hold til den bortsmeltede ismasse i nord, Nordøstisen, som i forhold til den Baltiske is i syd. I dette periglaciale miljø eksisterede der permafrost i området, hvilket dels fremgår af nutidige polygonmønstre i dyrkede marker, dels af afstøbninger af iskiler i grusgrave.

På en lokalitet, Vejby/Ljungby, på nordsiden af Skälderviken er tre typer af iskiler iagttaget. Type 1 optræder i glaciofluvialt materiale; type 3 er dannet i moræne (till). Begge typer har direkte tilknytning til den nuværende terrænoverflade. Type 2 har en intersedimentar beliggenhed og er dækket af senere aflejringer. Kilerne er undersøgt ud fra et morfogenetisk, morfostratigrafisk og kronologisk synspunkt. Forekomsten af iskiler i till er mindre vanlig. I det aktuelle tilfælde er dannelsen af iskilerne begunstiget af et stort isindhold i morænematerialet, hvilket fremgår af bevarede strukturer efter segregationsis i materialet lateralt for kilerne.

Tidspunktet for dannelsen af iskilerne i intersedimentær position (type 2) falder i tidsrummet 14.000-13.000 år B.P. ifølge Lagerlunds glaciationskurve. De kiler, som har forbindelse med den nuværende terrænoverflade (type 1 og 3), er begyndt at dannes under Ældre Dryas eller senest i Yngre Dryas (11.000-10.500 år B.P.), da området henlå som tundra.

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A new map of the Mitdluagkat glacier – a preliminary report

Bent Hasholt

Hasholt, Bent: A new map of the Mitdluagkat glacier – a preliminary report. Geografisk Tidsskrift 87: 19-21, Copenhagen June 1987.

A new map covering the whole Mitdluagkat Glacier has been elaborated. The map is based on air photos from Geodetic Institute in scale 1:150,000 taken July 30, 1981. The scale of the new map is 1:20,000 with 10-m contour intervals. Preliminary field tests indicate that the map is so accurate that it might be used for comparative studies of long-term variations in mass balance of the glacier.

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Keywords: *Mapping, glaciology, air photos.*

The terminus of the Mitdluagkat Glacier has been observed since 1933. Maps from Geodetic Institute (1:250,000 and 1:50,000 surveyed 1932-33 and 1943, respectively) exist. A detailed map based on air photos from 1972 has been evaluated together with the maps from Geodetic Institute by Hasholt (1986).

The evaluation showed several differences between the maps with contradicting consequences for the computation of a mass balance of the glacier. It is most likely that some of the discrepancies are due to errors in the old maps from Geodetic Institute.

Another difficulty is that the map showing the 1972-situation is not covering the whole glacier, partly due to inadequate overlap between air photos and partly because of lack of photos of the southern part of the glacier.

There was therefore a need for a map covering the whole glacier so that a hypsographic curve could be drawn to facilitate studies of precipitation distribution and of mass balance. Part of the glacier was photographed by

Aerokort 1980, but the photos covered only the southeastern part of the glacier and could therefore not be used.

These years Geodetic Institute is mapping the northern and eastern part og Greenland on the basis of aerial photography. Photos covering the Ammassalik Island were taken 1981, and it was obvious to try to use these photos for elaboration of a more detailed map of the glacier.

Purpose

The purpose of this investigation was to elaborate a map covering the whole glacier using the aerial photos from 1981, which are available in a rather smalle scale (1:150,000), however. It was therefore also part of the purpose to evaluate how detailed a map it is possible and meaningful to elaborate. The new map could also indicate the reliability of the 1972 map compared to the old maps from Geodetic Institute. To facilitate studies of the water balance in the area it was also the intention to find a more exact location of the watersheds on or near the glacier.

Elaboration of the map

It was first planned to use the Wild B8 at the Institute of Geography in Copenhagen for the map-drawing. The optics of the Wild B8 could not cope with the wide angle photos from 1981, however. Therefore the firm Aerokort A/S, which owns a Zeiss Planicomp, was contacted; it was agreed upon that it was realistic to try to draw in a map scale of 1:20,000 with contour intervals of 10 meters.

