THE OHIO STATE UNIVERSITY

RESEARCH FOUNDATION

1314 KINNEAR ROAD COLUMBUS 12, OHIO

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SUKKERTOPPEN ICE CAP STUDIES

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Institute of Polar Studies

Arctic Institute of North America, Inc.
Washington 5, D.C.

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PRELIMINARY

REPORT

By

THE OHIO STATE UNIVERSITY
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1314 KINNEAR RD.
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On SUKKERTOPPEN ICE CAP STUDIES

For the period 1 July 1963 - 31 August 1963

Submitted by R. P. Goldthwait

Institute of Polar Studies

Date September 1963

PRELIMINARY REPORT OF OHIO STATE UNIVERSITY-ARCTIC INSTITUTE OF NORTH AMERICA GREENLAND EXPEDITION, SUMMER 1963

INTRODUCTION

by ARTHUR MIRSKY

During the summer of 1963, the Ohio State University's Institute of Polar Studies together with the Arctic Institute of North America conducted detailed scientific studies in the western part of the Tasersiaq area of southwestern Greenland. This expedition was the first of several planned as a result of a 1962 reconnaissance to evaluate the research potential of this area.

Four basic programs were carried out during this work. The programs and the personnel involved are:

1.	Glacial geology :	Dr. Richard P. Goldthwait Dr. George H. Crowl
2.	Limnology :	Dr. Derry D. Koob Mr. Paul Richard
3.	Soils and slope movement:	Dr. K. R. Everett
4.	Climatology :	Mr. Henry Brecher Mr. Adolph Kryger

Dr. Goldthwait was leader of the seven-man party; Dr. Crowl assisted. The field season began June 21, 1963. The glacial geology and soils programs continued until August 15, 1963 and the limnology and climatology programs continued until September 1, 1963. Another Institute party, consisting of Dr. S. B. Treves assisted by John Boellstorff, studied the bedrock geology at the east end of Tasersiaq. Although they accompanied the main party to the field, their funding was through the National Science Foundation and their work is not considered here.

The season was successful and much was accomplished. All programs are to be continued next summer (1964) and a major glaciological-geophysical program expanded on the adjacent Sukkertoppen Ice Cap. A Jamesway hut was set up at the west end of Tasersiaq. A boat and an outboard motor are available for transportation on the lake.

The expedition was made possible by financial support from the Quartermaster Research and Engineering Command and the Office of Naval Research through the Arctic Institute of North America; the Ohio State University Mershon Fund again contributed financial support. The Arctic Institute of North America arranged for U. S. State Department clearance, for Danish permission to work in Greenland, and for MATS transportation of men and equipment between McGuire Air Force Base, New Jersey and Søndre Strøm Air Force Base, Greenland. Military personnel at Søndre Strøm were very helpful and cooperative, especially Col. John Y. C. Roth, Base Commander, Søndre Strøm Air Force Base. Radio contact between the air base and the base camp was made possible by the interest of the MARS operators.

THE GLACIAL GEOLOGY OF WESTERN LAKE TASERSIAQ, GREENLAND

by G. H. CROWL and R. P. GOLDTHWAIT

During the Pleistocene ice age all of the Tasersiaq area for ten miles east and south of Sukkertoppen Ice Cap at about 66°N latitude was covered by a thick ice sheet. Erratics were found on all high slopes climbed and striae and grooves were observed rarely where recently exposed by contracting soil cover. Markings indicate ice movement westward from the area of the present main ice sheet, channeled in the valleys in all directions from south through west to north. Main ice flow passed southwest down Evigheds Fiord and north-northwest up the outlet area of Lake Tasersiaq.

At the recession of this complete ice cover virtually no deposits except erratics and very thin till (now frozen) were left on high slopes. However, along both shores of western Lake Tasersiaq, in the deepest valley, are kettled kame terraces 40 to 60 feet above lake level; the height of these terraces increases eastward to 150 feet above lake level. The terraces slope southwest or northwest indicating lingering valley ice tongues still sloping westward. On the highland where Sukkertoppen Ice Cap now rests there must have been a residual ice cap slightly larger than that of today as two distinct moraines mark an ice limit below the present ice tongue A and in a tributary valley above the base camp. Presumably this general deglaciation occurred about 9000 years ago as dated elsewhere in Greenland.

