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EXPEDITION GLACIOLOGIQUE INTERNATIONALE AU GROENLAND
E. G. I. G. 1957—1960 Vol. 2 No. 2[1]

REPORT OF THE GEODETIC, GEOPHYSIC, AND PHOTOGRAMMETRIC WORK AT THE WEST COAST REGION OF GREENLAND

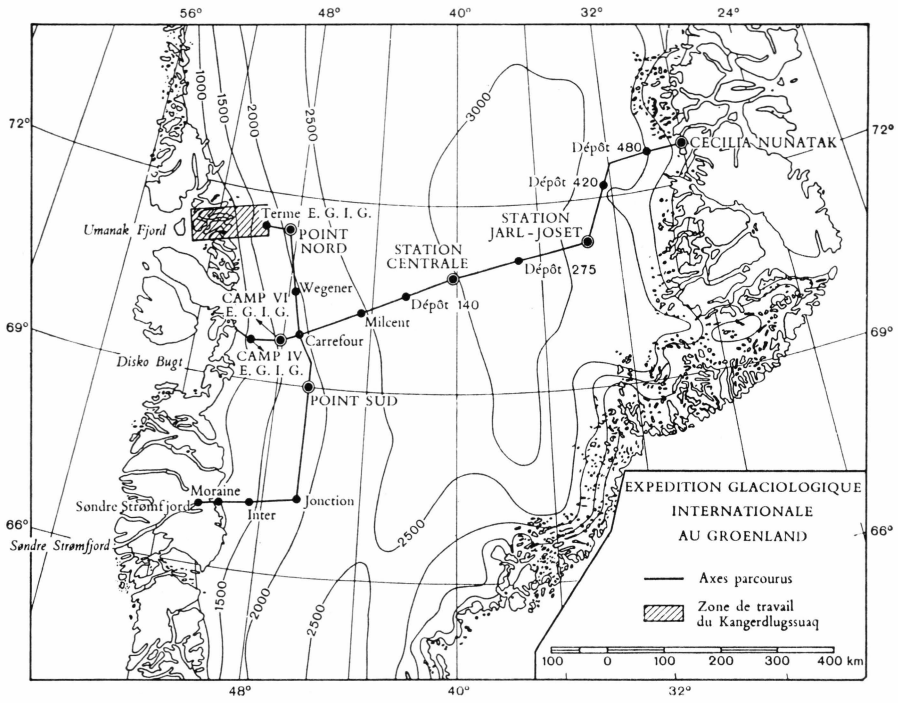
EXECUTED BY THE DANISH
GEODETIC INSTITUTE IN CONNECTION WITH
THE ICE-CAP WORK OF E. G. I. G.

BY

EINAR ANDERSEN

WITH 1 FIGURE AND 3 TABLES IN THE TEXT
AND 2 ANNEXES

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1969



EXPEDITION GLACIOLOGIQUE INTERNATIONALE AU GROENLAND 1957–1960

Réalisation technique:
EXPEDITIONS POLAIRES FRANÇAISES
(Missions Paul-Emile Victor)

L'Expedition Glaciologique Internationale au Groenland est une expédition commune à un certain nombre d'organismes scientifiques des pays suivants: Allemagne, Autriche, Danemark, France et Suisse. Créée en 1956, elle fut autorisée par le Gouvernement du Danemark et patronnée par l'Association Internationale d'Hydrologie Scientifique.

La direction scientifique de l'expédition est assurée par le Comite de Direction, et sa réalisation confiée aux Expeditions Polaires Françaises. Le chef d'expédition est Paul-Emile Victor. Le support aérien a été assuré par les Forces Armees Air (France).

Aprés deux années de préparation et de reconnaissances (1957–1958), le programme de recherches glaciologiques dans la partie centrale du Groenland a été réalisé pendant la campagne d'été 1959 et l'hivernage à la Station Jarl-Joset (1959–1960). L'expédition proprement dite s'est terminée par une campagne réduite en 1960 ramenant hivernants et matériel.

