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OPERATION HAZEN

NARRATIVE AND PRELIMINARY REPORTS FOR THE 1957 SEASON

DEFENCE RESEARCH BOARD
DEPARTMENT OF NATIONAL DEFENCE
CANADA

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JANUARY 1958
OTTAWA

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4c January 1958
0204b Ottawa ONT (CAN)
0204c Directorate of Physical Research (Geophysics)

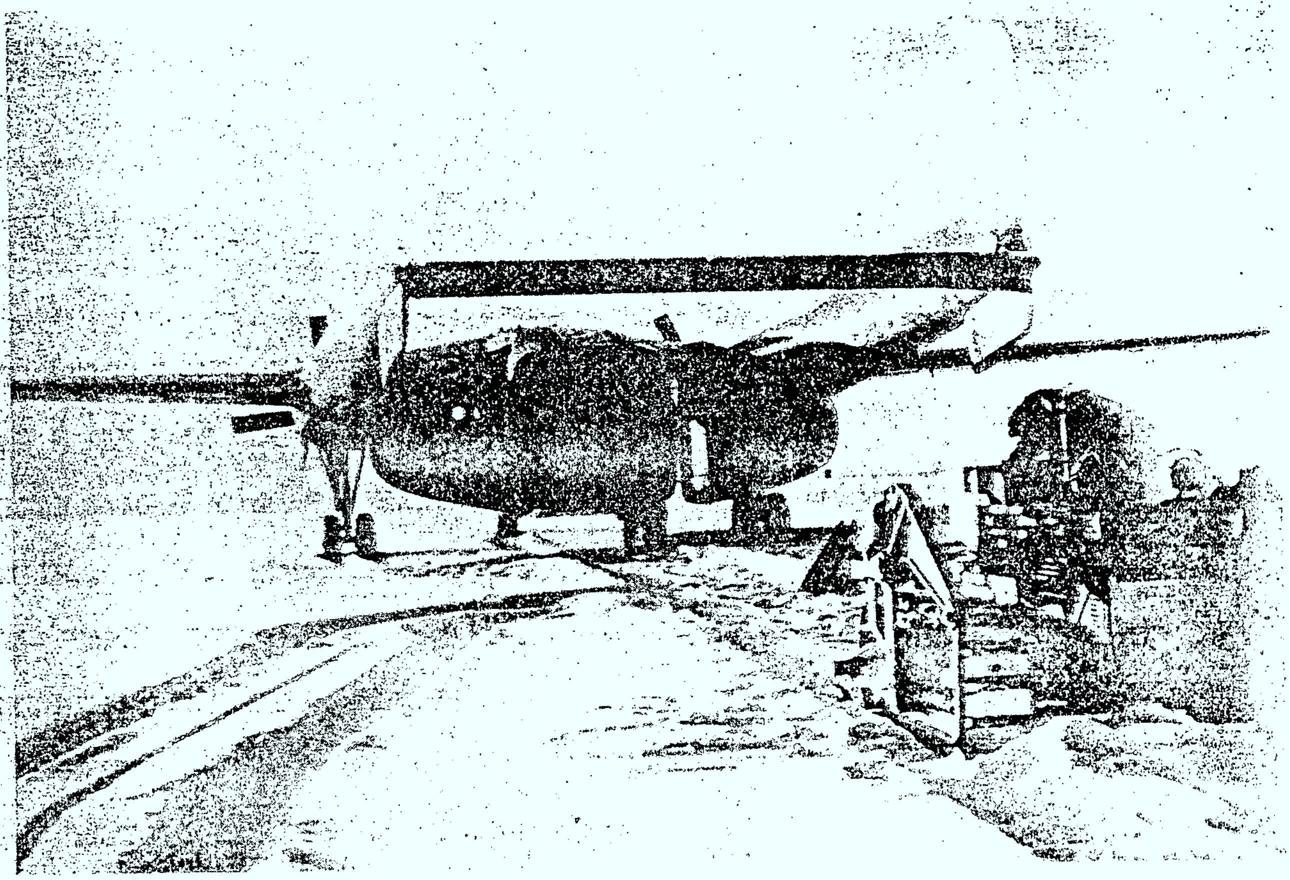

Fig. 1 C.119 aircraft on ice strip on Lake Hazen. 28 April 1957.

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(Note. Place names in inverted commas have not been officially accepted; they are given only for convenience in the presentation of this report).

ILLUSTRATIONS

INTRODUCTION AND AIRLIFT

G. Hattersley-Smith

Although the Discovery of the British Arctic Expedition wintered in Lady Franklin Bay in 1875-76, the main sledge journeys were made to the north-east and the south-west and Lake Hazen was not visited by that expedition. Lake Hazen was discovered in 1882 by A.W. Greely on the American Expedition of the First International Polar Year. Greely travelled to the west end of Lake Hazen and beyond to Mount Arthur via Very River; he also visited Henrietta Nesmith Glacier on the north side of the lake. In 1883 J.B. Lockwood and D.L. Brainard reached Greely Fiord from the head of Archer Fiord.

The next visitor to the region was R.E. Peary, who in 1900-01 wintered at Fort Conger and made hunting journeys inland to Lake Hazen. Except by hunting parties of Peary's 1905-6 and 1908-9 expeditions, Lake Hazen was not visited again until 1915 when W.E. Ekblaw of D.B. MacMillan's Crocker Land Expedition travelled along the south shore of the lake on his way back from Eureka Sound via Greely Fiord, returning to Greenland via Ruggles River and Lady Franklin Bay.

In 1935 H.W. Stallworthy and A.W. Moore of the Oxford University Ellesmere Land Expedition, accompanied by two Greenland Eskimos, visited the Lake Hazen region by dog sledge from Etah in north Greenland. Moore and the Eskimo Nookapingwa, travelling via Gilman Glacier, made the first ascent to the highland ice north of Lake Hazen, and climbed Mount Oxford, which was named for the expedition.

The present expedition was the first to visit Lake Hazen since 1935. "Operation Hazen" has been organized as part of the Canadian International Geophysical Year programme to carry out meteorological, glaciological and geological work over two summers and one winter. The glaciological work includes ice thickness determinations by seismic and gravity methods. Biological and archaeological investigations were not undertaken in 1957 but will form part of the summer programme in 1958. The following were in the field during the summer of 1957:

Dr. G. Hattersley-Smith, Defence Research Board - In charge, glaciologist

K.C. Arnold, University of Toronto - Surveyor

R.L. Christie, Geological Survey of Canada - Geologist

Professor R.E. Deane, University of Toronto - Pleistocene geologist

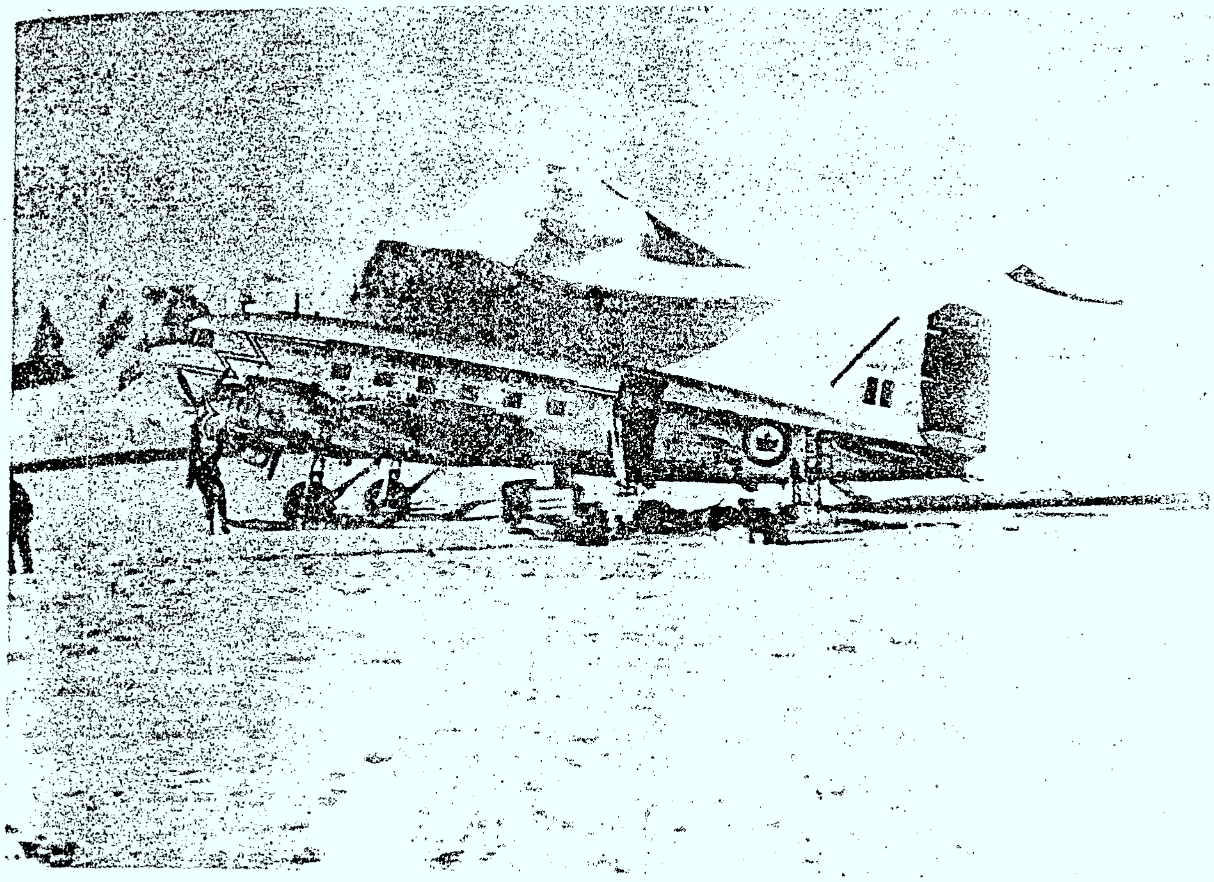


Fig. 2 C.47 aircraft at Gilman Glacier camp. 3 May 1957.

