# PRELIMINARY GLACIOLOGICAL PLANS FOR THE NORWEGIAN-BRITISH-SWEDISH ANTARCTIC EXPEDITION, 1949–52

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*(From an address given to the International Commission on Snow and Glaciers at Oslo, on 24 August 1948)*

An expedition to Dronning Maud Land in the Antarctic sector of the Antarctic—chiefly for the purpose of glaciological, meteorological and geological studies—was first proposed in London and Oslo in May 1946. This aroused great interest in the three countries—Norway, Great Britain and Sweden—whose participation was suggested. The Norwegian Polar Institute (Norsk Polarinstitutt) had been founded in March 1948, and Professor H. U. Sverdrup, returning from the United States in May to be its Director, was appointed chairman of the Norwegian Antarctic Committee. In July the *Storting* granted sufficient funds for the requisite preparations. The Norwegian Government sent special notes to the Swedish and British Foreign Offices, inviting their respective countries to participate in the expedition.*

The expedition will sail under the Norwegian flag and the leadership of Professor Sverdrup. The winter party will consist of thriteen or fourteen members, of whom six should be specially qualified scientists, two from each country.

The expedition will charter a modern Norwegian sealing vessel for transport, but it must also acknowledge its gratitude to the Norwegian whaling companies for undertaking to carry the heavier equipment including aircraft. In early January 1950 we hope to reach Dronning Maud Land close to the meridian of Greenwich where the shelf ice border is low.

It is planned to spend two winters in the Antarctic. The chartered ship will visit the wintering party in the summer of 1950–51, and the expedition will leave the Antarctic in 1952. Dog teams and weasels will be used for land excursions; the aircraft, either a helicopter, an aeroplane, or both, will undertake the longer journeys.

Some parts of the interior of Dronning Maud Land were surveyed from the air by the German *Schwabenland* Expedition in 1938–39. The resulting photographs and reports, published in 1942, indicate that these districts are extremely interesting, especially from the glaciological point of view.

The so-called "Wohlthat-massif" of the area which the Germans called "Neu-Schwabenland," about 10,000 sq. km. in extent, is surrounded and partly covered by inland ice the surface of which is 1000 m. above sea-level in the north and 3000 m. in the south. In that as well as in other *massifs*, extensive areas free of ice and snow form "oases" in the ice desert, with local glaciers of various sizes and morphological types. The detailed German maps also show some lakes, the largest of which—650 m. above sea-level—is 6 km. long and 4 km. broad. Smaller lakes are marked on the maps up to 850 m. above sea-level. It is very difficult to imagine the existence of liquid water at these heights and so far inland in present climatic conditions.

About 250 m. above sea-level, however, there are small lakes and ponds of liquid water both on the shelf ice and on the low-lying land projecting above it. Terminal and lateral moraines prove that the lobes of the inland ice in the broad spaces between the mountain ridges were formerly much thicker and larger than they are now. Small terminal moraines in front of the present local glaciers in these "oases," as well as long moraines at the bases of the mountain ridges, must have been left by earlier glaciers larger than the present ones. According to R. van Klebelsberg the topography of the ground in front of the glaciers in the area which the Germans called "Kurze Gebirge" indicates dead ice. In these relatively limited areas we have accordingly unmistakable proofs of a

* The Swedish contribution was approved by the *Riksdag* in November 1948.

former greater extension of the ice, and probably also of a considerably milder period. The rates of movement, and possibly also the regimes of the local glaciers, should be investigated. Thanks to a large number of nunataks of various sizes and positions, it will also be possible to determine the rate of movement of the inland ice surrounding and intersecting the whole district in streams of varying widths and gradients.

The photographic material obtained by the German expedition was abundant and of the highest quality. A small but instructive part of it was published in 1942, but most of it was destroyed, or at least is not at present available in western Germany. Some photographs have been saved at Hamburg, however, and will be placed at our disposal. We hope that what is left will, on comparison with new photographs taken from the air by our expedition, allow us to draw some conclusions regarding changes in the extension and thickness of the ice in the last ten or twelve years.

The glaciological work of the expedition will be done (1) at headquarters, (2) by flights inland to the mountain district and (3) by excursions with dog sledges or mechanical transport in that district.

