

# EXPÉDITION GLACIOLOGIQUE INTERNATIONALE AU GROENLAND 1957-60 (E.G.I.G.)

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**ABSTRACT.** Detailed account of the work to be undertaken by the International Glaciological Expedition to Greenland during 1959, together with brief notes on the previous researches which have led up to this work.

**RÉSUMÉ.** Aperçu détaillé des travaux à entreprendre par l'Expédition Internationale Glaciologique au Groenland au cours de l'année 1959, accompagné de notices sur les recherches antérieures qui ont conduit à ces travaux.

**ZUSAMMENFASSUNG.** Eingehender Bericht über das Werk, das von der Internationalen Gletscherexpedition nach Grönland im Laufe des Jahres 1959 unternommen werden soll, zusammen mit kurzen Aufzeichnungen über die vorhergehenden Forschungen, die zu diesem Unternehmen geführt haben.

THE International Glaciological Greenland Expedition was planned to investigate the Greenland Ice Cap in that region where the greatest activity of ice occurs, i.e. in the western area between lat. 69° and 72° N. (here the big ice streams run out into the fjords). Its aim is to obtain a better knowledge of the inner parts of the ice cap, its movement and behaviour from the surface down to the bedrock. Five countries are participating: Denmark, France, Switzerland, Austria and Germany. By the time this short report on the aims of the expedition is published in this *Journal*, most of the field work of the expedition will have been carried out by the principal summer campaign of 1959. In 1960, only the wintering of a group of six men at a station on the ice cap will remain to be done. This report must therefore be considered as preliminary and has been written at the request of the Editor.

The scientific work of E.G.I.G. is marked by the fact that many expeditions and scientists have worked in this part of the Arctic during the last 70 years. Therefore this research can be more specialized than is possible in other parts of the polar regions, which have, until now, been far less explored. For this reason it seems necessary first to refer briefly to the work and results of these previous investigations, which have provided the basis for the work to be carried out by E.G.I.G.

In 1880 Nordenskiöld discovered the big tongue of the Nordenskiöld Glacier, and was the first scientist to reach the ice cap. To his surprise he did not find green valleys on it but the immense inner ice plain. Nansen crossed this ice plain more to the south from east to west in 1888. The Swiss scientist A. de Quervain made a famous crossing in 1911, and was the first to carry out important scientific observations there. The Dane, J. P. Koch, and the German, A. Wegener, followed in 1912, crossing more to the north where Greenland is widest and again achieved interesting results on climate, topography and the nature of the snow and ice. A more intensive but locally limited piece of research was accomplished in 1892-93 by the German, E. von Drygalski, on the big glaciers of Umanak Bay. He systematically measured the ice velocities and discovered that the fast-flowing ice streams were moving 100 times faster than the glaciers of the Alps. He was the first to winter in the field with his expedition, and was also the first to obtain meteorological records covering a whole year.

The first modern expedition with a wide and intensive scope was that led by A. Wegener (1929-31). He drew a profile across the whole continent with three wintering stations—on the eastern and western coasts, and (especially) in the middle of the ice cap at "Eismitte" at an elevation of about 2,900 m. He gained a deeper insight into the anticyclone lying over Greenland. By soundings he found the thickness of the ice cap surprisingly great. He also tried to present a geodetic profile from the west to Eismitte.

A still more intensive investigation in the steps of Wegener was the aim of the famous French expeditions of Paul-Émile Victor from 1949 to 1953—the “Expéditions Polaires Françaises”. These expeditions made a profile across the ice cap on a route more to the south, but also from the “Station Centrale” near “Eismitte”, and further on to Cecilia Nunatak in the east. Excellent ice-soundings and gravimetric measurements were also made along far-reaching routes to the north and south, and gathered deeper knowledge of the bedrock and the ice regime of Greenland. Meteorological and snow conditions were systematically observed during several winters at the “Station Centrale”. The geodetic profile from the west