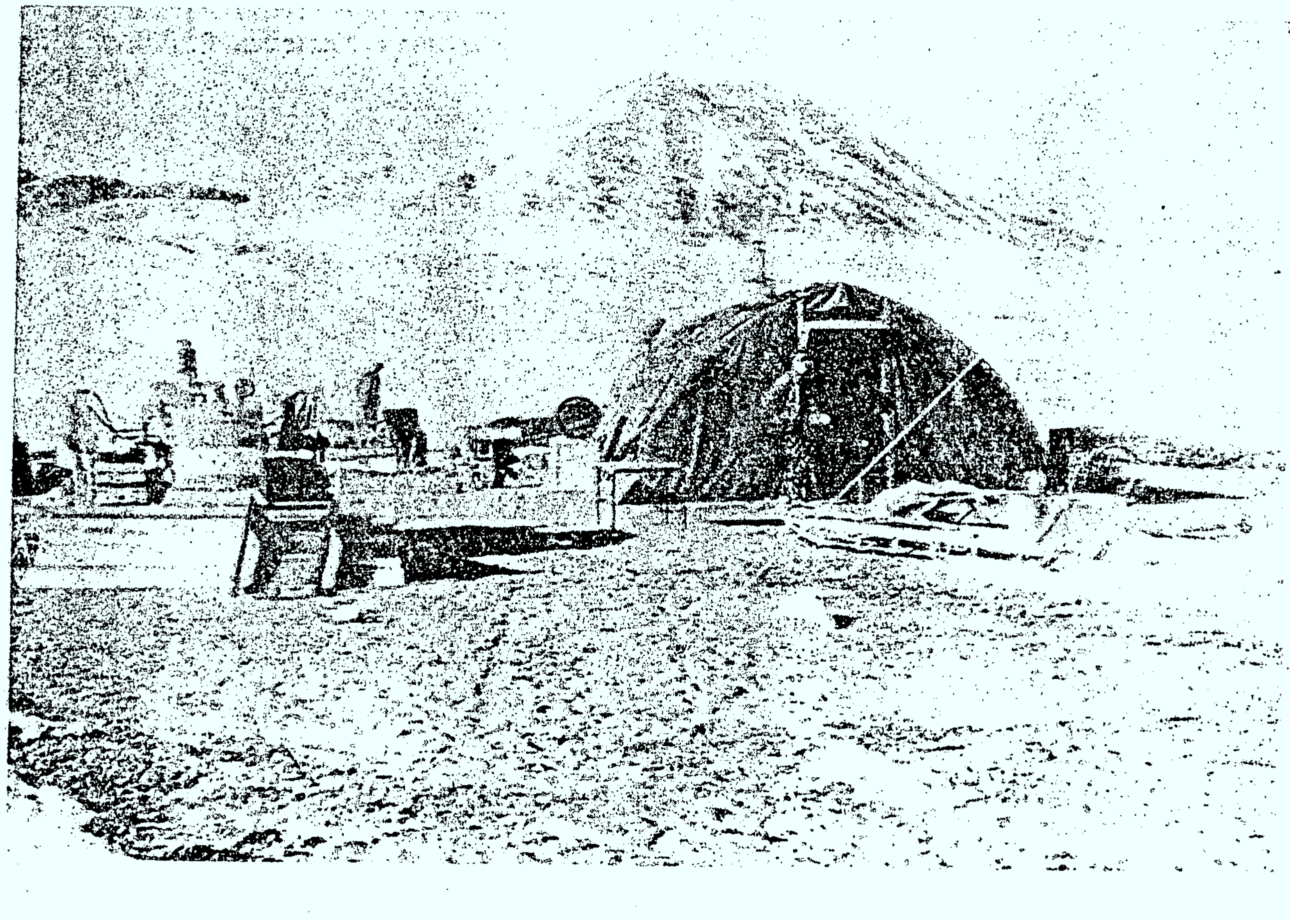


Fig. 3 Base camp on north shore of Lake Hazen. 23 May 1957.

J.D. Filo, University of Toronto - Assistant geophysicist

Dr. F.S. Grant, University of Toronto - Geophysicist

J.R. Lotz, McGill University - Meteorologist

H. Sandstrom, University of Toronto - Assistant geophysicist

Sgt. D. Engel, Royal Canadian Engineers - Tractor mechanic and driver (during the initial phase of the operation)

Between 28 April and 3 May seven members of the party were flown into Lake Hazen by 435 Squadron of Air Transport Command, Royal Canadian Air Force. A total of ten landings were made on the lake by C.119 aircraft ("Flying Boxcars"), in transporting approximately 35 tons of stores, fuel and equipment. The first two landings were made on an unprepared ice strip. A bulldozer, carried in at the first landing, was used to clear 9 inches of snow from a 3,500-foot airstrip for subsequent landings.

The base camp, which included two Attwell shelters, was established on the north shore of Lake Hazen opposite the west end of Johns Island, 520 feet above sea-level. On 3 May an advance camp was established on Gilman Glacier 25 miles north-east of the base camp at a height of about 3,400 feet. Three landings by a ski-wheel C.47 aircraft ("Dakota") of 408 Squadron, RCAF, and a paradrop by one of the C.119 aircraft were necessary to carry out this part of the operation.

LAKE HAZEN BASE CAMP: CHRONOLOGY

R.E. Deane

The base camp on Lake Hazen was occupied by R.E. Deane and R.L. Christie from May 2 to August 18. The following is a chronological summary of the main events and activities at the camp during the season.

April	28	Arrival of J.R. Lotz and Sgt. D. Engel at Lake Hazen.
	29	Arrival of R.L. Christie and K.C. Arnold.
May	2	Arrival of R.E. Deane.
	3	Arrival of G. Hattersley-Smith and F.S. Grant. Departure of Hattersley-Smith, Grant, Lotz and Arnold for Gilman Glacier station. Departure of Sgt. Engel for Thule.
	4-16	Moving equipment and supplies from ice airstrip to site of camp, erecting two "Attwell" huts, storing supplies and equipment at base camp, setting-up aerial etc.
	17	Trip to "Gilman River" in J.5 tractor to leave food cache.
	19	Exploratory trip to Henrietta Nesmith Glacier in J.5 tractor.
	22	Arrival of Hattersley-Smith, Grant and Arnold by dogteam from Gilman Glacier.
	24	Hattersley-Smith, Arnold and Deane to Henrietta Nesmith Glacier in J.5 tractor; left food cache.
	25	Departure of Hattersley-Smith, Christie and Arnold for Gilman Glacier by J.5 tractor and "Northland" sled to "Gilman River", thence by dogteam; additional food cache left at "Gilman River".
June	2	Arrival of H. Sandstrom, J.D. Filo, and J. Dobson ("Globe and Mail" reporter) from Thule in C.119 aircraft.

June 3		Return of R.C.A.F. C.119 aircraft and crew (9 men). Departure of Grant, Sandstrom and Filo in J.5 tractor to "Gilman River", thence by dogteam to Gilman Glacier. Grant returned to base camp to pick up generator.
	4	Departure of J. Dobson and C.119 crew for Thule. Departure of Grant in J.5 tractor for "Gilman River"; return of Christie to base camp.
	10-23	Trip down Ruggles River to Chandler Fiord, Conybeare Bay, Ida Bay and Archer Fiord by dogteam; food cache left at head of Ruggles River.
	25-29	Deane to Gilman Glacier camp on foot.
	25-27	Christie on reconnaissance geology of north shore of Lake Hazen.
July	9-10	Christie on geology of "Snow Goose River" valley; Deane making observations on "Snow Goose River".
	14-17	Christie to Gilman Glacier camp by boat and on foot.
	22-25	Deane to west end of Lake Hazen on foot with dogs.
	27-Aug 1	Trip to west end of Lake Hazen by boat.
Aug	4-8	Trip to east end of Lake Hazen; food cache left on "Salor Creek".
	7	Filo visited base camp.
	10	Arrival of Arnold, Sandstrom and Filo from Gilman Glacier.
	13	Departure of Christie for "Gilman River" by boat to meet Hattersley-Smith, Grant and Lotz.
	14	Arrival of Hattersley-Smith and Lotz from "Gilman River" by boat.
	15	Arrival of L/Cdr. J.P. Croal and C.R. Harington by helicopter from icebreaker *Eastwind*. Departure of Lotz for *Eastwind*.
	17	Departure of Croal, Arnold, Sandstrom and Filo for *Eastwind*.
	18	Departure of Grant and Christie from "Gilman River" for *Eastwind*. Departure of Hattersley-Smith and Deane for *Eastwind*. Departure of *Eastwind* from Chandler Fiord for Thule.