INTRODUCTION

Denmark has a natural and all-comprehending interest in scientific activity in Greenland. Owing to the immense size of Greenland specially compared with Denmark proper, Danish scientific initiative has mainly been limited to the large coastal regions. Therefore, Denmark highly appreciates foreign activity on the Ice-cap, and although Denmark is not a proper member of the EGIG it has been quite natural for The Danish Geodetic Institute to assist the expedition in making the necessary connection between the geodetic network of the institute and the measurements on the Ice-cap and in making the photogrammetric work of the coast region. In Denmark, too, there is a growing interest for Glaciology, and newly a Danish Commission on Glaciology has been formed.

Abstract

The present geodetic work gives the connection between the northern terminal of the E.G.I.G. network on the Ice-cap and the Danish first order triangulation on the West Coast and furthermore the geodetic control for the aerotriangulation. Gravity measurements have been made at all the geodetic stations. The computations have been made on GIER, the electronic computer of the Danish Geodetic Institute. A topographic map in scale 1 : 50 000 of Kangerdlugssûp sermerssua has been compiled.

A. GEODETIC AND TOPOGRAPHIC DATA AVAILABLE FOR THE WORK

A.1. The West Coast

The geodetic data consist in a first order triangulation along the entire coast and an area triangulation supported on the former for geodetic control of the maps.

Maps are available in the scale 1:250 000 covering the major part of the ice-free land. These were at the beginning based upon plane-table methods but are now all – with a few exceptions – compiled on aerial photogrammetry.

A.2. The East Coast

The geodetic data consist of several small triangulation chains or area networks, each based upon an astronomical datum. The triangulations are not connected to the West Coast network except for the southernmost 300 km.

The maps over East Greenland cover approx. 40 % of the total area. The scale is 1:250 000, and the basis is aerial photogrammetry throughout.

It is rather unlikely that a uniform datum will be available within few years.

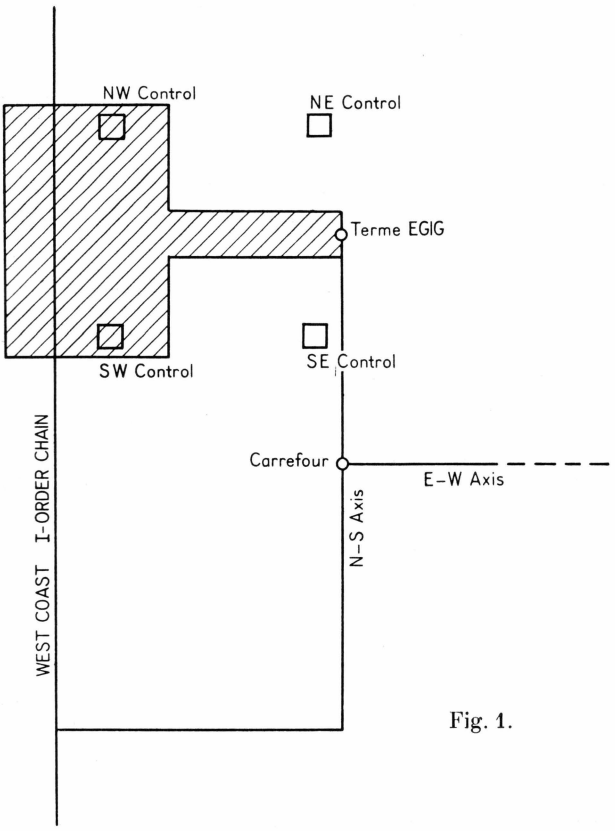


Fig. 1.

B. GEODETIC WORK

B.1. Introduction

The geodetic work should give a connecting of the network established on the Ice-cap by the Ice-cap Geodesy Group (IGG) with the triangulation on the West Coast. A reference on the East Coast would seem to be valuable, but as no uniform datum is available the subsequent evaluation of the movements of the ice must be based upon a fixed, but unknown station on the East Coast. It was consequently decided to give up any connection at the East Coast.

The connection at the southern terminal was established by other groups, and the IGG connected the east terminal. The connection at the northern terminal (Terme EGIG) thus remained to the Coast Geodesy Group (CGG), which was the contribution from the Geodetic Institute.

Besides this the CGG should provide part of the geodetic control for the aerotriangulation for the map in 1:50 000 of the ice drainage basin at Kangerdlugssuaq.

Fig. 1 shows a diagram of the geodetic work.