The aerial photos from Geodetic Institute to be used were: 878 G 329 and 878 G 331 taken July 30, 1981. The main problem was, however, that there were no triangulation points or other signals visible on the 1981 aerial photos. It was therefore not possible to orientate the photos in a stereoscopic model immediately. To facilitate comparisons with the map based on the 1972 aerial photos, it was decided that the triangulation points from 1972 should be included in the new map. It was first tried to transfer these to the 1981 photos manually by identification of characteristic landforms near the fixed points. A test computation showed, however, that this method was not sufficiently accurate.

The next step was to use the 1972 photos on which the triangulation points are visible, to create new points by an aerotrigulation. Furthermore, due to the favourable location of the glacier near the sea, it was possible also to use the sea-level for orientatin of the stereoscopic model. The results of the aerotriangulation and the transfer of points are shown in table 1 together with a theoretical evaluation of the accuracy.

The map was drawn on the Zeiss Planicomp by cartographer J. Johansen at Aerokort. The author helped to define borders of the glacier and interpret watersheds, watercourses and lakes. The map is shown in black and white in plate 1. To faciliate the interpretation also a coloured version of this map was drawn with contours in green, border of the glacier in black, watersheds in red and water in blue.

A preliminary evaluation of the map.

In August 1986 the author was head of an expedition to the Mitdluagkat Glacier; one of the aims was to establish triangulation points in solid rock near the upper part of the glacier to facilitate future computations of mass balance by aerial photography and to evaluate the maps based on the 1972- and 1981-photos. Measurements were carried out with a Kern T2 Theodolite and a DM 502 electro-optical distancemeter from a nunatak situated 515 m above sea-level and from a peak on the watershed south of the glacier. Unfortunately, we were not able to connect the new triangulation points with the triangulation network at the coast because of bad weather (a piteraq, a gale with wind speeds from 32-60 m/sec.). It is therefore only possible to compare relative differences in height. On the map the approximate position can be identified of the westernmost top of the nunataks giving name to the glacier (Mitdluagkat meaning the breasts), the peak at the watershed and the nunatak 515 m above sea-level. The level of these points could be computed by use of trigonometric levelling relative to nunatak 515. Also a traverse across the glacier has been measured; this could, however, only be used as a rough estimate of the level on the map, because the surface of the glacier varies due to accumulation and ablation. The height difference between the 515 nuntak and the Mitdluagkat nunatak was 455.6 m found by trigonometric levelling, and by barometric levelling the value was found to be 465 m. The difference found from the map was 416.7 m. The difference between the 515 nunatak and the peak at the watershed was found to be 395 m by trigonometric levelling and 402 m from the map. The signifacant and non-systematic differences are thought to be caused by the fact that the cartographer has not been able to locate the highest points exactly in the stereoscopic model as the peaks have a very small horizontal extension. the traverse of the glacier shows that the deviations between the 1986 surface relative to the 515 nunatak and the surface on the new map from 1981 are 5-10 m.

The new map could also be compared with the map based on the photos from 1972. The base levels differ by 1.5-2.0 m so that the zero contour line on the new map lies approximately 1.9 m below the mean sea-level found by Hasholt (1986). The lakes situated along the western margin of the glacier could easily be compared on the two maps. The height difference between the water-surface levels of the two lakes is 129.2 m on both maps. When a correction to mean sea-level is made, the water-level of the northernmost lake is 147.4 m a.s.l. on the 1972 map and 146.1 on the 1981 map. The locations of lakes and comparable nunataks and rock outcrops have the same coordinates, which indicates that there is no distortion in the x-y plane.

As the threshold of the two lakes have been the same both in 1972 and in 1981, the water-level of the lakes could be used as a relative base-level, when the two maps are used for comparative studies of the glacier surface.

