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Glaciological and climatological investigations at Qamanârssûp sermia, West Greenland

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As part of the GGU programme of investigations in connection with hydropower in West Greenland, glaciological and climatological measurements were continued at Qamanârssûp sermia (inventory number 1CH21002) in 1982. The station was first established in late summer 1979 so that records for three complete summers 1980–1982 are now available. Brief reports on the work have been given by Olesen (1981) and Olesen & Braithwaite (1982) while a more detailed field report and data summary for 1979–1981 is given by Braithwaite & Olesen (1982). A similar report for 1982 is now in preparation.

The sketch map in figure 44 shows the lower glacier together with locations of stakes and survey points. It should be noted that the three highest stakes, numbered 013, 015 and 016, are located off the map to the north-east of Stake 012.

Field work on Qamanârssûp sermia

Although some new additions were made to the field programme, the work was essentially the same as in previous years. Measurements of transient balance were made in the network of stakes which extends up to an elevation of 1500 m. Full climatological observations were made at the base camp, supplemented by a thermohygrograph station at Stake 075 on the glacier and by a new station established on Point 1020. Almost daily ablation readings were made at the three '751' stakes close to the base camp. The routine measurements of potential evaporation at the base camp, made with a Class-A pan and with a Piche-type recorder,

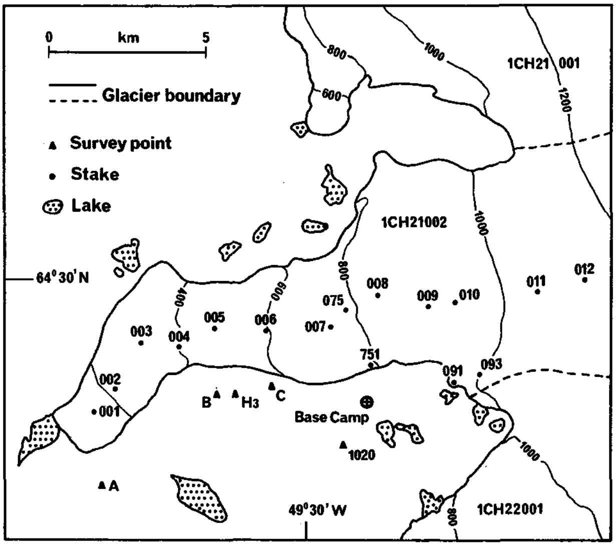

Fig. 44. Sketch map showing lower part of Qamanârssûp sermia together with locations of stakes and survey points.

were supplemented by Andersen and Knudsen evaporation gauges which were obtained on the initiative of Niels Gylling Mortensen from the Geographical Institute, Copenhagen University. An OTT water-level recorder was set in operation during the summer in the main outlet-stream from the glacier 1CH21001, just to the north of Qamanârssûp sermia, but there were some technical problems so that the record is incomplete.

The field work in 1982 was started several weeks earlier than in previous years so that the beginning of the ablation season, at and above about 700 m, was registered for the first time. It was found that the winter snow cover on the glacier was very patchy up to Stake 008, being confined mainly to drifts in gullies and crevasses, while it was more or less continuous from Stake 009. A snow-scooter traverse was made from Stakes 009 to 016 to measure the winter balance at the end of May. No serious problems were encountered *en route* with crevasses although full precautions were taken.

The stakes were revisited a number of times during the field season to measure the summer balance. However, at Stake 016 which is in the accumulation area it was found that density measurements were taken to insufficient depth in the firn to register the summer mass changes completely, i.e. meltwater percolation and refreezing still occur at depths of several metres below the final summer surface. However, the first trial of a Fadum-type corer in August 1982 indicates that this problem can be solved for the future. This is important because a better knowledge of meltwater refreezing is important for regional modelling of ablation (Braithwaite, 1980).

Field work on glacier 1CG14033

As an addition to the work at Qamanârssûp sermia, measurements of the mass balance of an unnamed glacier (inventory number 1CH14033) were started in 1982. The glacier drains into a large lake, Kangerdluarssúngûp taserssua, south of Godthåb where a hydropower project has been proposed, i.e. the so-called 'Buksefjord' project. One-day visits to the glacier were made by helicopter in mid-May and again in early September. On the first visit, the drilling was very difficult and it was only possible to drill one stake. However, on the second visit the stake was still standing so that a summer balance can be calculated for this single site, and at the same time a further seven stakes were drilled for use in future measurements. In addition to the practical applications of any data from this glacier in connection with the proposed hydropower project, the results can be compared with those from Qamanârssûp sermia to give information about how glacier regimes change with distance from the coast.