B.2. The Connection of Terme EGIG with the West Coast Network

This work was carried out jointly by the IGG and the CGG as measurements of distances and directions from a station established by the CGG to Terme EGIG and the station groups established in the NE and SE corners of the area to be covered by the map in 1:50 000 (See Annex 2).

Two stations at the coast area would have been desirable, but due to transportation shortage this had to be abandoned.

B.3. Geodetic Control

The CGG provided geodetic control for the aerotriangulation by means of station groups at the NW and SW corners of the area. The groups at the NE and SE corners were surveyed by the IGG.

B.4. Gravity Measurements

In general the gravity was measured at all stations occupied for the triangulation. The instrument was a Worden Gravity meter without thermostat. The nature of the work, however, did not permit special efforts in this respect. The transport of the instrument to and from Greenland gave a possibility of confirming the accepted value of the gravity difference between two reference stations in Denmark and Greenland, respectively.

B.5. Time Schedule

Table 1 shows the time and branches of work.

Table 1

Date 1959	Work
5 July –19 July	Installation of base camp. Measurement of SW geodetic control stations.
20 July – 5 August	Connection to Terme EGIG. Part of NW geodetic control stations.
6 August–15 August	Measurement of remaining stations of NW geodetic control. Connection of NW and SW stations.

B.6. Survey of Stations

Total number of stations:	41	(including 6 stations of the IGG).
ber of new stations:	35	–
Number of Ice-cap stations:	11	–
Number of old stations	6	

B.7. Methods

The network types are classical triangulations and Tellurometer-measured traverses. Annex 1 shows the network.

By the computation the network was divided in two blocks.

1) The primary network, consisting of a) the connecting network, b) the NE and SE geodetic control groups (as these in fact are part of the connecting network) and c) part of the NW geodetic control group.
2) The secondary network, consisting of the rest of the NW geodetic control group and the entire SW group.

The primary network included triangulation and traverse work, whilst the secondary one is a triangulation network.

For the traverses a double side technique frequently was adopted in order to acheive some control. The technique essentially consisted in using an eccentric station with the main station and duplicate the observations at the main station in the eccentric station. The mutual position of the main station and the eccentric one was determined too.

The angles were measured with three zeros.

The zenith distances were measured as two independent sets.

The determinations of distance were carried out as 1 or 2 measurements, each consisting of 10 sets.

B.8. Computation

The computation was executed by means of GIER (the electronic computer of the Geodetic Institute).

The field records were directly punched on paper tape, leaving all handling of the material to the computer with suitable programmes.

The Tellurometer measurements were reduced to geodetic distances by the computer. This included the forming of mean values in cases of more than one measurement. The output tape from this step then entered the adjustment jointly with the angular measurements.

The primary network was adjusted as one block. As eccentric setups were treated as independent stations the total number of new stations in this adjustment is 42, whilst 6 stations of the first order network were held fixed. The programme is based upon the principles of variation of coordinates. The programme handles both angles and distances, thus being without distinction of the type of the network. This permitted the full use of both traverses and triangulation jointly.

The secondary network was adjusted as one block, too.

The programme finds the elements of the inverted matrix needed for the computing of the mean errors of the coordinates and gives these mean errors jointly with the coordinates.

The mean errors of the coordinates are approx. 1 metre near the first order stations. At the far ends of the network, the mean errors are approx. 2.5 metres.

Table 2 gives the geographical coordinates and the altitudes of the stations.