The valley of modern Lake Tasersiaq is the site of a Little Ice Age glacial lake. It is a structural valley following a joint or fault system for most of its length of approximately 60 miles. The valley drains parts of both the Inland and Sukkertoppen ice caps. The country rock is a series of nearly vertical gneisses with small amounts of older schist and younger granites.

The present lake is about 2100 feet in elevation. The double shoreline of a late stage glacial lake is almost continuously exposed in the valley about 30 feet above the present shore. It shows as a small wave cut terrace (or two terraces) on older, higher terrace deposits and as a "trim line" on rock surfaces where there is distinctly more lichen cover above the former shore than below it. The shore line is much less continuous on till slopes, and for long stretches it has been destroyed by solifluction.

The lake was dammed by the advance of a tongue of the Sukkertoppen Ice Cap across the gorge of the river draining Lake Tasersiaq; the north wall of this gorge shows a distinct trim line made by this ice advance. The shore line has been traced into the gorge on this side of the valley and to the moraine at the ice edge on the south side. The shore line has been traced 40 miles up the lake and extends an unknown distance beyond towards the Inland Ice Sheet.

The outlet of this late glacial lake was by way of the valley between the Inland Ice and the Sukkertoppen Ice Cap, and this drains into Evigheds Fiord. The shoreline is at the elevation of the broad passes between the two valleys. The water flowed through a broad lowland now partially occupied by a Lake Q in front of the Inland Ice, and then plunged into a strike gorge which it excavated to a depth of about 700 feet and a width of 500 feet. At the present time talus slopes have partially blocked the old outlet gorge so that the stream now flows partly underground in the slide rock and in one place forms a small lake.

Three tongues of the Sukkertoppen Ice Cap and a nearby tongue of the Inland Ice show a comparable history: an early ice advance which cut a trim line beyond each of the tongues, but left no morainal deposit; then the ice lobes retreated, built the present end moraines still ice-cored and about 50-75 feet in height; now the ice has retreated short but variable distances from these moraines.

There have been two moraine systems in the estimated century or two of retreat.

The precise age of glacial Lake Tasersiaq is uncertain, but it was drained probably less than 200 years ago. The evidence is summarized: below the trim line umbillicaria lichens are small - generally less than 20 mm in diameter; the trim line beyond the Inland Ice tongue near Lake Tasersiaq was made by a pro-glacial lake dammed by the ice front. Its basin has been emptied so recently that lake silts have not all been washed off the boulders in the bed.

At a few places solifluction has brought surface materials downslope across the shoreline. One of these solifluction lobes has been excavated, and it is hoped that C-14 analysis of buried soil material will give a minimum date for the disappearance of the glacial lake.

THE LIMNOLOGY OF SELECTED LAKES OF THE TASERSIAQ REGION, GREENLAND

by D. D. KOOB

Following a preliminary survey of the region, eight lakes were chosen for weekly sampling. These lakes include the western end of Lake Tasersiaq and seven small lakes between Lake Tasersiaq and the eastern edge of the Sukkertoppen Ice Cap. Paul Richard assisted in the field work. Of the lakes selected, three receive a steady inflow of glacial melt water. The remaining five are small seepage lakes less than 4 meters deep, fed by ground water. Distinct fluctuations in water level occurred in all of the lakes studied. The drop in water level during the warm, dry summer months varied from a few centimeters in most lakes to as much as two meters in both Lake Tasersiaq and a single small seepage lake.

In addition to the regular sampling program, nine other lakes in the same area were visited once or twice. Seven of these were high altitude lakes in glacial rock basins about 300 meters above Lake Tasersiaq; one was similar to the small seepage lakes, although larger in area; one was a kettle lake formed in a lateral moraine of a tongue of the inland ice cap.