In the preliminary glaciological programme for the expedition drawn up by W. L. S. Fleming and myself at a meeting in Oslo in July 1947, we pointed out that in measuring the accumulation special attention must be paid to the difference between precipitation and snow drift. As regards the latter, Bagnold's methods for measuring sand drift at different altitudes above the ground may prove the most practical. Direct precipitation might possibly be distinguished from drift-accumulation by studying the form of the snowflakes or grains in each case. Observations of ablation should be made with a view to determining how much of the ablation can be ascribed to melting, to evaporation and to wind erosion (corrasion). An important but very difficult problem is to devise a method of differentiating between the ablation attributable to evaporation and that due to wind erosion.

The ablation measurements are intimately associated with the whole problem of the heat economy of the snow or ice surface—the balance between incoming radiation, conduction, condensation, reflection and outgoing radiation. During the Norwegian-Swedish expedition to West Spitsbergen (Vest Spitsbergen) in 1934 Professor Sverdrup devised the method of calculating the heat economy of glaciers, and C. C. Wallén has since continued these investigations on a small glacier in the far north of Sweden. The relation between radiation and conduction in the ablation processes varies with latitude and altitude as well as with the progress of the ablation season. We know little or nothing of these conditions on the Antarctic continent.

The most important task at the base station will be to study the physical properties of the inland ice, which is of the high polar type, *i.e.* its temperature is negative down to a considerable depth.

The geophysical and meteorological conditions in the Antarctic differ so much from those in the Arctic—except in the central and northernmost part of Greenland—that the results of the more detailed investigations round the North Atlantic coasts cannot be directly applied in the Antarctic. While all glaciers in the northern hemisphere have typical accumulation and ablation areas, the Antarctic inland ice is a single, almost continuous, accumulation area, the equilibrium of which is maintained by calving. Particularly on account of the low summer temperature, the ice masses of the Antarctic must presumably differ essentially in internal structure and movement from those of the northern hemisphere. The mechanical influence of the Antarctic glaciers on their substrata is, moreover, likely to differ from what is known of temperate glaciers.

Much evidence indicates that appreciable climatic variations occurred in northern Europe during and after the recession of the last Pleistocene inland ice, and it is probable that these variations were more or less concurrent in large parts of the globe. Very little is known of conditions in the Antarctic, but similar variations may well have occurred there.

We are planning to record by electric resistance thermometers the temperature of the frozen

firn and ice at different depths down to about 100 m. A thorough study of the temperatures hitherto observed shows that no one has so far reached a sufficient depth to be able to answer all the questions necessary for a full understanding of polar glacier physics. We have, for instance, as yet no certain basis for calculating the depths at which melting point is reached at any of the places where temperature observations have been taken. Of Borg, the headquarters of the expedition of J. P. Koch and Alfred Wegener to Greenland in 1912–13, situated 62 m. above sea-level in lat. 76° 41′ N. and long. 22° 24′ W., Wegener only states that it is at any rate proved that to a depth of at least 140 m. the glacier temperature must be negative. No light is thrown on these problems from the famous "Eismitte" station of Wegener's expedition of 1930–31, 3000 m. above sea-level, nor from the "Weststation" of the same expedition. Less than 6–7 m. below the surface the seasonal variations were very marked. Deeper down the mean annual temperature first rose very slowly to a depth of about 12 m., after which it decreased slowly at the rate of 0·04° C. per metre. This is remarkable, considering that the temperature in the deeper sections of the inland ice must presumably be raised to near melting point by the transfer of heat from the earth. E. Sorge suggests that in this case the fall of the temperature with increasing depth may be due to the fact that the air temperature on the inland ice, as elsewhere in Greenland, has in recent years been higher than before.

The U.S. Antarctic Service Expedition of 1939–41 took temperature observations on the Ross shelf ice down to a depth of 41 m., where the temperature was nearly constant at −22° C. According to the seismic soundings taken by the United States Operation "Highjump" 1946–47, the thickness of the Ross shelf ice was only 200 m.

The possibility of differentiating between the several seasonal layers is also of great importance to all problems connected with the physical properties, structure and regime of all glaciers, local as well as inland ice. This problem can be investigated in open pits and by cores drilled from undisturbed material at different depths. Koch and Wegener came to the conclusion in Greenland in 1912–13 that the previous winter's layer could be distinguished from the new layer below it, but that the rest of the firn deeper down in the inland ice was not stratified at all. At "Eismitte" on the other hand, they were of the opinion that seasonal layers could be traced with certainty right to the bottom of their shaft, 16 m. deep. At the top the seasonal layers could be seen with the naked eye; deeper down they could be recognized by the size of the firn grains, which are somewhat larger when deposited in the summer than in the winter. Below a depth of 6 m. the varying densities of the frozen firn provided evidence which was considered satisfactory. No annual stratification is believed to occur in the Antarctic. Its existence has actually been definitely denied, but I hesitate to accept that dictum as correct. All the methods used at "Eismitte," and every other conceivable means, must at least be tried before giving up hope completely.