GILMAN GLACIER CAMP: NARRATIVE

G. Hattersley-Smith

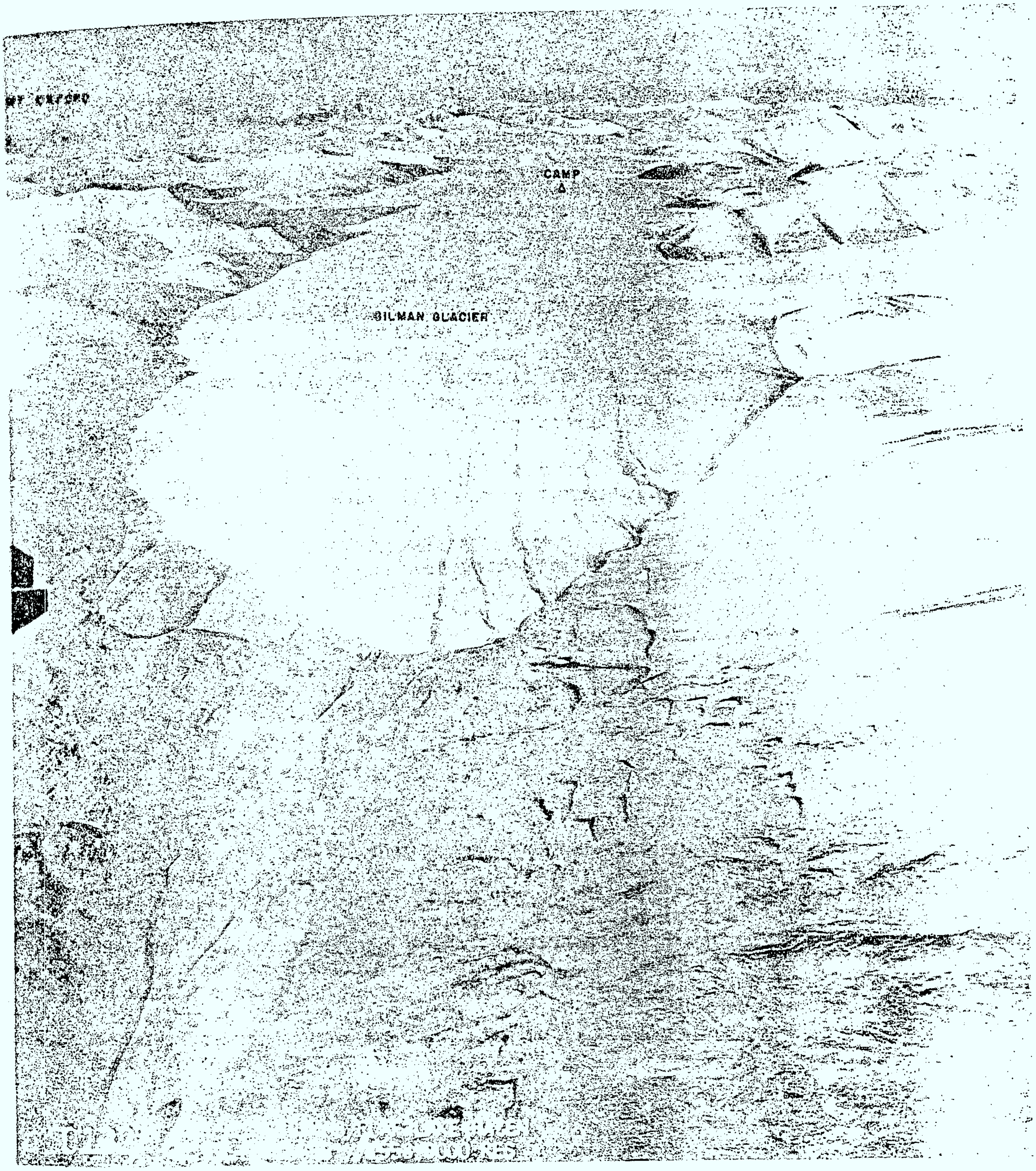
The glacier camp was manned at first by a party of four - Hattersley-Smith, Grant, Arnold and Lotz. After the landing on 3 May a blizzard came down on the camp and lasted for two days; the next four days were spent in collecting the airdrop, in digging out stores from the snowdrifts, and in establishing the camp.

Scientific work was started on 8 May. A bore-hole was put down to a depth of 50 feet for the purpose of measuring englacial temperatures and collecting ice cores for study of crystal structure. Two rows of movement and ablation stakes were also set out across the glacier about a quarter and half a mile above the camp and the snow was sampled at numerous places across the glacier. Survey stations were established on nunataks at the sides of the glacier for triangulation work in connexion with the movement study of the glacier. The meteorological instruments and the 30-foot mast for the micrometeorological work were set up. Regular meteorological observations in the screen were started on 18 May, and were continued throughout the summer. The geophysical equipment was overhauled; unfortunately it was found that the generator was unsatisfactory for the requirements, and that it would be necessary to bring another generator up from Lake Hazen.

For two weeks the party of four were engaged in work which did not take them more than three or four miles from the camp. On 19 May it became necessary to travel down to Lake Hazen to meet the two remaining members of the party, namely Filo and Sandstrom who were expected on an aircraft about 24 May. Hattersley-Smith, Grant and Arnold set off by dog team down the glacier, and made camp about four miles down the river from Gilman Glacier the following evening. It took about half a day to negotiate the steep snout of Gilman Glacier. The following day the party continued down the river, and camped in the evening about six miles east of Johns Island. They reached the base camp next morning, 22 May.

During the next three days it was learned by radio that the "clean-up" aircraft expected on 24 May would not arrive until early June. It was therefore decided that Hattersley-Smith, Christie and Arnold would leave for the icecap on 28 May, while Grant stayed down at Lake Hazen. In the meantime the impressive terminal ice-cliff of Henrietta Nesmith Glacier was visited by tractor, and Greely's record of 4 May 1882 was recovered from a cairn about two miles south of the glacier. The record, which was in a cocoa tin, had been badly damaged by moisture and rust and was indecipherable.

Fig. 4 Gilman Glacier. 21 September 1956 (Photo: Royal Canadian Air Force).



The party returned to the glacier camp in three days, taking with them a generator from the base camp which had to be manhandled up the glacier snout. During the next week glaciological and survey work was resumed, and a geological reconnaissance of the nearby nunataks was made. Micrometeorological observations on the mast were started on 9 June and continued for the rest of the summer. Unfortunately it proved impossible to transmit by radio to the base camp, although reception from the base camp was usually good.

On 2 June a C.119 aircraft flew over the camp; by prearrangement this meant that Filo and Sandstrom had arrived at the base camp on Lake Hazen and would set out for Gilman Glacier within twenty-four hours. Christie and Hattersley-Smith left camp early on 3 June and met Deane, Grant, Filo and Sandstrom about seven miles from the mouth of the river in the evening. The party had walked two or three miles up river from where they left the "Bombardier" J.5 tractor.

The next day the glacier party manhandled equipment up the glacier snout, while Deane and Christie returned to the base camp. Arnold by this time had joined the camp at the foot of the glacier; for the next three days he, Filo and Sandstrom did survey work near the foot of the glacier and then started to carry a level survey up to the main camp. This work was completed by 12 June. By 14 June Grant was ready to start the seismic work and with Arnold, Filo and Sandstrom travelled down glacier with all the seismic equipment to set up the first profile. Two profiles were shot across the glacier, one two miles below camp and one a mile below camp. During this time another hole was drilled at the camp for temperature and crystallographic measurements.

On 20 June, while seismic work was still in progress around the camp, Arnold and Hattersley-Smith left with one dog team to go up the glacier. On the first day they travelled about fifteen miles and made camp by a small nunatak twelve miles east of Mount Oxford. The next day they headed for Mount Oxford, which they recognized from a distance with the help of a photograph taken by Moore in 1935, making camp below the peak in the evening. The twenty-second of June was very clear and still, and it was possible to spend the whole day from 10 a.m. to 5 p.m. making theodolite observations from the top of Mount Oxford and taking a series of panoramic photographs. Two further days were spent digging a deep pit into the firn below Mount Oxford in which it was possible to measure the annual accumulation for about the last twenty years and to measure the temperature of the firn.

On 24 June the party started back to Gilman Glacier, and reconnoitered on the way a possible route down to the Disraeli Bay glacier, which unfortunately led down an icefall about ten miles north-east of Mount Oxford. Camp was made that night in the same place as on 20 June. Further glaciological data were collected and Arnold established a survey station on the nunatak behind the camp. The party left at 9 p.m. and, after setting up ablation poles along the route, reached the glacier camp at 6 p.m. By this date, 26 June, the thaw was well advanced; all the snow had melted at camp and ablation of the ice had started. The previous day Deane had made his way up to the glacier camp from the lake under difficult conditions in the height of the thaw with the melt streams in full spate. The following day Hattersley-Smith and Arnold accompanied Deane by dog sledge to the snout of the glacier and for about five miles on his return route to Lake Hazen. They then spent two days in the valley west of the glacier snout, which they reconnoitered up to the col above a valley leading down to the base camp on Lake Hazen. The snout of a glacier on the east side of the col was examined. About thirty musk-oxen were seen and a number of close-up photographs were taken. An ancient tent ring was found on the bank of the stream about twenty-nine feet above the water. The outside measurements of the ring were six feet by four feet; inside there was a "turf" up to four inches deep, produced mainly by grasses.

On 2-3 July the seismic party moved camp five miles up the glacier. From this camp and from another camp a few miles further north seismic profiles were shot over the main basin of Gilman Glacier during the next two to three weeks. The triangulation of the glacier was carried towards the snout from stations established on prominent rock spurs at the sides of the glacier. The absence of snow cover provided a good opportunity to study the structure and stratigraphy of the glacier portrayed in the marginal ice cliffs and slopes. From vantage points at the side of the glacier the progress of the melt, the pattern of the numerous surface streams, and the rapid growth of the marginal drainage rivers and lakes could best be observed.

On 23 July the seismic party were joined by Arnold and Hattersley-Smith and the whole party moved camp about seven miles to the northwest where during the next few days a seismic profile was shot across the icefield at 4,500 feet, about ten miles south-east of Mount Oxford. The firn line is situated just below this level as determined by the digging of pits. Glaciological and temperature data were also obtained from a 20-foot bore hole. This work was completed by 30 July and the party sledged back to camp with all their equipment. On 31 July the seismic party went down the glacier in bad weather and surveyed and partially set up a profile about two miles from the terminal snout, returning on 2 August. Arnold, Filo and Sandstrom left by dog team on 4 August for the snout of the glacier, whence they were to carry a level survey across to the base camp on Lake Hazen, using their dogs for packing food and equipment. During the next week the remaining members of the party were fully occupied in striking camp and securing equipment and stores for the winter. On 9-10 August they shot the seismic profile which had been set up near the snout of the glacier a week ago.

