low-lying tracts are found in Jameson Land north of Scoresby Sund, on Shannon, and in Hochstetter Forland, while fairly large areas occur around Germania Havn, and extensive low areas around Danmarks Fjord and Independence Fjord.

There can be no doubt that the first glaciers in East Greenland developed—probably already in the last half of the Tertiary period—around the highest peaks of Watkins Bjerge (including Gunnbjørns Fjeld), Mont Forel, Petermanns Bjerg, Staunings Alper, and Dronning Louises Land; similarly, if the inland ice melts some day, the last glaciers in Greenland will, no doubt, be found in these regions[1]).

In order not to destroy the picture of the altitudinal conditions, only the most important place names are indicated on pls. 1 and 2. For further information the reader is referred to the available special maps of the particular regions.

It is understandable that a representation of the geographical and geological features of a land like Greenland, so difficult of access, is

[1]) As early as 1913, L. R. WAGER states that "the Greenland Ice Cap . . . is believed to have been in existence since Miocene times".

attempted even though the available material is somewhat incomplete. But, as pointed out above, it is obvious that the maps will have to be revised gradually as the more accurate topographic mapping proceeds. In this connection mention may be made of three attempts to explain the fact that Greenland is one of the most extensive continuous high plateaus of the world, of a magnitude similar to those of Tibet, the South American Andes chain, and probably Antarctica. The first of these theories was published by G. De Geer in 1912. According to his theory the area between Greenland and Europe had subsided and the margins of the vast area of subsidence become uplifted in comparatively recent times. Another theory was advanced by the present author in a lecture in 1920 (published in 1923), namely that parts of Greenland had become uplifted with the result that the country had broken right across, and thus been divided into a northern and a southern block, both tilted towards the north. On the basis of this theory the author tried to explain the occurrence of large basalt areas both on the west and the east coast around 70° N. lat. Our knowledge of the topography of East Greenland was then very slight.

The upheaval of Staunings Alper seems to have commenced at the beginning of the Triassic period, and these alps probably supplied a large proportion of the material of the sediment basin located between Staunings Alper and Liverpool Kyst. The origin of this basin probably dates even farther back in time. As will appear from pl. 4, huge deposits of Carboniferous and Permian sediments are found on the eastern slope of Staunings Alper. This abrasion surface is traceable over large areas in the eastern part of Milne Land, as ascertained on a flight in the summer of 1949, when remnants of Mesozoic sediments, which formerly covered the whole eastern slope of Milne Land, were observed at rather considerable altitudes west of the known sediment areas around Kap Leslie. From the aircraft I also observed here what I took to be Permian sediments. The abrasion plane continues southward in the eastern part of Gaaseland, Mesozoic sediments being likewise found here.

The elevated area around Petermanns Bjerg has been explained as a Tertiary shield. It is doubtful whether this explanation is correct. Nor do we know whether Dronning Louises Land was formed by Tertiary upheaval. Since Tertiary sediments are of very rare occurrence in East Greenland, it is difficult to say anything about the Tertiary upheavals, but the numerous basalt occurrences both north and south of Scoresby Sund, decreasing gradually as we move away from the fjord, are suggestive of very unstable conditions here in Tertiary times.

The third theory was propounded by Alfred Wegener, known from his theory of continental drift. It may perhaps be briefly explained

as WEGENER explained it to the present author not long before his death: He compared Greenland to a cup filled to the brim with inland ice and with its bottom located in the centre of Greenland below sea-level, having been pressed down by the inland ice, which was likewise responsible for an uplift of the coastal mountains along the margins. If we imagine that the inland ice melted away, the interior of Greenland would rise, and the coastal mountains subside to a similar level to that of Arctic Canada. As will be known, WEGENER died before he succeeded in verifying his theory, but for the last few years his studies have been continued by a French expedition under the leadership of PAUL EMILE VICTOR.

Geological Maps.

(Pls. 3—7).