Table 2

No.	Latitude	Longitude	Altitude
	° ′ ″	° ′ ″	m
5 001	70 55 00.55	52 05 23.54	1688
5 002	71 10 32.26	52 57 59.37	740
5 003	70 48 21.16	54 04 44.93	754
5 004	70 44 41.67	52 52 58.78	743
5 005	70 43 16.60	51 48 11.93	1418
5 006	70 49 55.86	50 54 20.37	940
5 025	70 59 54.82	52 14 51.36	98
5 510	71 20 17.38	51 34 15.66	1420
5 511	71 10 02.69	52 26 29.01	1329
52 001	71 31 57.61	51 27 42.63	1829
52 002	71 23.32.70	51 24 46.83	1809
52 003	71 28 14.67	50 55 13.46	1619
52 004	71 14 12.76	51 19 53.02	1696
52 005	71 09 13.18	50 53 12.68	1168
52 006	71 12 57.06	51 44 50.02	1608
52 007	71 11 13.57	51 32 24.99	1682
52 008	71 17 23.72	51 45 23.23	87
52 009	71 17 26.84	51 45 22.39	84
52 010	71 18 24.50	51 30 21.92	9
52 011	71 17 27.09	51 30 57.55	242
52 012	71 18 00.28	51 29 42.49	213
52 013	71 15 14.52	51 43 30.24	20
52 014	71 24 27.26	51 41 14.81	347
52 015	71 24 26.81	51 41 16.91	348
52 016	71 30 39.20	51 35 35.42	33
52 017	71 30 18.10	51 30 14.08	25
52 018	71 29 44.06	51 25 03.53	151
52 019	71 26 48.30	51 34 11.29	70
52 020	71 27 10.21	51 35 46.17	10
52 022	71 32 57.33	51 28 13.33	1735
52 023	71 32 42.42	51 26 41.02	1769
52 024	71 29 37.39	51 18 28.06	1417
52 025	71 18 17.06	51 21 28.26	766
52 026	71 17 13.36	51 25 51.58	548
52 027	71 17 14.50	51 22 57.34	651

(continued)

Table 2 (cont.)

No.	Latitude	Longitude	Altitude
	° ′ ″	° ′ ″	m
52 028	71 17 45.89	51 20 04.53	725
52 029	71 14 40.36	51 33 12.95	71
52 030	71 16 39.46	51 32 45.57	4
52 031	71 31 44.32	51 18 36.78	1737
52 032	71 18 25.75	50 45 01.24	1242
52 033	71 11 10.59	52 13 51.23	28
52 034	71 25 14.82	49 35 40.14	1776
52 035	71 30 29.18	49 52 00.04	1707
52 036	71 32 51.85	49 52 04.65	1702
52 037	71 30 40.83	49 43 53.44	1724
52 038	71 32 34.08	49 44 26.89	1727
52 039	71 31 51.18	49 46 28.68	1688
52 040	71 20 23.64	49 54 52.70	1632
52 041	71 23 05.11	49 53 36.82	1641
52 042	71 20 14.65	49 50 40.94	1668
52 044	71 22 42.40	49 52 39.35	1646
52 045	71 27 41.66	49 49 33.08	1710
52 047	70 59 55.55	52 14 56.15	96

B.9. Instruments

The theodolites were four Wild T 2 and one Wild T 3. The latter was brought mainly for astronomical observations (in emergency) but was not used.

The set of Tellurometers consisted of one Master and one Remote MRA 1, modified for arctic use by means of crystal ovens and better power supplies. A frequency measuring equipment was brought for check of the modulation frequencies.

B.10. Personnel

Survey Group.

J. K. Ekholm, civ.eng., leader
O. B. Andersen, M.Sc., geodesist
C. J. Lehn, M.Sc., geodesist
K. Poder, M.Sc., geodesist.

H. Boysen, assistant
T. Jensen, assistant
I. D. Petersen, assistant.

4 Greenlanders were employed at the camp.

Ship officers and crew onboard Ole Römer.

A. TOFT, captain
S. SEHESTED, mate
B. WOCHNER
B. JENSEN

The helicopter group.

Mr. PAUL-EMILE VICTOR most kindly placed two helicopters at the disposal of the Coast Geodesy Group. The two *Alouette* helicopters belonged to the Centre d'Expérimentations Aériennes Militaires de l'Armée de l'Air Française.

Equipages (crew):

CLAIREAUX, pilote, Adj. Chef
DRION, mécanicien hélicoptère, Sgt. Chef
GALLIER, pilote, Sgt.
LACROIX, mécanicien hélicoptère, Sgt.
CASTERRA, mécanicien équipements, Sgt.
VIOLLON, radio, Sgt.
HUDEBERT, mécanicien réacteur, Sgt.

C. THE PHOTOGRAMMETRIC WORK

C.1. Introduction

In connection with the programme of the EGIG, some special photogrammetric work was undertaken in Greenland. The aerial photography team of the Geodetic Institute was instructed – in addition to the normal flying programme of the Institute – to carry out the following:

a. Photo coverage in scale 1:45 000 of the drainage-basin of the Kangerdlugssûp sermerssua (71°30′ N, 51°00′W).

b. Photo coverage in scale 1:50 000 of the border of the Ice-cap on the West Coast between 68° and 72° N.

c. Photo coverage in scale 1:50 000 of the outfall of the more significant glaciers in the area above mentioned, repeated after a period of 8–14 days.