On 12 August the party left with a Greenland sledge and the remaining ten dogs, and eight puppies which had been born on the icecap. The sledge was left at the western edge of the glacier near the snout. Packs were put on the dogs and the party made their way down to the tributary stream west of Gilman Glacier, which was crossed about two miles above its junction with the main stream. The party made camp by a food cache which had been laid out in the spring one mile south of the glacier snout. Next day the march was resumed to the mouth of the river where it had been arranged that Christie would meet the party by motorboat. After a long day's march, on which the dogs were each carrying fifteen to twenty pounds of equipment, Christie's camp was reached at the mouth of the river late at night. On the 14th Lotz and Hattersley-Smith left for the base camp by motorboat, leaving Christie and Grant in camp by the river. During the last week the survey party had completed their levelling traverse to the base camp. The traverse was extended to the Shoran station on Johns Island during the next two days.

On 15 August a "Piaseki" helicopter arrived early in the morning and Lt.Cdr. Croal stepped out. This was the first indication of the arrival of the U.S. Coast Guard Cutter Eastwind in Chandler Fiord. During the next three days the members of the winter party arrived to take over their duties, and fifteen tons of stores, fuel and equipment were transferred from the ship by helicopter. The summer party, who had been expecting to walk to the mouth of Black Rock Vale to join the ship, were taken by helicopter to Eastwind, which sailed for Alexandra Fiord and Thule on 18 August.

SEALIFT

J.P. Croal, LCDR, RCN

Through the courtesy of the Commander, United States Military Sea Transportation Service, U.S.C.G.C. Eastwind was assigned to the Operation Hazen Sealift. Direct liaison was established between Geophysics Section, Defence Research Board and COMSTSLANTAREA. This arrangement was made by the Directorate of Naval Plans and Operations, R.C.N. and proved very effective.

Final plans were made on 24 April 1957 to transfer the winter party of four men with 2,000 lbs. of equipment from Thule to Lake Hazen, and eight men, twenty dogs and 2,000 lbs. of equipment from the Lake Hazen base camp. The men and equipment from the lake would be landed at Thule and the twenty dogs returned to Kanak, Greenland. I was appointed to act as liaison officer in Eastwind and to assist the Commanding Officer in any way possible.

The Canadian Department of Transport icebreaker N.B. McLean was to deliver oil, gasoline, food, scientific equipment and other stores, amounting to approximately 15 tons, to Thule. With the exception of 2,000 lbs. of food and scientific equipment to go in Eastwind to Lake Hazen, the cargo was to be stored at Thule to await the spring 1958 airlift.

When the operation was planned, it was thought that ice conditions might prevent Eastwind from entering Chandler Fiord, the northern end of which is only 15 miles from Lake Hazen, and that a considerable distance might have to be flown by the ship's helicopters. Therefore cargo requirements for Lake Hazen were cut to a bare minimum. Nine hundred gallons of 115/145 aviation gas were flown into Lake Hazen in the spring of 1957, in case the icebreaker helicopters had to refuel at the camp.

In the company of C.R. Harington, J.M. Powell, and C.I. Jackson of the winter party, I arrived at Thule via Military Air Transport Service on 3 August. D.I. Smith, the fourth member of the winter party, arrived in the N.B. McLean and transferred directly to the Eastwind on arrival.

Administrative details were arranged with the local authorities for the handling and storage of cargo. The fact that I am an honorary member of the 7278th Transportation Corps greatly assisted in by-passing the usual formalities. Excellent cooperation was extended to us by the heads of all the departments we dealt with at Thule, and their hospitality was much appreciated.

During our wait for the N.B. McLean and the Eastwind at Thule, continuous contact was kept with the U.S.N. Ice Reconnaissance Group, and I was thus enabled to keep track of ice conditions further north. Attempts were also made to establish radio contact with Lake Hazen, which proved to be most unsatisfactory.

On 6 August a "Canso" aircraft of 121 Squadron (Vancouver) landed at Thule en route to Alert. I was able to dispatch a letter in this aircraft to Lake Hazen, which was dropped to the party at the base on 7 August. The letter informed the party that we were in the area and instructed them to remain in a group at the base camp for evacuation on or about 15 August. A very favourable ice report was sent by the "Canso" indicating a five-tenths concentration in Lady Franklin Bay, and two-tenths in Conybeare Bay and Archer Fiord.

On 9 August a message was received from the Lake Hazen party confirming they had received the letter dropped by the "Canso". No further radio contact was made from this date until the ship arrived in Chandler Fiord on 15 August.

N.B. McLean had been scheduled to arrive at Thule on 7 August, but all attempts to establish her whereabouts by radio were futile. However, on the 12th she docked at Thule with D.I. Smith and our cargo.

As the Eastwind was also in harbour, cargo transfer was commenced. The Commanding Officer of Eastwind, Capt. R.F. Rea, decided that as reported ice conditions in the north looked so favourable an attempt would be made to land all the cargo at Lake Hazen, and so the entire 15 tons was put aboard the Eastwind. If it proved possible to deliver this cargo, the spring 1958 airlift would be greatly simplified, and winter storage at Thule would be eliminated. Unfortunately the N.B. McLean was short in her delivery to us of 13 drums of diesel fuel oil. The manifest showed 29 drums loaded at Montreal and only 16 could be accounted for when the ship arrived at Thule. Fortunately this shortage did not seriously affect the plans for the winter party.

On 13 August the Commanding Officer of Eastwind and I accompanied a P2V ice reconnaissance flight from Thule to Lake Hazen. The prospects of an easy passage north and good working conditions from Chandler Fiord to Lake Hazen seemed very reasonable, and the chances of landing the entire cargo by helicopter from the north end of Chandler Fiord looked good.

Eastwind sailed from Thule the same evening, and about noon on 15 August anchored in 30 fathoms, 1,000 yards from the north end of Chandler Fiord. The trip north was uneventful and the ship was able to average approximately 10 knots through the ice.

The airlift to Lake Hazen by *Eastwind's* "Piaseki" helicopter commenced immediately. Taking advantage of breaks in fog and rain over the Chandler Fiord-Ruggles River area, the two pilots working in shifts landed at Lake Hazen four men and 15 tons of cargo, and evacuated eight men, twenty dogs, and 2,000 lbs. of equipment in a total of 35 hours of flying.

The ship sailed for Alexandra Fiord about noon on 18 August to deliver cargo at the Royal Canadian Mounted Police Station. The side was piped in honour of A.W. Greely as Fort Conger was passed abeam to port, and the Executive Officer made a speech in honour of the occasion.

That evening *Eastwind* lost her port propeller off Cape Baird in a 9/10 concentration of ice. With all six engines running the ship had broken through to an open lead. This may have strained the shaft, which later proved to have been cracked previously, and the propeller dropped off after the ship reached the open lead.

The following evening the ship anchored 500 yards off the beach at Alexandra Fiord in 160 feet of water, and offloading of cargo started. Hydrographic work in the fiord and triangulation of beacons erected by H.M.C.S. *Labrador* in 1954 were carried out. The information has since been passed to the Dominion Hydrographer, along with all information collected on the passage in and out of Chandler Fiord.

The Underwater Demolition Team from the *Eastwind* landed to attempt removal of a reef extending in front of the landing beach, but no mark was made on the reef in spite of a number of violent explosions, in which the natives took an obvious interest. It is felt that a bulldozer at low tide, or a drag line would produce much better results, as the reef consists mainly of gravel, mud and sandy silt.

At noon on 20 August one of *Eastwind's* helicopters was reported to have crashed on an 800-foot rocky hill east of the RCMP post. Fortunately on one was injured, but there seemed to be a little concern about the chances of recovering the wreckage. I volunteered the services of the Lake Hazen scientific team and they were accepted. A party of eighteen, including the Lake Hazen scientists, Engs. P.D. Morris and I, left the ship by L.C.V.P. and made our way to the top of the hill. Tools, ropes, timber, blocks, etc. were flown to the top in the "Piaseki" in advance of the invasion of the summit. The day was cold and bleak with low overcast and snow.

When we reached the top, the "Bell" helicopter looked in rather miserable shape; the plexiglass dome was smashed, the main rotor blades broken, the tail boom and assembly twisted, both pontoons punctured, and the machine lying on its port side in a pool of gasoline and oil. Apparently loss of power while hovering about six feet off the rocks caused the crash. I recommended that we should dismantle the aircraft and carry the pieces back on our shoulders, except the engine which could be flown out in the "Piaseki". After much delay this course of action was decided upon. The U.S. Navy pilots were loath to see their wounded bird stripped. It took about three hours to lift out the engine and take the tail boom off. The frame and boom were carried back to the ship without mishap, and the engine flown out to the ship the following morning. We returned to the ship cold and soaked, but happy in the knowledge that we had accomplished a difficult task. The Commanding Officer was quite concerned about the long absence of the party up in the cloud and snow, and showed his relief by issuing all hands a measure of medicinal brandy on arrival back aboard.

The Eastwind sailed from Alexandra Fiord on the evening of 21 August, after discharging 35 tons of cargo, and headed for Kanak, Greenland, where the twenty dogs were landed the following evening. Eastwind passed through Murchison Sound on the way into Kanak, possibly the first time a ship this size has made the passage. She left Kanak late on the 22nd and arrived the following morning at Thule, whence our party flew south by M.A.T.S. and R.C.A.F., arriving in Dorval a few days later.

The Eastwind performed an outstanding job, and a letter of appreciation of her services has been sent through the Canadian Joint Staff, Washington to the United States Military Sea Transportation Service and the United States Coast Guard.

HYDROGRAPHIC INFORMATION

J.P. Croal, LCDR, RCN
(With the cooperation of the U.S.C.G.C. Eastwind)

During the first resupply of the Lake Hazen station the Eastwind made the first recorded passage through Conybeare Bay into Chandler Fiord. Soundings were recorded and other hydrographic data collected.

Approaches to Conybeare Bay and Chandler Fiord

A good deep water channel lies between the north shore of the entrance to Conybeare Bay and the north side of Miller Island. The depth of water averages approximately 150 fathoms. This is the recommended shipping channel. Good navigational control is possible due to the prominent landmarks and high land from which radar gives a good return.