Finally, it is possible to compare the south-eastern part of the new map with a map drawn by Aerokort for GTO on the basis of aerial photos from 1980. Mean sea-level was used as base level in the 1980 map. When differences in base-level on the two maps are taken into account, the water-levels of the lakes differ only 0.5-1.1 m. A comparison between peak levels on the two maps also shows good accordance. This comparison indicates that, although the fixed points only are available in the westernmost part of the new map, no serious distortion of the height scale is present in the map.

```
Bilag 1

MODEL SCALE 1:  10000      TABLE SCALE 1:  10000      PHOTO SCALE 1:  14634

ORIENTATION DATA     LEFT PHOTO     RIGHT PHOTO                        MODEL
----------------
               F       152.420        152.420     FLIGHT HEIGHT         2217
           OMEGA          .621           .726     ABOVE GROUND
             PHI         -.704          -.893
           KAPPA         4.003          4.257     AZIMUT             -86.627
              BX       -59.273         59.273     MODEL     ( XGO    1542.96
              BY        -2.722          2.722     CENTER    ( YGO   11853.43
              BZ          .020          -.020     POSITION  ( ZGO    2217.67
MODEL BASE: B =   118.672 (ORTHO)    EARTH CURV.CORR.: R =           6370000

ORIENTATION REPORT
------------------
ABSOLUTE ORIENT.  USED CONTROL POINTS  PLANIMETRY   3 ELEVATION  7
                  POINT NO.              102           119              104
                  POINT NO.             1003          1004             1005
                  POINT NO.             1006          1007             1008
                  POINT NO.             1009
                  RESIDUAL COORDINATE ERRORS          MEAN              MAX
                                                 X    .114             .160
                                                 Y    .036            -.045
                                                 Z    .094             .185
RELATIVE ORIENT.  USED PARALLAX POINTS   9
                  RESIDUAL PARALLAXES     MEAN        .001    MAX     -.002
INTERIOR ORIENT.  USED FIDUCIALS  1234                LEFT       RIGHT
                                   X-SHRINKAGE     1.000562   1.000561
                                   Y-SHRINKAGE     1.000695   1.000645
                                   RECTANGUL.       .00005     .00000

Bilag 2

MODEL SCALE 1:  20000      TABLE SCALE 1:  20000      PHOTO SCALE 1:  156341

ORIENTATION DATA     LEFT PHOTO     RIGHT PHOTO                        MODEL
----------------
               F        87.716         87.716     FLIGHT HEIGHT        13165
           OMEGA          .598           .250     ABOVE GROUND
             PHI        -1.664          -.514
           KAPPA         4.015          4.444     AZIMUT             -50.614
              BX      -337.537        337.537     MODEL     ( XGO     693.57
              BY       -23.666         23.666     CENTER    ( YGO    7972.32
              BZ        -1.151          1.151     POSITION  ( ZGO   13203.71
MODEL BASE: B =   676.735 (ORTHO)    EARTH CURV.CORR.: R =           6370000

ORIENTATION REPORT
------------------
ABSOLUTE ORIENT.  USED CONTROL POINTS  PLANIMETRY  18  ELEVATION  10
                  POINT NO.             3005          3006             3002
                  POINT NO.             3016          3007             3009
                  POINT NO.             3017          3014             3015
                  POINT NO.             3008          3013             3010
                  POINT NO.             3011          3004              119
                  POINT NO.              104           102              105
                  POINT NO.             1001          1002             1003
                  POINT NO.             1004          1005             1006
                  RESIDUAL COORDINATE ERRORS          MEAN              MAX
                                                 X   1.258           -2.589
                                                 Y   1.187            2.752
                                                 Z   1.911            3.416
RELATIVE ORIENT.  USED PARALLAX POINTS   9
                  RESIDUAL PARALLAXES     MEAN        .001    MAX     -.002
INTERIOR ORIENT:   USED FIDUCIALS  1234               LEFT        RIGHT
                                   X-SHRINKAGE     .999470     .999673
                                   Y-SHRINKAGE     .999673     .999790
                                   RECTANGUL.      .00004      .00000
```

Table 1. Aerotriangulation data.

Acknowledgments

The Commision for Scientific Research in Greenland and the Danish Natural Science Research Council are thanked for supporting the project; also thanks to director O. Valbjørn and cartographer J. Johansen, Aerokort, for help and valuable discussions.

Summary and perspectives

A new map of the Mitdluagkat Glacier based on aerial photographs from 1981 in scale 1:20,000 has been elaborated. It is shown that it is possible to draw a fairly accurate map in the scale 1:20,000 with 10-m contour intervals although a very limited number of fixed points are at hand. This indicates that the aerial photos from Geodetic Institute in scale 1:150,000 could be used for elaboration of more detailed maps in other areas of scientific interest and for tourism purposes.

The new map represents a significant improvement of the knowledge of the Mitdluagkat Glacier. The good accordance with the 1972-map supports the hypothesis that there are significant errors in the topography on Geodetic Institute's old maps (from 1932-43). It is intended to make a more detailed evaluation of the map in the future; thus the triangulation points in the upper part should be connected with the points near the coast, and the level should be determined of the characteristic points that could be identified on the aerial photos. Such points will also be useful in case of future photo flights or availability of satellite scenes with high resolution. The glaciological and hydrological application of the new map will be described in a later report.