Based upon that information it was thought to prepare:

ad a. Compilation of a topographic map in scale 1:50 000 with 10 metre contour line intervals based upon aerotriangulation between 4 specially established, marked, and measured groups of points.

ad b. A record of the border of the Ice-cap at a fixed date.

ad c. Determination of the speed of movement of the glaciers.

C.2. Photographic Flights

ad. a. The area was photographed on August 10th 1959 with a B-17 (CF–IBC). The camera was a ZEISS RMK 15/23 no. 2118. The film material was Ilford Hyperpan Aerial. The flight resulted in runs no. 236 A–K, 6 east/west and 4 north/south directed flights with a total of 271 photograms.

ad b+c. The border of the Ice-cap and the glaciers were photographed simultaneously on June 25th and 26th 1959. The resulting runs were: 237 A–L, 238 A–Q, 27 flights with a total of 203 photograms.

Unfortunately the photoflights were not repeated. Even if the crew was watchful about the weather-forecast for the region in question the meteorologists on Thule Air Base could not give them a reasonable forecast until August 20th, when the Kangerdlugssuaq region was photographed, but so much time had passed that a repeated photoflight would have been useless.

C.3. Plotting

The markings of signals etc. were finished and the area ready for the photoflight on July 27th, but due to the above mentioned weather conditions the flight first took place from Thule Air Base on August 20th. This might be the reason why none of the signals were to be identified on the pictures. The original plan for the plotting to condense the 4 groups of control points in the field by a block-triangulation thus had to be modified and reduced considerably. Consequently the plotted area also had to be reduced to the mere mouth of the glacier.

Nevertheless, it is doubtful whether an earlier photomission could have improved the final result. At any rate, it appears that the existing photographs have poor definition in the Ice-cap, just a few models away from the border of the glacier. Therefore, it was impossible to establish models for either triangulation or plotting, in spite of the fact that the altitude was reduced from 10.000 metres – as recommended by E.G.I.G. – to about 7.000 metres.

Since there were no detailed specifications given in the request for making a "topographic map in scale 1:50 000 with contour intervals of 10 metre" modifications were made to meet the existing conditions. The alpine character of the surrounding walls is too vigorous for that relative dense interval, and equivalent conditions prevail to a certain degree for the glacier itself.

In order to present as detailed a representation of the glacier as possible – which was the main aim of the plotting – it was decided to give a contour interval of $12^1/_2$ metre, while the surrounding ice-free areas were represented by an interval of 50 metres.

Very soon it was clear that the contour lines in some places would give a disturbed picture of the ice, but it was decided to maintain $12^1/_2$ metre intervals which was best suited to the main purpose of the plotting, *i.e.*, not to produce a conventional topographic map but to give a picture or rather an observation of the appearance of the glacier at a certain date.

It must be emphasized that only the main features of the relief are represented. Many minor, local contour lines have been omitted since

they would destroy the general impression of the relief representation and make it impossible to read the map. An attempt to give more detailed information by use of more spot elevations was given up in the interest of clarity.

In accordance with these considerations the two identified groups of points were connected by Stereoplanigraph C8 no. 71010 in September-October 1960, while the strips had to be adjusted separately because of lack of the ice-stations. The plotting was not started until November 1961, by use of Wild A8 no. 740, and was completed in December 1961.

C.4. The Topographic Map

The clean-drawing, *i.e.* colour-separation, engraving on plast, lettering etc. has been completed at the Geodetic Institute, and the final map is enclosed as Annex 2.

As it stands this map is no final answer to any glaciological question. Only when compared with a new map, made in connection with another expedition in some future, perhaps in about 10 to 20 years time or more, possible changes in the bed-rock or in the ice-flow can be observed.