The southern entrance between the south shore of Miller Island, and Keppel Head and Mount Grinnell, has not been sounded but it is believed that a deep channel also exists. Passage through the southern entrance should not be attempted if ice conditions are bad, or if visibility is poor, as an exposed reef extends from the south shore to within 1000 yards of the western end of Miller Island.

Miller Island

Miller Island is located in the centre of the entrance of Conybeare Bay, and is castle-like in appearance, with steep cliffs above a very narrow foreshore which surrounds it. The approximate heights of the three main peaks of the island are: N.E. peak 1100', S.E. peak 1500', S.W. peak 985'. No good landing beaches were observed on the north side of the island.

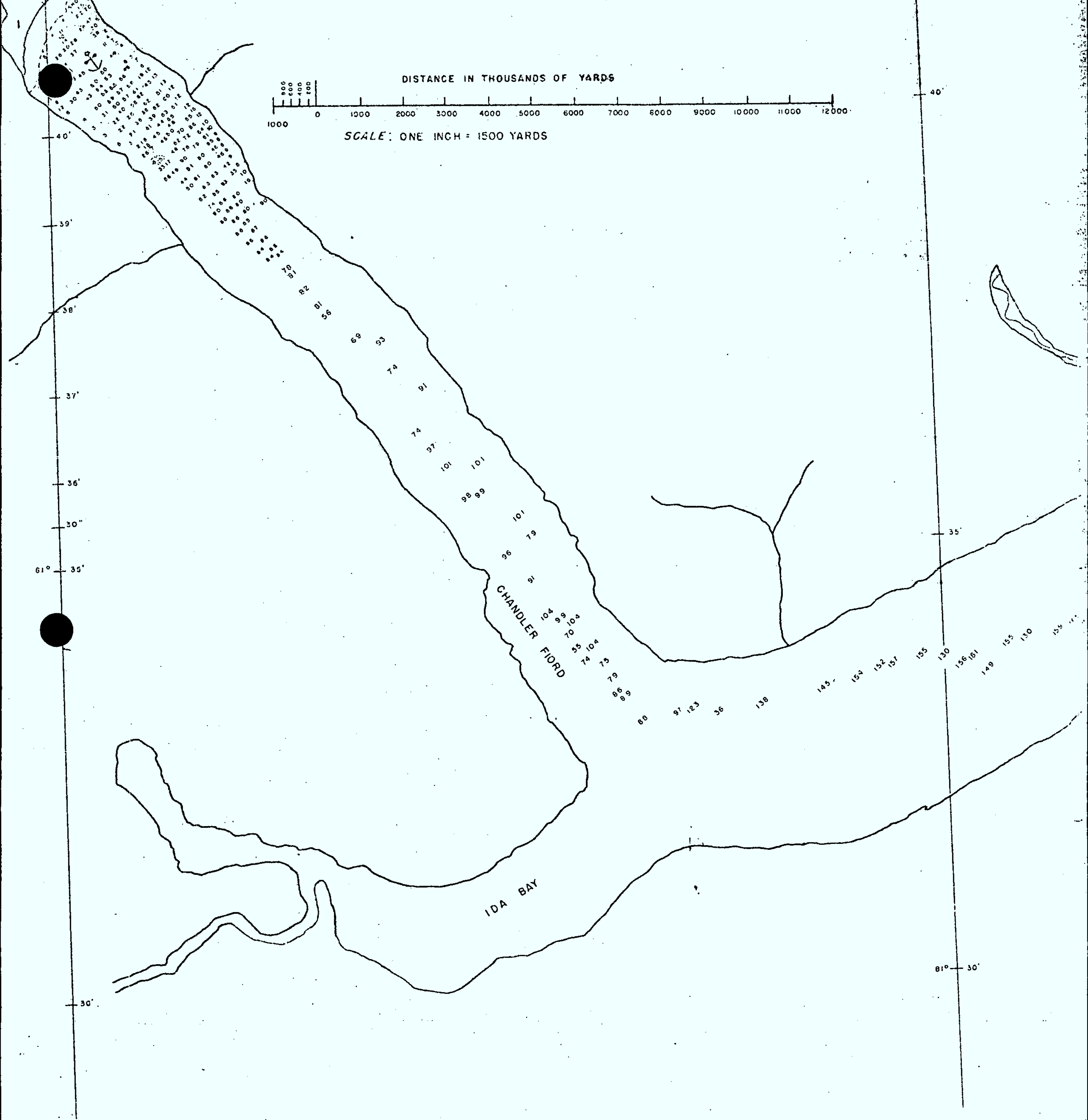
Conybeare Bay

When the west end of Miller Island is cleared to port, the approach to Chandler Fiord through Conybeare Bay presents no problem. The channel is deep, never less than 100 fathoms. When clear of Miller Island the amount of ice decreases in Conybeare Bay, where the concentration on 15 August was 1/10 to 2/10, whereas the concentration in Lady Franklin Bay and near the east end of Miller Island was 7/10 to 9/10.

ELLESMERE ISLAND

MILLER ISLAND TO MOUTH OF RUGGLES RIVER

SOUNDINGS IN FATHOMS BY USCGC EASTWIND WAGB-297



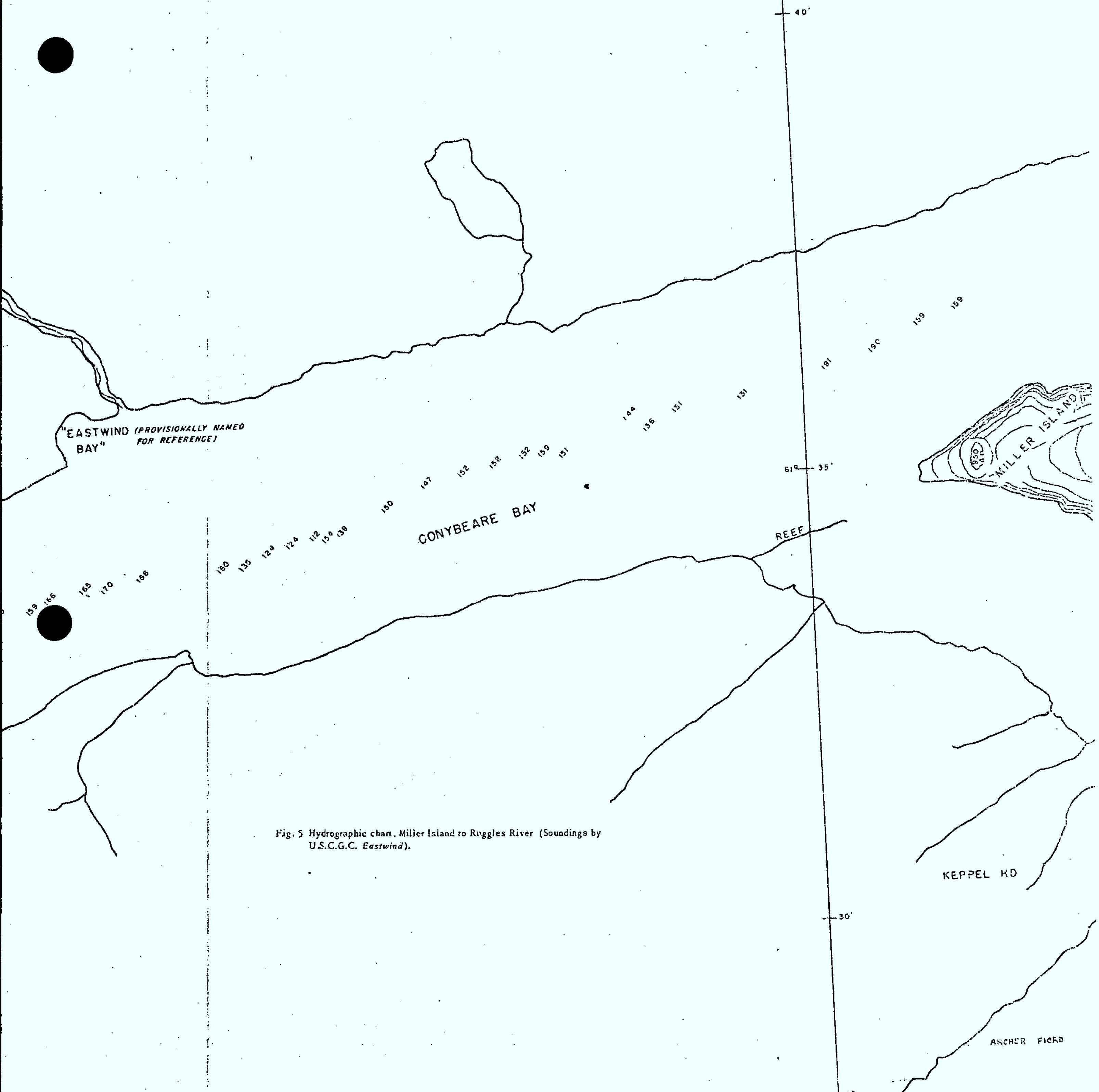


Fig. 5 Hydrographic chart, Miller Island to Ruggles River (Soundings by U.S.C.G.C. *Eastwind*).

A small "fiord", shown on Canadian Chart No. 5604, $5\frac{1}{2}$ miles east of Chandler Fiord, is in fact not a fiord, but a small bay with a deep gully in the background. The gully has a small stream emptying into the bay. This small bay has for reference purposes been named "Eastwind Bay". Boat landings would be possible in "Eastwind Bay".

The north and south sides of Conybeare Bay are high and precipitous.

Chandler Fiord

A good deep water channel exists from the mouth of Chandler Fiord to the recommended anchorage half a mile from the icefoot at the northwest end. Soundings of 55 fathoms were recorded at the entrance, deepening to 90 fathoms half way down the fiord and gradually rising to 30 fathoms at the anchorage. The anchorage has good holding ground in mud and silt. The Ruggles River drains Lake Hazen in a general southeasterly direction to its mouth at the head of Chandler Fiord. Care should be taken not to use the evaporators at the anchorage, since the water is heavily silt-laden due to the discharge from the Ruggles River.