Factors analyzed in the field included temperature, limit-of-visibility, pH, conductivity, alkalinity, oxygen concentration, and productivity by use of the oxygen light-dark bottle technique. Preliminary plankton analyses were made at the base camp. Quantitative analyses will be completed at The Ohio State University.

Ice cover persisted in the lakes until early July. Once ice free, the temperature of the small seepage lakes responded closely to ambient air temperature. Periodic strong winds prevented any but ephemeral thermal stratification. However, early in August, a thermocline formed in Lake Q a large lake 3 miles south of the base camp; this lake was 16 meters deep at the sampling station. Stratification persisted there for over two weeks.

Conductivity was less than 0.18 millimhos/cm in most lakes at the time of ice breakup in July. Values increased to 0.50-0.60 millimhos/cm by the beginning of September when sampling was terminated. pH values exhibited a similar trend. Increases from near neutral to 7.8-8.0 occurred. No evidence of increase in pH due to adsorption of hydrogen ions onto particles of glacial milk was found.

Oxygen concentration was, with rare exceptions, near or above saturation at all times in these lakes. No values lower than 80% saturation were found at the time of ice breakup, indicating only moderate oxygen depletion during the winter stagnation period.

Although quantitative data are not yet available for the plankton populations, superficial examination revealed algal blooms in at least three of the lakes. In a small glacial-fed lake, large populations of Zygnema, Gonatozygon and Hyalotheca developed. In glacial-fed Lake Q the diatom Asterionella formosa was present in large numbers throughout the season. Dinobryon was the dominant genus present in the seepage lakes, reaching bloom proportions in at least one lake.

Of the zooplankton genera found only Diaptomus was present in all lakes. Lepidurus arcticus occurred only in a single seepage lake. The Anostracan, Branchinecta paludosa was abundant in most of the lakes. On the basis of plankton composition, Lake Q was distinct from the other lakes. The number of species present was small, Cladocerans were absent, and the rotifer Filinia longiseta was abundant. Similar communities have been found in nutrient-rich alpine lakes in other regions.

It is hoped that the current quantitative analyses will elucidate the relationships between the nutrient sources of these lakes and the distinctive plankton populations.

RECONNAISSANCE OF THE SOILS OF THE LAKE TASERSIAQ AREA, SOUTHWEST GREENLAND

by K. R. EVERETT and N. HOLOWAYCHUK

The complex of soils in the Lake Tasersiaq area of Greenland is developed on three broad classes of parent material: (1) kame terrace deposits of sand and gravel related to at least two stages of ice advance and retreat; (2) ground moraine and/or sandy till; and (3) residual weathered material of gneissic and granitic bedrock.

Podzolization, complicated by salinization, is the dominant soil-forming process in the area. The soils are weakly to moderately acid and a seasonal reversal of water movement occurs in many of the soils.

The deepest and best-developed podzols occur on the valley fill terraces on either side of Lake Tasersiaq, and at scattered positions on the finer-grained till on the south and southwest-facing slopes. In several areas, these soils lie beneath a surface of lag gravel which supports only a very scattered assortment of plants. In other areas the surface horizon is complicated by the periodic addition of wind-blown sands. Efflorescence of $CaCO_3$ and salts of sodium and magnesium ? were noted when intense drying conditions prevailed in late July and August.

The most extensive soils are those developed on ground moraine and/or sandy till and usually occupy slope positions (3-20°) on either side of the valley. The dominant soil-forming process ~~of~~ is podzolization. Invariably the profiles are thinner than those developed on the terraces and are usually contorted by the processes of slope movement. Salt efflorescence is common, but by no means universal. It generally occurs in moderately well-drained areas which are wet in early summer but dry in late July and August. Efflorescence is most pronounced where the surface is covered with moss which may act as a wick. Soil profiles which closely resemble the Arctic Brown soils identified in Alaska by Tedrow (1958) and Holowaychuk et al. (1962) were described from several localities around Lake Tasersiaq. An accurate estimate of the frequency of occurrence and areal distribution of the Arctic Brown in this area must await the chemical and mechanical analyses of samples.