The last but not the least important item of the base station programme is the crystallographic investigation of the inland ice. It is highly desirable to follow the structure of the frozen firn and the ice as far down as possible. We do not know at what depth the frozen firn turns into true ice, but we will try to reach a depth of about 150 m. This necessitates the drilling of undisturbed cores by a specially designed machine. Technically, the most difficult problem is to remove the cuttings from the bottom of the hole. Our experts on drilling machines recommend alcohol as a flushing medium and do not believe that this would affect the structure of the core.

It will be important, especially to the glaciologists, to take as many photographs as possible of the "Neu Schwabenland" district for comparison with those taken by the Germans. If practicable one or more local glaciers should also be selected for detailed study.

The most important object of these regional studies is to ascertain whether the recent climatic fluctuation has or has not extended to the Antarctic. We know that for one or more decades most glaciers in the world have been shrinking at an increasing rate. Those round the northernmost Atlantic, and in the whole Arctic region, are receding particularly rapidly owing to a climatic

improvement which takes the form of higher temperatures especially in winter, spring, and autumn. The ablation season has been lengthened to such a degree that the total amount of ablation more than compensates for the small increase in the precipitation of snow and hoar frost. One speaks of increased atmospheric circulation accelerating the transfer of heat from low to high latitudes. The present climatic fluctuation is undoubtedly the most remarkable that has occurred for the last two hundred years, and is moreover a phenomenon of great economic significance, not least to the countries of the north. It is accordingly attracting the increasing interest of meteorologists, glaciologists and biologists. The problem cannot be discussed in its entirety until we know whether this climatic fluctuation extends also to the Antarctic or not. If it does, the climatic change is global and its cause probably must be sought outside the earth. If it does not, the perspective alters.

One consequence of the present glacier shrinkage is the rise in the levels of the oceans, calculated at about 1 mm. per annum. This relatively small figure indicates that the Antarctic and the bulk of the Greenland inland ice—which between them contain more than 90 per cent. of all the present-day ice covers—cannot have diminished at the same rate as the local glaciers. If the polar inland ice sheets should begin to melt as rapidly as the other glaciers, the rising sea-level would become a phenomenon of great and far-reaching practical importance. The whole problem of eustatic movements—the rise and fall of the sea surfaces—must remain more or less unsolved as long as we do not know for certain whether, and to what extent, the Antarctic has contributed to these volumetric changes.

Every effort will also be made to record the meteorological and climatological observations necessary for a proper understanding of glaciological processes.

## MEETING OF THE INTERNATIONAL COMMISSION ON SNOW AND GLACIERS, OSLO, 1948

THIS meeting was held under the auspices of the International Union of Geodesy and Geophysics from 17 to 28 August. The opening General Assembly was attended by H.M. King Haakon and H.R.H. The Crown Prince of Norway.

Considering the lapse of time since the last meeting at Washington in 1939 and the fact that several prominent officials had died, a considerable amount of work was satisfactorily completed. Representatives from twenty countries attended the Commission meetings, those from the British Commonwealth being Messrs. J. M. Wordie, W. N. McClean, Professor G. Manley, Lieut.-Col. A. Croft and G. Seligman (Great Britain); Messrs. R. F. Legget, Lieut.-Col. P. D. Baird and G. J. Klein (Canada); Mr. L. Kent (South Africa); and Mr. S. K. Banerji (India).

Over fifty papers were read in full, in summary or by title. A list is given below.

Dr. J. E. Church resigned the Presidency of the Commission and Professor H. W:son Ahlmann was elected President for the present triennium. Mr. J. M. Wordie was elected Vice-president and Lieut.-Col. F. D. Baird has undertaken the post of Honorary Secretary in place of the late Mr. F. E. Matthes. The Commission's title was changed to the "International Commission on Snow and Ice"—a slightly more comprehensive if unnecessary variant.

It was decided to reduce the size of the Commission, which had become unduly large. In future each country adhering to the I.U.G.C. will be entitled to nominate one member and the President will be allowed to add ten more names to this number. It is recommended that a national group be formed in each country which would propose that country's representative. In Great Britain the British Glaciological Society could usefully continue to act in this capacity.

In view of their outstanding services to glaciology, Drs. P. L. Mercanton and J. E. Church were elected Permanent Honorary Members of the Commission.