A large icefoot fills the northwest end of Chandler Fiord; its face is sheer and is 20-25' in height. The Ruggles River cuts a deep channel through this icefoot and the sides of this channel are also sheer, being about 20-25' high. The icefoot extends up-river for several miles with the ice walls of the river gradually lessening in height.

No suitable landing beaches were observed in Chandler Fiord. However, it would be possible to land at one side or the other of the icefoot and construct a ramp up from the water's edge to the top of the icefoot, using talus from the steep fiord walls as construction material.

In winter the Ruggles River when frozen provides easy access to Lake Hazen. There is also a good possibility that an all-season road might be constructed along the river bank.

The cliffs on each side of Chandler Fiord are precipitous; they are about 1000' to 1500' on the eastern side with clefts in several places. The western side attain heights of 2000', and is cut by some narrow gorges.

Shelter from the wind in Chandler Fiord is excellent. The prevailing winds appeared to be from the southeast but in the short reach of the fiord, approximately 10 miles, the sea does not build up to any great extent. A small shoal at 5-6 fathoms exists close to the point two miles from the icefoot on the southwestern side of the fiord.

Off the entrance to Chandler Fiord there was observed quite a heavy concentration of reddish yellow streaks in the water, which were assumed to be plankton.

The tide in Chandler Fiord in the short time observed appeared to have a rise and fall of 4.5 feet, with a high water interval of approximately 11 hours 33 minutes.

Weather

During the three days we lay at anchor in Chandler Fiord there was usually fog and low clouds in the fiord, whereas at Lake Hazen 15 miles northwest and 520' above sea level the weather was generally good. This is probably due to the mountains which surround Lake Hazen and give it its own weather conditions.

Sailing Directions

The following corrections are suggested to Sailing Directions for Baffin Bay and Davis Strait, United States Navy Hydrographic Office, Publication No. 76, 1947.

Page 550

Chandler Fiord, line 1-2. Delete "is about 5 miles wide" and substitute "is $1\frac{1}{2}$ miles wide".

line 4. Delete "18 to 20" and substitute "15".

line 6. Delete "bay" and substitute "fiord".

BEDROCK GEOLOGY[1]

R.L. Christie[2]

Reconnaissance geological study in the Lake Hazen region was carried out by the writer during the three months from 15 May to 15 August 1957. The work was done in cooperation with Prof. R.E. Deane of the University of Toronto, who was engaged primarily in limnological and glacial-geological studies. The party travelled in various ways - by snowmobile, dog-sled, ski, boat, and on foot. Dogs were used with packs on a few occasions.

The region examined extends north to Gilman Glacier in Latitude 82°41'N and south to Judge Daly Promontory in Latitude 81°25'N. Traverses were made up some of the major valleys north of Lake Hazen;; the valley of Gilman Glacier was examined up to and a few miles north of the glacier camp, and specimens and geological information were obtained by Hattersley-Smith and Arnold north and west to Mt. Oxford; the valley north of the Lake Hazen base camp was traversed; and the lower parts of the Henrietta Nesmith Glacier were studied. Short trips were made to the east and west of Lake Hazen, and most of the shoreline was more or less carefully studied on foot and from a boat. An extended trip was made down Ruggles River and Chandler Fiord, up Ida Bay and its tributary river valleys, down Conybeare Bay, and across Archer Fiord to Daly Promontory.

The geology may be summarized as follows:

The most widespread and the oldest formation of the region is the Cape Rawson group of tightly folded, slightly metamorphosed grits, slates, sandstones, quartzites, and greywackes of probable early Paleozoic age or older. The folding in these rocks is isoclinal to chevron in form, and consistently trends northeast. The Cape Rawson group underlies both the plateau region south of Lake Hazen and the southeast flanks at least of the United States Range. (There appear to be some differences in lithology between the two regions, but the amount and importance of the differences have not been studied as yet).

[1] Reproduced by permission of the Director, Geological Survey of Canada, Ottawa.

[2] Geologist, Geological Survey of Canada.

An apparently younger group of rocks comprising sandstone, arkose, limestone, and conglomerate (probably late Paleozoic in age) forms the higher parts of the United States Range. These rocks were examined in only two places, but they form a structurally and petrographically distinct group which is easily distinguished from great distances.

A group of weakly consolidated sand and shale with coal seams underlies the foothills of the United States Range along the north shore of Lake Hazen, and underlies an extensive low, hilly area northeast of Lake Hazen. Fossils from various localities are tentatively dated as of Permo-Carboniferous, of probable Triassic, and of probable Cenozoic age. The group is generally gently folded, but locally, as along "Gilman River", it is extremely contorted.

Coal seams are present in the vicinity of "Gilman River"; as many as 5 seams about 2 to 4 feet thick are exposed, and coal is exposed nearly continuously for about 10 miles along the north shore of Lake Hazen, mainly west of the mouth of "Gilman River". One seam, at its thickest, is about 8 feet. The coal is generally very clean, and is slightly brown and lignitic or shining black and bituminous in appearance.

The sandstone-shale group is down-faulted and bounded on the north for many miles by a steep-dipping, major fault zone.

A more complete geological report will be presented when the field data, rock specimens, and fossil collections have been more thoroughly studied.

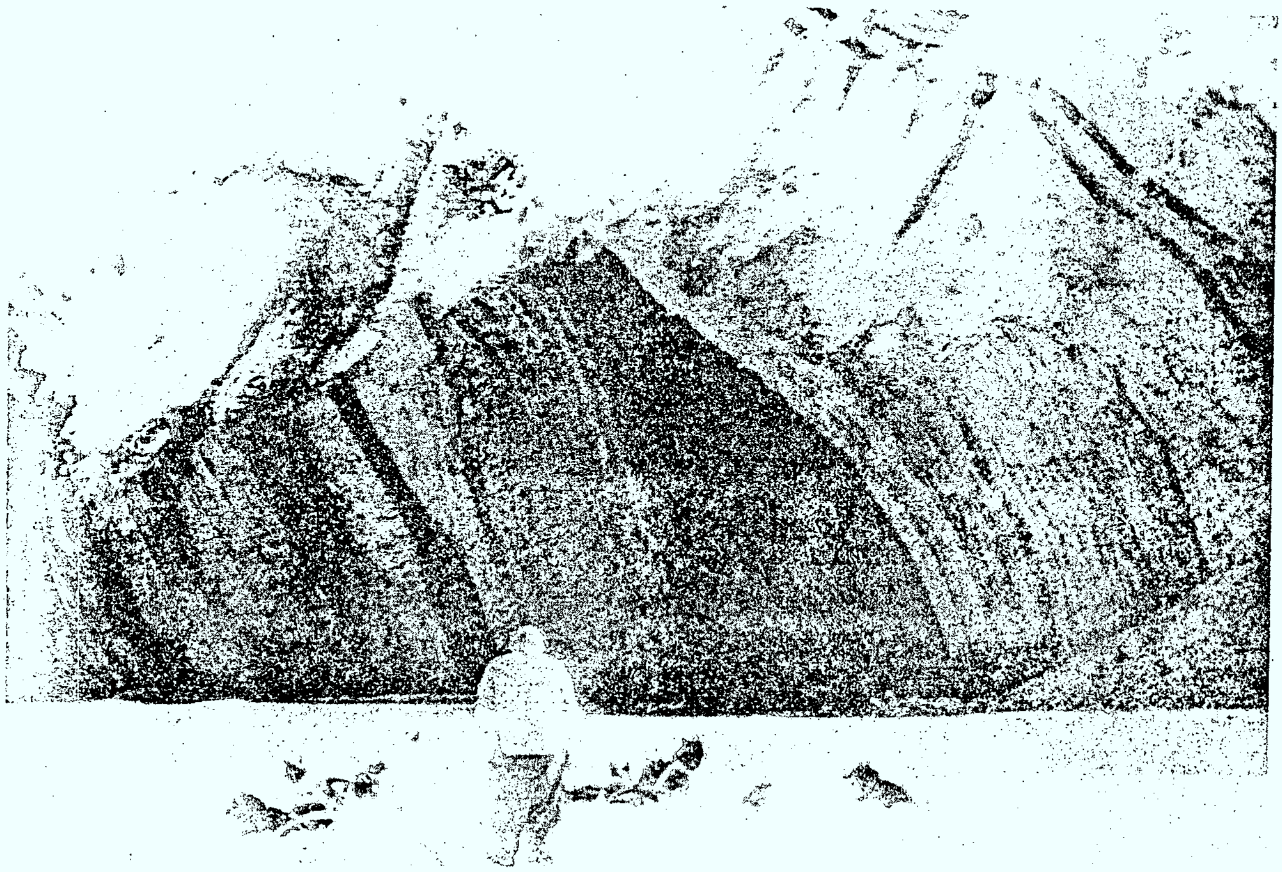


Fig. 6 Folded sandstone and shale with coal seams along "Gilman River". 21 May 1957.

REPORT OF ANALYSIS
OF
COAL SAMPLE COLLECTED BY R.L. CHRISTIE FROM LAKE HAZEN, N.W.T.

Field Spec. No. CB-57-5-45-C

Lab. No. 3031-51

Location: 1.4 miles west of mouth of "Gilman River", north shore of Lake Hazen.

Grab sample sealed in a tin can by solder.

Coal seam about 8 feet thick at the sample locality.

Rank: Sub-bituminous B.

ANALYSIS (PROXIMATE)

	As Rec'd	Dry
Moisture	23.5 %	0.0 %
Ash	5.5	7.2
Volatile matter	38.3	50.0
Fixed carbon (by difference)	32.7	42.8
Fuel value	9,097 BTU/lb.	11,884 BTU/lb.