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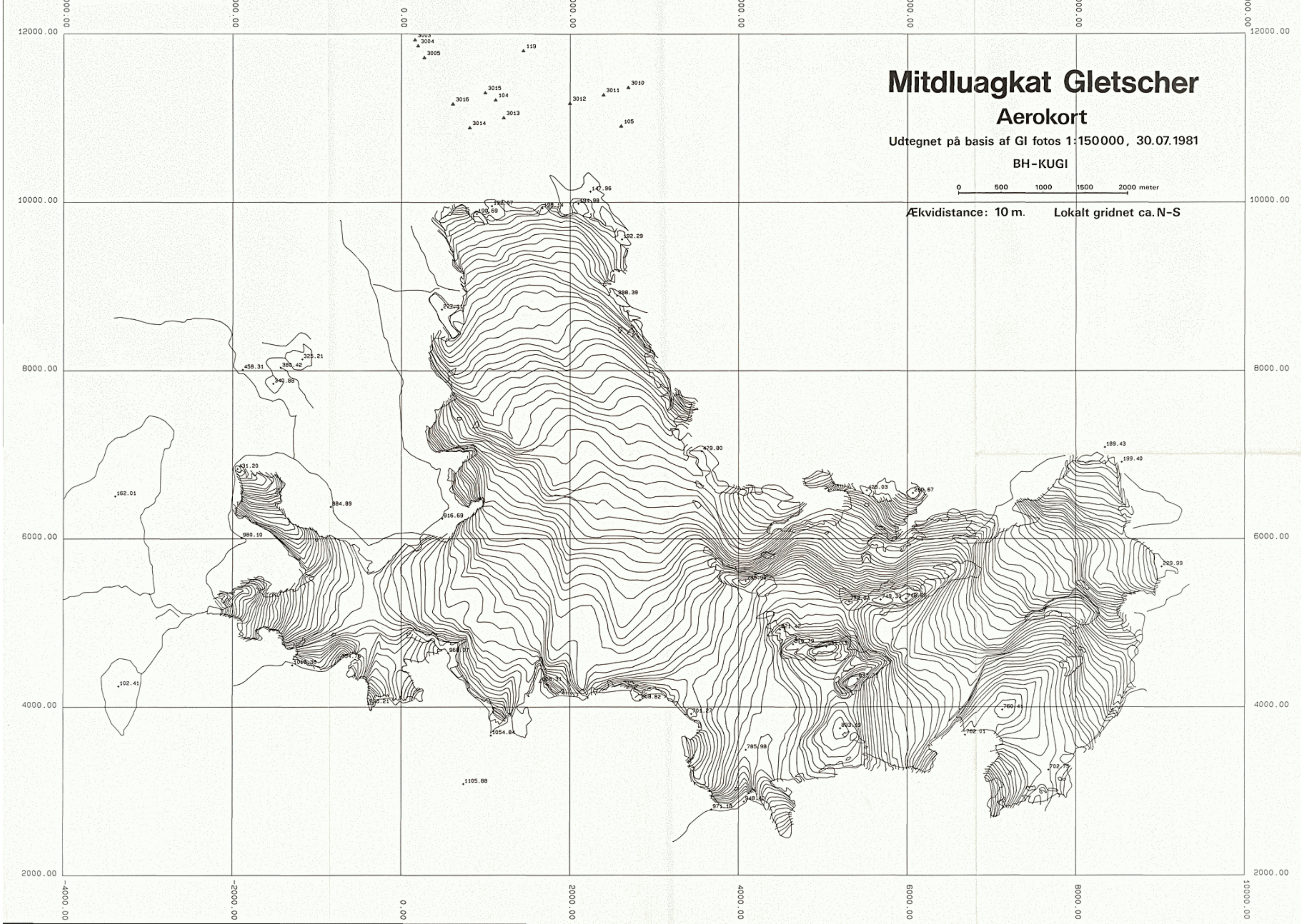
Mitdluagkat Gletscher
Aerokort
Udtegnet på basis af GI fotos 1:150000, 30.07.1981
BH-KUGI
0 500 1000 1500 2000 meter
Ækvidistance: 10 m.
Lokalt gridnet ca. N-S

and 146.1 on the 1981 map. The locations of lakes and comparable nunataks and rock outcrops have the same coordinates, which indicates that there is no distortion in the x-y plane.