The third category of soils, those developed on the residual products of weathering, is somewhat artificial and may well be abandoned or modified in the final report. These soils are generally found in protected pockets, usually along joint planes on the uplands. The profile is usually very thin. Most of these soils are well drained and show some evidence of leaching. Their relationship to the slope and terrace soils must await laboratory study.

Not included in the categories just described are wet meadow soils. These soils may be formed on all parent material and slope situations. The development of peat on these soils is much reduced (not exceeding 24 cm) when compared to similar soils in Alaska. Gleying is pronounced down to and into the permafrost. Although these soils dry partially in late summer, they remain the wettest soils of the area and are usually the most acid.

Large portions of the uplands are devoid of soil in any sense of the term.

Because of the almost complete lack of soils information in southwest Greenland, i.e., profile description and soil type delineation, it is hoped that after the soils collected this past summer are analyzed, a sound basis for future detailed mapping can be reached as well as a more complete understanding of soil-forming processes in arctic environments. It is expected that some valid contrasts and/or comparisons can be made with arctic and sub-arctic soils already described in Alaska, arctic Canada, and Antarctica.

SLOPE MOVEMENT AND PATTERNED GROUND IN THE LAKE TASERSIAQ AREA, SOUTHWEST GREENLAND

by K. R. EVERETT

Slope movement in the Tasersiaq area was assessed by two methods: (1) direct measurement of stakes, and (2) indirect estimates and occasional direct measurements from the walls of excavations.

In the direct measurement method, three sites were selected for study. The first was on a northeast-facing slope (7-22°), downslope from an early melting snow bank. The area contained both poorly-drained wet meadow and moderately well-drained slope soils. The microrelief consisted of large solifluction lobes, small terraces and non-patterned areas. The second site was established on a northeast-facing slope (9-21°), downslope from a semi-permanent snow bank. The soils ranged from permanently wet meadows to poorly-drained soils with a podzolic character. Microrelief was essentially absent.

A third site was selected on the southwest-facing slope (3-23°). No snow banks were present as of June 21, 1963. The area was comprised largely of moderately-well to well-drained soils and the microrelief ranged from well-developed, small solifluction terraces to non-patterned wet meadow areas.

Each site was composed of twelve stakes, 17 x 3 x 3 cm which were inserted 15 cm into the soil. The position of each stake was fixed in three dimensions by theodolite survey. Each of the three sites were surveyed at least twice during the summer. These data have not yet been reduced, but a few preliminary calculations indicated downslope movement is randomly distributed over the slope and amounted to several millimeters in 30 days.

Small contour oriented, nonsorted terraces and nonsorted circles occur on a variety of slope situations. Where best developed, on slopes between 6-15°, they contribute substantially to slope movement. Their contribution is greatest in spring and early summer when thaw is in progress. These features receive moisture from melting seasonal frost as well as rain and snow melt. From many observations it appears that the liquid limit in the upper 10 cm is exceeded and flow occurs quickly (as mudflow). Large-scale mudflows appear to be common on the south and southwest-facing slope as evidenced by embanked gulleys. Debris slides are also important.

Examination of many ground patterns, sorted and nonsorted stripes and polygons, suggest that they may be less active at present than at a previous time. Production of ground pattern today is controlled largely by dessication and it may have been so controlled previously.

The evaluation of the significance of ground ice in developing or perpetuating certain patterns awaits an analysis of the mechanical properties of the soil, e.i., bulk density, packing index, and mechanical composition. Studies of ground ice in spring and fall should be carried out.

Several samples were taken for C-14 dating from solifluction lobes on both sides of the valley. It is hoped that dates obtained from these samples will give at least a qualitative estimate on the rate of slope movement. In one case it may give a minimum date on a beach 32 feet above the present level of Lake Tasersiaq which is related to a fairly recent ice advance but has been partially overridden by a solifluction lobe.