In 1926, when I commenced geological investigations in central East Greenland, some geological maps of parts of the area, published by earlier expeditions, were available, and they showed that the geological structure of these regions must be very complicated. In an earlier paper (KOCH 1929) I have treated the whole earlier literature and the results of the expedition in 1926—27 under my leadership. On the following expeditions, 1929—34, central East Greenland was investigated by a great many geologists, and a number of geological sketch maps were prepared. In the years 1931—34 the Geodetic Institute undertook surveying and prepared some preliminary topographic maps; copies of these, then unpublished, maps on a scale of 1:100,000 were at our disposal on the expedition 1936—38, so actual geological mapping could be done. The accompanying five maps are results of this mapping. In the forthcoming parts of the report the various geologists who carried out the mapping, will, as stated above, give accounts of their working conditions. Here it should especially be pointed out that the map of northern Jameson Land is not based on maps issued by the Geodetic Institute, but a topographic outline map had to be prepared on the basis of topographical measurements and a number of air photographs. On the whole the maps have naturally an individual character. A future revision of the maps may, of course, result in alterations of geological details, but the main features will probably be retained.

In the forthcoming parts of the report it is also stated which regions have been subjected to detailed geological mapping, and in which mostly air observations were made. The greater part of the northernmost area, comprised by pls. 6 and 5, the easternmost parts of which were mapped by A. VISCHER and W. MAYNC, was carefully investigated. A geological description by VISCHER (1943) and various geological maps and sections are available. A few corrections are due to W. MAYNC,

VISCHER staying in the tropics when the map was printed. VISCHER only aimed at mapping the regions not covered by post-glacial formations, on which account his maps differ from the other maps. Owing to deep snow and lack of time VISCHER and MAYNC were only able to carry out a rather sketchy mapping of the Kap Franklin area and Giesecke Bjerge, and, as a matter of fact, investigations after the war have shown that rather considerable corrections will have to be made in the maps of these areas. The available topographical maps of these regions are not good, either, being based on air photographs taken in bad weather, so more correct topographical maps will be required before the final geological revision, already commenced, can be completed.

In pl. 6 the symbols used by A. MITTELHOLZER (1941) are employed for the crystalline rocks. The disagreements between the geological mapping by A. MITTELHOLZER (pl. 6) and H. BÜTLER (pl. 7) as regards the southwesternmost area have not been taken into account; no doubt, however, BÜTLER's mapping is the more correct, MITTELHOLZER being here near the limit of his working area.

BÜTLER's map (pl. 7) is based on observations made on sledge journeys, numerous trips in motorboat, and two summer excursions, with Icelandic ponies, north of Moskusokse Fjord. These regions as well as the regions north and south of Gael Hamkes Bugt are among the areas of which the best geological maps are available. Further, H. STAUBER made detailed investigations of the eastern part of Geographical Society Ø, while the southeastern part of Traill Ø is represented on the basis of mapping carried out by H. P. SCHAUB (1942).

Almost the whole literature on the geology of central East Greenland is published in the "Meddelelser om Grønland", to which interested readers are referred for geological treatises, special maps, sections, etc. The accompanying maps are the first geological maps of Greenland based for the most part on modern topographical maps on a scale of 1:250,000. As stated above, a revision of them has already been commenced, and since 1947 the geological mapping has been extended westward between 72° and c. 74° N. lat. In future more uniformity of the geological maps will be aimed at, i. a. it will gradually be possible to publish them on sheets the same size as, and covering the same area as the topographical maps issued by the Geodetic Instutite, though for some time yet it will be most practical that they should have an individual character.

The colours used in the geological maps have been chosen by the individual authors. The colours in STAUBER's maps (pls. 3—4) are in the main those employed in the most recent geological map of France except for Tertiary basalt, which is indicated in black. However, this seemed a little too glaring, so on the two maps (pls. 5 and 6) of more

northerly areas the basalt is indicated by a dull blue colour in accordance with the French maps. As for BÜTLER's map it was necessary to choose quite a different colour scale owing to the many formations, the object being to give as clear a picture of the geology as possible without adapting the colours to those used in other geological maps.

To sum up: It should be borne in mind that many of the regions in which the geological mapping was carried out are extremely difficult of access, and the presence of snow in spring and autumn and sometimes in the summer, also, may interfere seriously with the plans laid beforehand. Only when the next part of the report has been published, will it be possible to form an idea of which regions have been satisfactorily mapped geologically, and where a revision will be required.

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