As the threshold of the two lakes have been the same both in 1972 and in 1981, the water-level of the lakes could be used as a relative base-level, when the two maps are used for comparative studies of the glacier surface.

Finally, it is possible to compare the south-eastern part of the new map with a map drawn by Aerokort for GTO on the basis of aerial photos from 1980. Mean sea-level was used as base level in the 1980 map. When differences in base-level on the two maps are taken into account, the water-levels of the lakes differ only 0.5-1.1 m. A comparison between peak levels on the two maps also shows good accordance. This comparison indicates that, although the fixed points only are available in the westernmost part of the new map, no serious distortion of the height scale is present in the map.

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Bilag 1

MODEL SCALE 1:  10000      TABLE SCALE 1:  10000      PHOTO SCALE 1:  14634

ORIENTATION DATA    LEFT PHOTO    RIGHT PHOTO                          MODEL
----------------
              F     152.420       152.420       FLIGHT HEIGHT          2217
          OMEGA        .621          .726       ABOVE GROUND
            PHI       -.704         -.693
          KAPPA       4.003         4.257       AZIMUT              -86.627
             BX     -59.273        59.273       MODEL     ( XGO     1542.96
             BY      -2.722         2.722       CENTER    ( YGO    11853.43
             BZ        .020         -.020       POSITION  ( ZGO     2217.67
MODEL BASE: B =   118.672 (ORTHO)   EARTH CURV.CORR.: R =           6370000

ORIENTATION REPORT
------------------

ABSOLUTE ORIENT.  USED CONTROL POINTS  PLANIMETRY   3 ELEVATION  7
                  POINT NO.             102          119                104
                  POINT NO.            1003         1004               1005
                  POINT NO.            1006         1007               1008
                  POINT NO.            1009
                  RESIDUAL COORDINATE ERRORS        MEAN                MAX
                                             X      .114               .160
                                             Y      .036              -.045
                                             Z      .094               .185
RELATIVE ORIENT.  USED PARALLAX POINTS   9
                  RESIDUAL PARALLAXES      MEAN     .001    MAX       -.002
INTERIOR ORIENT.  USED FIDUCIALS  1234              LEFT      RIGHT
                                  X-SHRINKAGE      1.000562  1.000561
                                  Y-SHRINKAGE      1.000695  1.000645
                                  RECTANGUL.        .00005    .00000

Bilag 2

MODEL SCALE 1:  20000      TABLE SCALE 1:  20000      PHOTO SCALE 1:  156341

ORIENTATION DATA    LEFT PHOTO    RIGHT PHOTO                          MODEL
----------------
              F      87.716        87.716       FLIGHT HEIGHT         13165
          OMEGA        .598          .250       ABOVE GROUND
            PHI      -1.664         -.514
          KAPPA       4.015         4.444       AZIMUT              -50.614
             BX    -337.537       337.537       MODEL     ( XGO      693.57
             BY     -23.666        23.666       CENTER    ( YGO     7972.32
             BZ      -1.151         1.151       POSITION  ( ZGO    13203.71
MODEL BASE: B =   676.735 (ORTHO)     EARTH CURV.CORR.: R =         6370000

ORIENTATION REPORT
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ABSOLUTE ORIENT.  USED CONTROL POINTS   PLANIMETRY  18  ELEVATION  10
                  POINT NO.             3005         3006              3002
                  POINT NO.             3016         3007              3009
                  POINT NO.             3017         3014              3015
                  POINT NO.             3008         3013              3010
                  POINT NO.             3011         3004               119
                  POINT NO.              104          102               105
                  POINT NO.             1001         1002              1003
                  POINT NO.             1004         1005              1006
                  RESIDUAL COORDINATE ERRORS         MEAN               MAX
                                             X      1.258            -2.589
                                             Y      1.187             2.752
                                             Z      1.911             3.416
RELATIVE ORIENT.  USED PARALLAX POINTS   9
                  RESIDUAL PARALLAXES      MEAN      .001   MAX       -.002
INTERIOR ORIENT:    USED FIDUCIALS  1234            LEFT          RIGHT
                                  X-SHRINKAGE  .999470       .999673
                                  Y-SHRINKAGE  .999673       .999790
                                  RECTANGUL.   .00004        .00000
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