CLIMATOLOGICAL OBSERVATIONS IN THE TASERSIAQ REGION, GREENLAND

by HENRY H. BRECHER and A. H. KRYGER

Climatology.--A program of local climatological observations was carried out for the period 22 June to 3 September 1963 with the full complement of instruments (described below) operating from 28 June through 31 August at the Base Camp and from 2 July through 31 August on the moraine at the foot of Glacier A, about one mile west of the base camp.

Temperature, humidity, barometric pressure, wind velocity, solar radiation and precipitation were recorded at Base Camp by means of the following instruments: Casella thermohygrograph and Bendix-Friez microbarograph in an instrument shelter with the floor one meter above the surface; Belfort recording pyrheliometer mounted on the instrument shelter roof; Lambrecht totalizing wind recorder (Wölfle type) mounted on a separate post with anemometer cups 175 cm above the surface; H. J. Green rain gauge with opening 15 cm above the surface.

The recordings at Base Camp were supplemented with observations at 3-hourly intervals from 0900 hours to 2100 hours daily as follows: cloud cover, current wet and dry bulb temperature and daily minimum temperature with thermometers in the shelter, wind speed (but not direction) with a hand-held anemometer and pressure (altitude) with a Paulin altimeter.

At Glacier A, wind and radiation recordings were made with instruments identical with those used at Base Camp and mounted in a similar manner. Temperature was recorded with an H. J. Green thermograph. The glacier station was visited once a week to change charts on the pyrheliometer and thermograph. At this time, wet and dry bulb temperatures were taken with a Taylor sling psychrometer, and maximum and minimum thermometers, mounted in the instrument shelter, were read. An attempt was made to compare precipitation at the glacier with that at Base Camp by setting up a large tin can as a rain gauge at each location. However, no water was ever found in the can at the glacier station. Copies of the hourly surface observations at Søndre Strøm Air Base for the duration of the field season were made available by the U. S. Air Force weather station at the base and should prove valuable as a basis for comparison with the data obtained at Tasersiaq.

The data has not yet been examined in sufficient detail to present any general results at this time. The following brief remarks may be of interest, however. A maximum temperature of 65.0°F for the period of the observations was recorded at approximately 1500 on 12 August and a minimum of 27.7°F at approximately 1700 hours on 29 August. Diurnal maximum temperatures normally occurred in the period from 1300 hours to 1600 hours, minimums in the period 0300 hours to 0600 hours. Temperature variations at Glacier A were usually in phase with but of smaller amplitude than those at Base Camp. Average daily temperatures increased steadily from 28 June through 12 August and decreased steadily from this date to the end of the season.