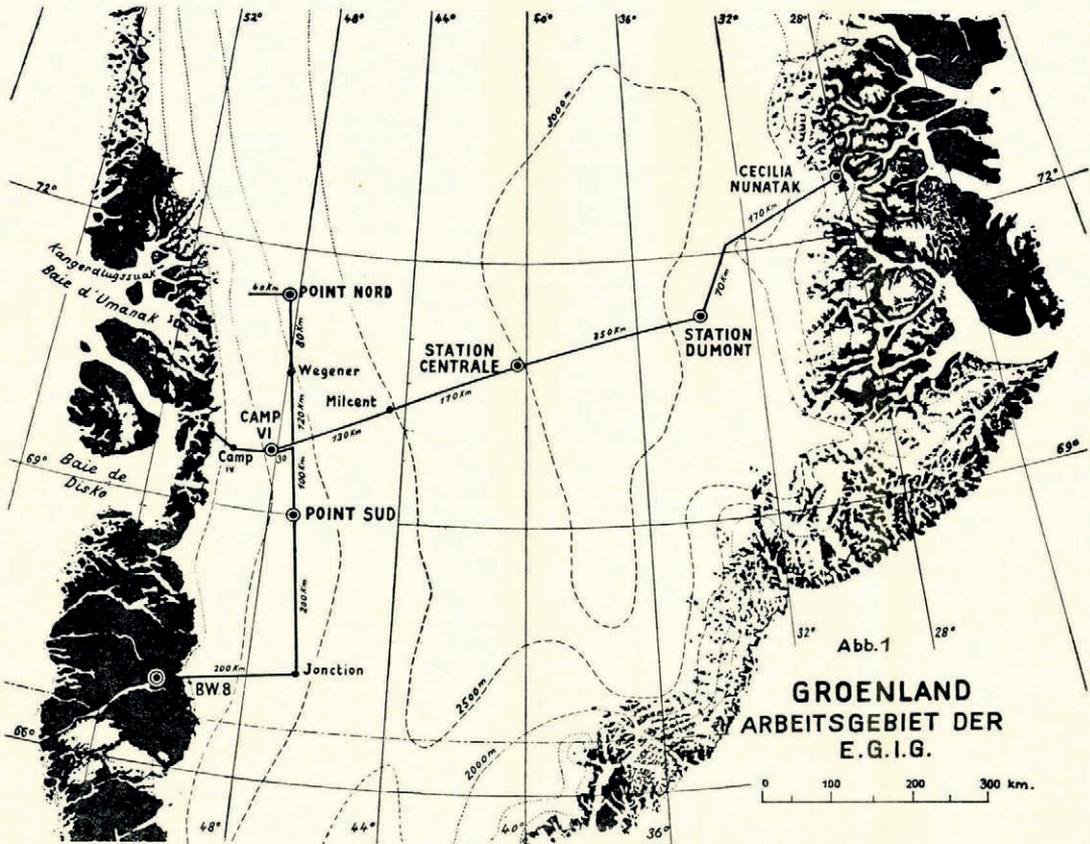


Fig. 1. Area covered by the E.G.I.G. researches

coast to the station was of great value, as this was fixed by strongly bedded stakes which remained visible some years later. Some of these were lengthened in 1955 by an American team and are still standing. Great experience about modern transport was gained with weasels and aircraft, also about the *organization* of intensive scientific research. The French suggestion of international co-operation in order to solve the problems not yet completed, especially those brought to light by their expeditions, was of decisive value. This initiative led in 1956 to the foundation of E.G.I.G., in which the French again take the greatest part, not only in organization and transport through the “Expéditions Polaires Françaises”, but also in scientific experience gained during the former expeditions.

From the previous work briefly summarized above the following tasks for E.G.I.G. have presented themselves:

## 1. GEODESY

Fixing two profiles, the main one across the whole ice cap from de Quervainshavn through "Station Centrale" as far as Cecilia Nunatak, and the second parallel to the western coast at a distance of 120 km. from the coast line. The aim is to fix the height and position at permanent points with as great accuracy as possible—perhaps one metre—in order to note the movement of ice when repeating the profile measurement after several years. The methods of measurement are derived from the experiences of the former expeditions. The height measurements were not satisfactory at that time as the air layers just above the ice and snow surfaces are greatly disturbed by radiation. The temperature gradient is 100 times more uncertain than over normal land surfaces. Therefore the rays of light are not straight but curved in an irregular manner. Long rays of one to ten km. as used formerly cannot give a reliable result. For that reason E.G.I.G. plans to use normal levelling with stands 100 m. apart. The levelling is performed by the aid of two sets of self-controlling weasels. For the main profile of 800 km.,  $2 \times 4,000$  stands will be necessary.

For fixing positions the normal methods of triangulation and traverse fail on the immense ice plain, nor does astronomical measurement give sufficient accuracy. Therefore modern distance measurements are to be made by the new device of the tellurometer, using radar waves. The measurements will be in the form of quadrangles of 10 km. side length. Eighty successive quadrangles are necessary for the main profile. Difficulties will be encountered especially in the western ablation zone, and in the meridional profile parallel to the coast. At both ends of the main profile connexion will be made with the existing Danish coast triangulations. French, German and Swiss geodesists are in charge of this geodetic programme under the responsibility of Dr. Hofmann of Munich.

## 2. GLACIOLOGY. MASS BALANCE

An important task is the study of mass balance of the ice cap. The surface movements fixed geodetically as indicated above give an accurate base.

(a) An essential supplementary task is to ascertain the output of ice, by means of the snouts of the big glacier tongues. Special measurements of the velocities of these tongues are to be obtained by air photogrammetry from repeated air surveys which will be carried out by the Danes. The procedure has already been settled by reconnaissance flights.

(b) Accumulation and ablation data will be obtained at all stakes of the profiles at distances of 10 km. The stakes have been carefully prepared for that purpose as gauges.

(c) Special studies will be made in the ablation zone including radiation and its influence on the upper layers of ice. The shape of the ablation area will also be studied. Work on these projects will be done by a special group led by Professor A. Bauer of Strasbourg and Dr. W. Ambach of Innsbruck.

(d) It is an interesting phenomenon that fresh water runs out from the ice, especially at the snouts of the big glaciers. A special study of this will be made in Kangerdlugssuak Fjord by the German research vessel *Gauss*, which will carry out measurements of salinity and currents near the Kangerdlugssuak Glacier and further out.