Reported by W.J. Montgomery, chemist, of the Fuels Div., Mines Branch, Dept. of Mines and Technical Surveys

PLEISTOCENE GEOLOGY AND LIMNOLOGY

R.E. Deane

Introduction

The scenery and climate at Lake Hazen in summer are outstanding. Physiographically the area is divided into two distinct provinces in striking contrast to each other; a lowland on the south and a highland on the north. South of the lake a plateau rises gently from an elevation of 500 feet above sea level at Lake Hazen to approximately 2,700 feet in the fiord area 25 miles to the south. This plateau presents an even sky line but is locally irregular and dissected by numerous streams, some of which follow the general east-west trend of the rocks, while others cut across the structure to flow either north toward Lake Hazen or south to the sea. On the north side of Lake Hazen the beautiful mountains of the Garfield Range rise abruptly 3,000 to 4,000 feet above the lowlands. The long axis of the basin occupied by Lake Hazen is parallel to the strike of the rocks, which is N 60°E, but the fault line scarp which marks the front of the range trends N 50°E. Consequently, the lake at its western end is at the foot of the mountains, while at its eastern end it lies 10 miles from the mountain front.

Snow disappears from the lower mountains of the Garfield Range during summer, but in the higher area of the United States Range a permanent ice cap covers the valleys and mountain slopes. The two most prominent outlet glaciers of the ice cap in the vicinity of Lake Hazen are the Henrietta Nesmith Glacier, with its snout just a mile from the lake near its western end, and Gilman Glacier ending 14 miles from the lake near its eastern end.

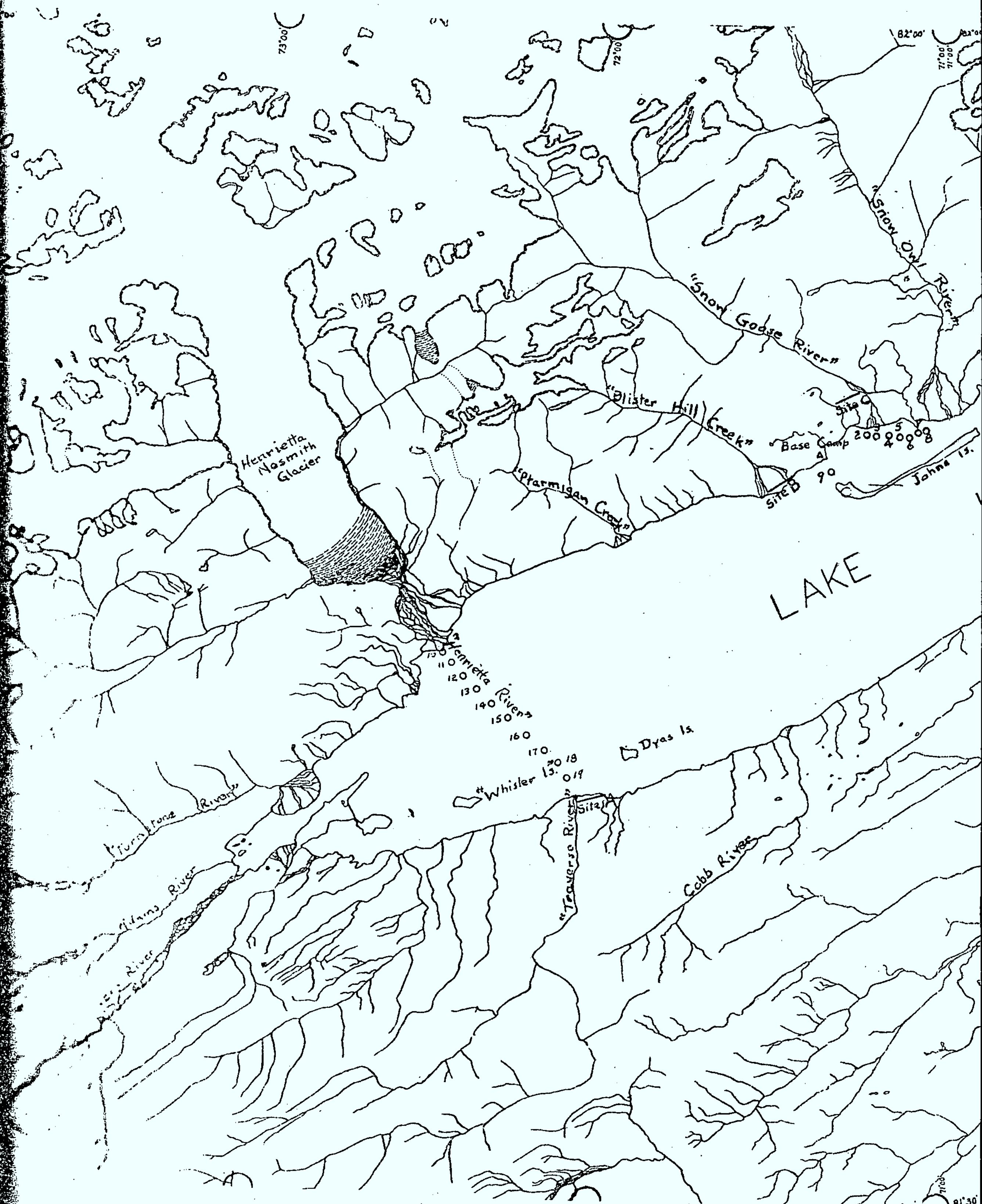
Bedrock crops out abundantly, particularly in those areas underlain by hard Palaeozoic sediments south of Lake Hazen, and in the mountains. Evidence of glaciation is seen in the thin, bouldery till that covers the bedrock in places. Fewer outcrops are found in the area east of the base camp between the lake and the mountain front, underlain by soft, Tertiary (?) sediments, where till and outwash sand and gravel cover most of the underlying rock. At the east end of Lake Hazen thick deposits of lacustrine and deltaic sand, silt and clay fill most of the valleys. The flat tops of these deposits rise 50 feet above the lake and possibly mark a period when the west end of Lake Hazen was filled with glacier ice, blocking the outlet of Ruggles River, and when drainage from the area at the east end of the lake was down Black Rock Vale.

May and most of June were marked by almost perpetual sunshine at Lake Hazen. During parts of June, July, and the first half of August intermittent cloudiness marred an otherwise perfect climate. On a few occasions low clouds blanketed the lake and valleys, but in general, clear skies with distant clouds around the horizon in all directions are typical of the Lake Hazen area. The area is also remarkable for its almost complete lack of wind; a light breeze, from 1 to 8 miles per hour, mainly from the east, was the general rule. After the melt season, occasional strong winds from the west occurred; the following were recorded during the summer: 20 mph on June 28, up to 45 mph on July 20-21, 15 mph on August 2, and 26 mph on August 12. The condition of the snow and lack of drifts indicate that the Lake Hazen area is free of strong winds throughout the fall, winter and spring. The melt season began on June 12. The minimum temperature during the season was -5°F on May 2, and the maximum temperature 62°F on July 3. No frost occurred at Lake Hazen from June 12 until the party left on August 18. A total precipitation of less than 3 inches makes the lowland area around Lake Hazen an arctic desert. The maximum winter snowfall during the winter of 1956/57 was 11 inches; a light quarter-inch of snow fell on May 24-25; and the total rainfall up to August 18 was 1.525 inches.

Lake Hazen

Lake Hazen, 45¾ miles long and 7½ miles wide, is the largest lake in the Queen Elizabeth Islands. The deepest part, measured at 1,000 feet, is between Johns Island and Ruggles River. The ends of the lake are shallow, with depths of 43 feet maximum across the east end of the lake at Garret Island and 16 feet maximum west of "Turnstone River". The west, south and east sides of the lake are marked by low shore-bluffs generally less than 10 feet high. Along parts of the north shore, between "Henrietta River" and the base camp and between "Snow Owl" and "Gilman" rivers the shore-bluffs are steeper, occasionally rising to 100 feet or more above the lake. The remarkably straight north and south shorelines suggest a basin whose origin may be due partly to faulting and partly to glacial erosion. Several bedrock-controlled islands occur in the lake, the largest being Johns Island which is 4½ miles long and has a maximum width of 1,750 feet near the west end but narrows to 300 feet in the central part. It rises approximately 200 feet above the lake near its western extremity. The other islands are small - Garret and "Clay" near the east end of the lake, and Dyas and "Whisler" near the south-western end.

Several rivers drain into Lake Hazen; clockwise from the west end they include the Very, Adams, "Turnstone", "Henrietta", "Snow Goose", "Snow Owl", "Gilman" and "Turnabout" which is at the extreme eastern end. All these rivers drain the mountainous regions to the west and north. In addition there are numerous smaller streams, some of which drain the