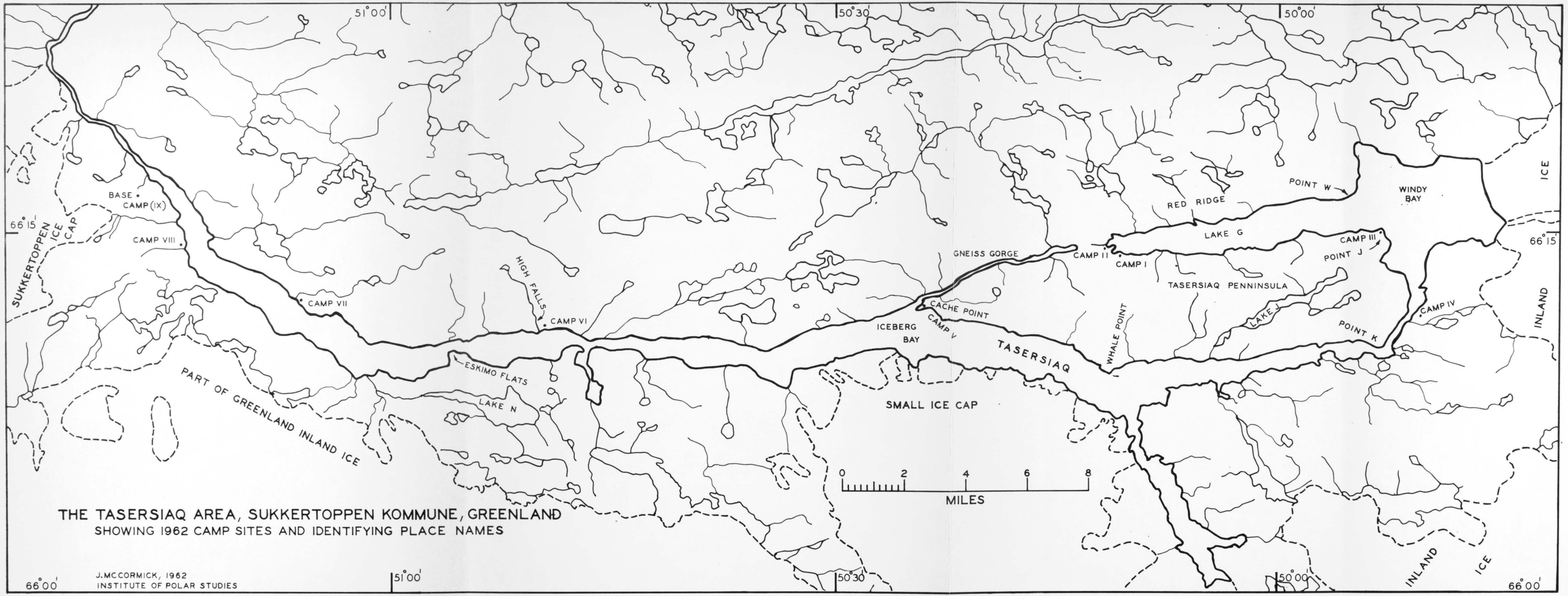
The maximum wind gust recorded at Base Camp was 42 mph on 31 August. Wind speeds over 20 mph were not uncommon. The strongest winds were normally from the south-southeast. Prevailing winds were in the quadrant from east to south with occasional short periods of northwest winds.

Total precipitation of 1.93 inches was recorded at Base Camp for the season. Of this total 1.34 inches fell between 26 June and 18 July and 0.45 inch between 24 and 31 August. The rainiest day by far was 6 July with 0.54 inch recorded. No precipitation was recorded for the period 19 July through 2 August. Although there were some snow flurries during the last few days of the season, all the measurable precipitation fell as rain.

A partial eclipse of the sun was observed at 1800 hours on 20 July. At the time of the observation the eclipse was approximately at midpoint. Rayed band type aurorae of faint to medium brightness were observed on 19 and 23 August.

Hydrology.--The water level of (Lake) Tasersiaq was measured daily beginning on 30 June and that of Camp Creek beginning on 18 July. Tasersiaq rose 5.3 feet to a peak on 18 July and fell by 3.3 feet from this date to 29 July. Another steady rise of 1.4 feet was observed to a secondary peak on 18 August. From this peak a rapid drop began which continued until the last observation on 2 September, when the level was only 0.3 feet above that of 30 June. The level of Camp Creek also fell off very rapidly from 21 August on after maintaining a fairly constant level throughout the rest of the season. As might be expected, there was a very pronounced similarity between the diurnal variation of the creek level and the diurnal temperature variation.

<u>Ablation of Ice on Glacier A</u>.--Ablation measurements on Glacier A were made utilizing stakes emplaced on 12 August 1962. Of these 15 stakes, only 7 were located in 1963. On these 7 stakes average ablation for the period 24 July to 19 August was 67 cm of ice and average ablation for the year 12 August 1962 to 19 August 1963 of 160 cm of ice.



THE TASERSIAQ AREA, SUKKERTOPPEN KOMMUNE, GREENLAND
SHOWING 1962 CAMP SITES AND IDENTIFYING PLACE NAMES

J.MCCORMICK, 1962
INSTITUTE OF POLAR STUDIES