(e) In order to provide a basis for later study of glacier fluctuations one glacier of medium size will be surveyed as accurately as possible by air photogrammetry. This will be done by the Danes on the Kangerdlugssuak Glacier. They will also fix the necessary control points there.

## 3. THE GLACIOLOGY OF THE INLAND ICE

This very difficult and essential task will be handled chiefly by the Swiss.

(a) Professor Haefeli of Zürich has worked out a detailed programme in order to study the rheology of the ice. This programme is in close relation to his investigations of snow

mechanics, and to the results obtained by him at the cold ice cap at the Jungfraujoeh. The deformations of the firn surface on the Greenland Ice Cap will be measured by surveying equilateral triangles of 1 km. side length. In the wintering station (Station Dumont) laboratories will be installed for investigations of snow and ice. At this station an inclined shaft was dug to a depth of about 40 m. by the Dumont Expedition in the winter of 1956-57. There the necessary samples will be taken. The deformation of two spherical hollow chambers excavated in the ice will also be measured. The mechanical and rheological properties of the polar firn will be investigated *in situ* as well as in the naturally cooled laboratory. Ing. F. Brandenberger of Zürich is in charge of this programme.

(b) Snow research will be handled according to a programme which Dr. M. de Quervain of the Eidg. Institut für Schnee- und Lawinenforschung, Weissfluhjoeh, has worked out. He is the leader of the Swiss team. By the projected investigations the amount of the annual accumulation will be fixed at points which are representative of the whole area to be investigated by the E.G.I.G. Later the aim is to obtain knowledge about the metamorphism of the snow into polar firn and the ice of the marginal zones (with special regard to the "superimposed ice"). The crystallographic work on the deposition and metamorphism of the snow has to be performed in close connexion with the rheological work mentioned under (a). The temperature regime must be investigated with reference to the metamorphism, the movement of the firn and the mass balance. It must be investigated at the surface and at depth.

(c) A third programme is that concerning physical chemical conditions. Cores of snow and ice will be assembled systematically from all parts of the expedition areas, and studied at the winter station with reference to density, air content, dimensions and orientation of crystals. Dating of the ice by the tritium,  $C^{14}$  and other methods will also be done, partly in the laboratories in Zürich and Bern. Special accumulation measurements will be made by aid of lattices of finest iron wires sunk into the firn. Professor A. Renaud is responsible for this work.

#### 4. GEOPHYSICAL AND METEOROLOGICAL RESEARCH

In general the programme is similar to that of the previous French expeditions. Seismic soundings and gravimetric and electrical measurements are to be made, but are to be more specialized than earlier ones. They will be concentrated at six points and their immediate neighbourhood along the profiles, in order to obtain a closer connexion between the surface and the bedrock; the temperature of the ice will also be measured at depth if possible. It is hoped to get information about the bedrock itself by deep soundings.

Meteorology is but a supplementary task on this expedition. Nevertheless meteorological data are needed for the methods employed in geodesy, glaciology, and geophysics. Therefore continuous meteorological observations must be made at many stations during both summer and winter. All groups are equipped with meteorological instruments. Barographs and thermographs are installed at essential points along the profiles and at the winter station. A meteorological mast is to be erected there, and one meteorologist will stay there during the whole winter. Professor H. Brockamp of Münster, a former member of the Wegener expedition during 1930-31, is in charge of the geophysical and meteorological work.

#### 5. TOPOGRAPHY

Topographic cartographic work forms an essential basis for all the scientific work on the western coast and its hinterland. The Geodætisk Institut of Denmark has taken over the photogrammetric survey and map-making in that region, and will produce a modern map of 1:250,000. The host country Denmark thus makes a very valuable contribution to the scientific work of the expedition.

## THE ORGANIZATION

Altogether 25 scientists are members of the expedition. The technical and operational organization is a matter of prime importance, as most of the scientific work must be carried out during the four summer months of 1959. Paul-Émile Victor with his "Expéditions Polaires Françaises" has taken over this task as leader of the expedition with 25 of his very experienced collaborators and a number of aircraft crews, etc. Transport is provided by the use of weasels, aeroplanes, and helicopters, according to a carefully worked out plan. The starting point is the harbour and airport Sondrestromfjord (BW 8), see Fig. 1, from which the weasels will have started in the middle of March of this year, after the snow cover of late winter had rendered the western slope accessible for snow carriers.

The scientific programme has been worked out by a directing committee to which each participating country contributes three scientists and some other specialists. The first President of this Committee was Professor Haefeli; now the author is President. The Committee has a General Secretary, Professor A. Bauer. Owing to his great experience he is able to give valuable advice on all scientific tasks and problems. The representative of the host country, Denmark, is Professor B. Fristrup of Copenhagen.

All results will be published in the periodical *Meddelelser om Grønland*. The expedition is under the patronage of the Association Internationale d'Hydrologie Scientifique.

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In a communication dated 5 September 1959 Professor Finsterwalder reported that the programme for 1959 had been completed in its entirety. *Ed.*