Results and outlook

Monthly values of temperature, precipitation and sunshine duration at the base camp, together with ablation at the three '751' stakes, are compared with those from previous years in Table 5. On average, the 1982 summer was the coldest of the three, while with respect to precipitation and sunshine duration it was intermediate. However, the total ablation in 1982 was the highest of the three summers. Furthermore, the 1980 summer had the highest mean temperature and the lowest total ablation of the three summers. This might seem to be in contradiction to the fact that daily ablation is quite strongly correlated with temperature for each of the three summers. Although the corresponding regression equations are remarkably similar to each other they are not identical; the temperature-response of ablation in 1980 was low enough to offset the higher temperature compared to 1982. A

Table 5. Climatological and glaciological data summary for base camp, Qamanârssûp sermia 1980–1982

	JUNE	JULY	AUGUST	SUMMER
Monthly mean temperature (deg C)				
1980	4.7[a]	6.6	5.5	5.6
1981	5.2[b]	7.5	3.9	5.5
1982	4.9	6.0	4.3	5.1
Mean	4.9	6.7	4.6	5.4
Monthly precipitation (mm)				
1980	20[a]	61	64	145
1981	27[b]	148	81	256
1982	8	111	55	174
Mean	18	107	67	192
Sunshine duration (hrs)				
1980	(226)	258	327	811
1981	(252)	214	124	590
1982	314	130	222	666
Mean	264	201	224	689
Mean ablation of three '751' stakes (mm)				
1980	(910)	1330	1010	3250
1981	(1110)	1860	800	3770
1982	1070	1580	1160	3810
Mean	1030	1590	990	3610

[a] = based on 26 days of record
[b] = based on 29 days of record
() = adjusted to full month

more detailed analysis of this effect will be attempted in the future, especially to test conclusions made by Braithwaite (1981) on the basis of data from Arctic Canada.

Data from an automatic climate station at Qamanârssûp sermia, supplied and maintained by the Greenland Technical Organization (GTO), have now become available for the period 1980–1982. Comparisons between these data and the hand-collected GGU data show excellent agreement for elements like air temperature and wind although there were some problems with the precipitation measurements. A detailed report of the comparisons is in preparation.

The winter 1981–1982 temperature data from the automatic climate station have already been used to estimate the monthly distribution of ablation at the '751' stakes during the period September 1981 to May 1982 for which only a measured total is available. Of the total annual (September to August) ablation, 82 per cent falls in the June to August period, 13 per cent in September, and 3 per cent in May.

From analyses of the summer temperatures at Qamanârssûp sermia it is clear that the area is much warmer than might be expected on the basis of data from Godthåb on the coast. However, the winter temperature data from the automatic climate station show the opposite trend. No doubt this reflects the greater continentality of the area, i.e. warmer summers and colder winters compared to a coastal station. An attempt will be made to study this effect in detail with the help of additional data from several discontinued stations in the Godthåbsfjord, i.e. lying between Godthåb and the Qamanârssûp sermia area. It would be useful to find some expression of the continentality, especially with respect to summer 'inland heating', as Braithwaite (1980) has identified this as one of the major problems involved in the use of data from coastal climate stations for estimation of ablation.

From analyses of the data collected for potential evaporation at Qamanârssûp sermia (three summers of data from the Piche-recorder and two summers from the Class-A pan) it seems that there are many errors and measurement problems. However, the data are in moderate agreement with values calculated using standard engineering formulae, e.g. the Thornthwaite and Penman methods, so that rough estimates of the regional distribution of potential evaporation in West Greenland can be made soon. This will be useful because evaporation constitutes a loss of water. At present it can only be guessed that evaporation from ice-free areas in West Greenland is about 100–200 mm/year which represents a significant fraction of the incoming precipitation.

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Photogrammetric investigations at glaciers in West Greenland

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In order to determine glacier variations, photogrammetric measurements and especially terrestrial photogrammetric surveys have become increasingly important because they can be carried out accurately and quickly. As part of the GGU programme for regional mapping of the hydroelectric potential of glaciers in West Greenland, a photogrammetric survey was carried out at Qamanârssûp sermia in 1980 and in Johan Dahl Land in 1982. The survey was carried out by staff members from the Geological Institute, Aarhus University.

Qamanârssûp sermia

The main result of the survey was the construction of three maps on the scale of 1:10 000 covering Qamanârssûp sermia below 900 m above sea level and the neighbouring glacier to the north 1CH21001 below 600 m above sea level. They are based on vertical aerial photographs taken on 28th August 1968. Two maps on the same scale covering Qamanârssûp sermia below 500 m above sea level and 1CH21001 below 550 m above sea level were constructed using terrestrial photogrammetric measurements taken on 3rd August and 31st July, respectively. To establish a net of control points for these surveys a triangulation was carried out around the periphery of the glaciers.

Information on glacier variation is gained by comparing maps depicting the glacier surface at different times. The result of a comparison between the maps covering Qamanârssûp sermia is shown in figure 45.

It is safe to conclude that the glacier was nearly stationary between 1968 and 1980. Right at the margin where it ends in lakes an advance was noticed, but this might just reflect a slight change in calving from one year to the next, because it is often observed that large pieces are calved rather than small bits. The lake at about 70 m was definitely smaller in 1980 than in 1968, probably because erosion by the stream connecting the 50 and 70 m lakes lowered the outlet, and also because of the influx of sediment. Between the two lakes a retreat of the order of 25 to 50 m could be determined. Along the periphery in general no changes could be seen; the variations were a result of the difficulty of determining the exact position of the glacier margin because of debris cover. On the surface right at the margin a slight thinning could be seen, but it was less than 10 m and at higher elevations the contour lines were almost identical, the differences being within the limits of experimental error.