C.5. Glacier Measurements

Table 3. *Photo coverage in scale 1:52 000 of the outfall of the more significant glaciers between 69° and 72° N.*

Jakobshavns Isbræ	69°10′	29/6:	272 C/265–268	12/7:	273 C/107–110
Sermeq avangnardleq	69°20′	29/6:	D/259–262	12/7:	D/111–114
Eqip sermia	69°47′	29/6:	E/252–257	12/7:	E/119–125
Kangilerngata sermia	69°55′	9/6:	F/ 21–27	22/6:	F/239–245
Sermeq kujatdleq	70°00′				
Sermeq avangnardleq	70°03′	9/6:	G/ 13–17	22/6:	G/232–236
Store Qarajaq Gletscher	70°23′	9/6:	H/ 30–33	22/6:	H/225–228
Lille Qarajaq Gletscher	70°31′	9/6:	J/ 36–39	22/6:	J/218–222
Sermiliq/Kangidleq	70°43′	9/6:	K/ 44–49	22/6:	K/158–164
Sermeq silardleq	70°48′	9/6:	L/ 52–54	22/6:	L/168–170
Perdlerfiup sermia	71°00′	9/6:	M/ 58–61	22/6:	M/213–215
Kangerdluarssûp sermia	71°15′	9/6:	272 N/ 65–67	22/6:	273 N/174–176
Kangerdlugssûp sermerssua	71°28′	9/6:	O/ 72–75	22/6:	O/181–183
Rinks Isbræ	71°45′	9/6:	P/ 79–81	22/6:	P/202–204
Umiámako Isbræ	71°43′	9/6:	Q/ 83–85	22/6:	Q/208–210

As mentioned in C.2. b–c above, no repeated photoflights over glaciers were executed in 1959.

However, a renewed attempt was made during the summer of 1964 resulting in the above-mentioned photograms, see Table 3.

The table only gives the numbers of the photograms covering the glaciers. Normally the runs are somewhat longer in both ends.

Færdig fra trykkeriet den 16. april 1969.

Annex 1.

52° 30' 52° 51° 30' 51° 50° 30' 50° 49° 30'

71° 35' 71° 30' 71° 15' 71°00' 70° 45'

52022 52023 52001 52031 52016 52017 52018 52024 52020 52019 52014 52015 52002 5510 52010 52009 52008 52012 52025 52028 52011 52026 52027 52030 52013 52029 52004 52006 52033 52007 5511 52005 52047 5025 5001 5006 52003 52032 52036 52038 52039 52035 52037 52045 Terme EGIG 52034 52041 52044 52040 52042

KANGERDLUGSSUAQ

KANGERDLUGSSUP SERMERSSUA

KANGERDLUARSSUK

PERDLERFIUP KANGERDLUA

TORSSUKÁTAK

E

EXPEDITION GLACIOLOGIQUE INTERNATIONALE AU GROENLAND

COAST GEODESY GROUP

Primary Network

Secondary Network

E Electronic Distance Measurement

Geodetic Institute, Copenhagen 1965.

Reproduceret ved Geodætisk Institut. København 1965

GRØNLANDS GEOLOGISKE UNDERSØGELSE
THE GEOLOGICAL SURVEY OF GREENLAND

MAP OF THE GENERAL GEOLOGY OF THE AREA BETWEEN SERMILIGÂRSSUK AND IGALIKO FJORD

Legend

Gardar
- Granite
- Nepheline Syenite
- Augite Syenite AS
- Gabbro
- Lavas
- Igaliko sandstone

pre-Gardar
- Intrusive Granite
- Julianehåb Granite and other autochthonous granites
- Gneisses
- Low Metamorphics

Fault

0 10 20 30 km.

SERMILIGÂRSSUK
TÖRNÂRSSUK
KUNGNÂT
IVIGTUT
ÂRSUK FJORD
ÂRSUK
GRØNNEDAL
KINÂLIK
SÂNERUT
KOBBERMINEBUGTEN
Isortoq
Ilordleq
Ilorro
AS
NUNARSSUIT
Sarqamiut
OKSSIMIUT
QAERSUARSSUK
BREDEFJORD
TUGTUTOQ
NARSSARSSUAQ
Eqalulit kûa
ILÍMAUSSAQ
TUNUGDLIARFIK
IGALIKOQ
NARSSAQ
IGALIKO FJORD
JULIANEHÅB
Pârdlit
TCRP 1961

61°
48°
47°
69
66
63
60
48
40