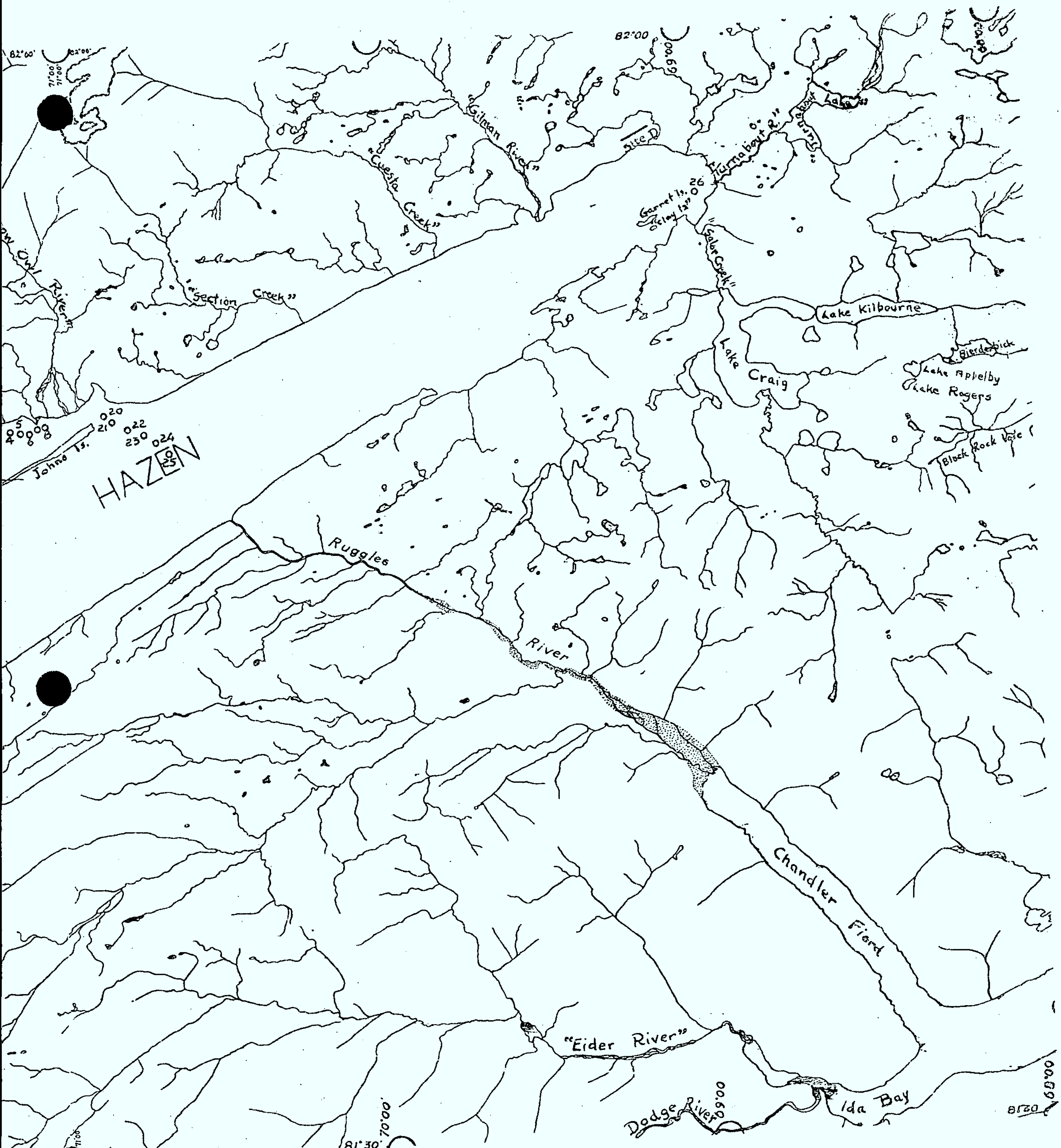


... area (Cartography by Surveys ... Department of Mines and ... Ottawa).

MAP OF LAKE HAZEN AREA
ELLESMERE ISLAND

Scale in miles

1 0 1 2 3 4 5



RE

∘ 21 Location of measurements for temperature, pH, & transparency

Site A Possible air strip sites

area south of Lake Hazen. The lake itself is drained by Ruggles River, which leaves the lake about halfway along the south shore.

Soft snow, 7 to 11 inches in depth, covered Lake Hazen in the spring of 1957. The melt season began about June 12 and by June 20 all the snow cover had gone from the lake ice leaving an excellent surface for travelling. The lake ice varied from 59 to 61½ inches in thickness. By July 3 melting around the edge of the lake had developed a lead which made access to the lake ice difficult; by July 7 the lead was sufficiently wide to allow the use of a boat. Between July 7 and August 3 when the last ice disappeared from the lake, the ice drifted about, opening and closing leads and piling up on shore during periods of strong wind. Melting of lake ice was aided by the great volume of water brought in by the rivers. This surcharge, greatly in excess of discharge, resulted in a rise of the level of Lake Hazen. The highest level was reached on August 3, when the lake stood 37.9 inches above the level of July 1. During the first half of July the rise was about 2 inches per day. From July 21 to August 15 the level rose and fell with minor fluctuations of daily temperatures. After August 15 the level of Lake Hazen was steadily lowered, and will reach a minimum by the beginning of the 1958 melt season.

The temperature of the water in Lake Hazen did not rise above 3°C in the summer, except in the shallow east and west ends of the lake where the "Turnabout" and Very rivers enter. These two rivers and the streams from the lowlands south of the lake were relatively warm, in some cases reaching a temperature of 12.6°C. On the other hand the glacier-fed rivers were cold, the maximum temperatures varying directly with the distances of the glaciers from the lake. The temperature of the river water fluctuated throughout the day, the lowest temperature occurring about 4 a.m., the highest temperature about 4 p.m. The volume also changed throughout the day, the maximum volume occurring at about 6 p.m., and the minimum volume, which was approximately one half that of the maximum, occurring about 6 a.m.

The water in Lake Hazen before the melt season was extremely clear. Muddy river water, on entering the lake, sank to the bottom and flowed under the lake water into the deeper parts of the basin. This turbid river water gradually mixed with the clear lake-water but reached the surface only in the shallow ends of the lake. Wave action on the shores, particularly in the southeastern part of the lake where the shores are predominantly a clay till or lacustrine clay and silt, caused some of the turbidity in the surface water. The waters in the rivers and in Lake Hazen are decidedly basic. The pH of Lake Hazen ranged from 7.7 to 8.1 and showed very little variation from surface to bottom.

Ruggles River

Ruggles River drains Lake Hazen and empties into Chandler Fiord. It drops approximately 500 feet over its length of 18 miles; no falls occur in the river but the steep gradient gives fast water throughout its course.

Ruggles River is remarkable in two ways. First, the upper 2,000 feet from Lake Hazen remains ice-free throughout the year. Lower down ice bridges the river in winter and is 10 feet thick a mile downstream. This ice bridge begins to collapse early in June, first in the upper reaches of the river, until by the middle of August the river bed is almost completely free of ice. The second remarkable feature of Ruggles River is the presence of permanent ice in its lower reaches, extending for approximately two miles upstream from the head of Chandler Fiord. This river ice, approximately 25 feet thick, stretches across the floodplain of the river except in a few narrow channels melted by the river during the summer. The excessive thickness of ice, which is more than can be melted during the summer, probably forms when the gently flowing water at the mouth freezes to the bottom causing water from the upper part of the river to flow on top.

The water leaving Lake Hazen is more or less clear at all times. The temperature of the water was measured at 0.8°C on June 11 and at 3.4°C on August 4. On June 11, the river, at its head, had a maximum depth of two feet and width of approximately 100 feet; on August 4 when the lake level was near its maximum, the river was nearly five feet deep and 250 feet wide.

Outwash sand and gravel extend as terraces from near the mouth of the river for almost half the distance to Lake Hazen. These flat-topped terraces increase in elevation upstream and towards the valley walls. At the mouth of the river and extending approximately one mile upstream, fossiliferous marine sands, silts, and clays form the river banks, extending to a maximum elevation of 200 feet above sea level. They thin out upstream and are overlain by outwash sand and gravel. The marine sediments and the outwash sand and gravel were deposited when sea level was approximately 200 feet higher than at present.

The Fiord Areas

The Chandler Fiord, Conybeare Bay, Ida Bay, and Archer Fiord areas were traversed during the period June 10 to 23. The fiords have characteristically straight sides with precipitous slopes rising in places to 2,000 feet. Ida Bay receives the drainage of Dodge and "Eider" rivers, both of which are gently flowing streams occupying deeply-incised, broad valleys in their lower reaches. Marine silts and outwash sand and gravel are conspicuous in the valleys of both rivers. Elsewhere in the fiord areas visited the streams are smaller, have steep gradients, and have deposited alluvial fans of sand and gravel with but minor amounts of marine silt at their mouths.

Economic Considerations

Sand and gravel is abundant in places around the north shore of Lake Hazen but is lacking around the south shore. The most extensive gravel deposits occur east of "Gilman River", extending as terraces for about five miles along the shore. Good gravel also occurs in the terraces associated with "Snow Goose" and "Snow Owl" rivers. Minor amounts of gravel may be obtained in the valleys of "Henrietta" and Very rivers. The alluvial fans of the streams between the base camp and "Henrietta River" contain some gravel but in general too many large boulders are present to permit its use. Permafrost would make deep excavation difficult but the active layer, which extends to a depth of at least five feet in well drained gravels, would allow extensive stripping.

Four possible airstrip sites are shown on the map; all could be constructed with a minimum length of 3,000 feet. Site A on the south shore of Lake Hazen at "Traverse River" would require a minimum amount of levelling, but very little sand and gravel is available in this area. Site B, on the alluvial fan of "Blister Hill Creek", would also require very little levelling and some coarse gravel is available at this site. "Blister Hill Creek" does not have a large flow; at present it is confined to the west side of its fan and could be held to this position without much difficulty. Site C, west of "Snow Goose River", would require considerable fill in places but a quantity of sand and gravel is available. Site D, east of "Gilman River", also has extensive amounts of gravel available for necessary fill. These sites warrant further investigation.

A coal seam, from 2 to 8 feet thick, crops out at lake level along the north shore between "Section Creek" and a point two miles west of "Gilman River". Sufficient coal could easily be mined from this seam to supply the base camp.

Fig.8 Coal seam along north shore of Lake Hazen. 19 June 1957.

GEOPHYSICS

F.S. Grant

Personnel and Equipment

The geophysical field party consisted of three members of the University of Toronto's Geophysical Laboratory employed under a contract with the Defence Research Board of Canada. Dr. F.S. Grant was assisted by Messrs. J.D. Filo and H. Sandstrom. Mr. K.C. Arnold, surveyor for the expedition, assisted the party from time to time, as his duties allowed.

The party was equipped with high resolution seismograph apparatus and a Worden gravity meter, both built by the Houston Technical Laboratories. These instruments functioned very well on the whole. Transport was by dog team. Because of the weight of equipment including batteries, motor-generator and explosives, the practical range of movement was quite limited.

Programme

The field work of the geophysical party consisted in measuring six profiles of bedrock topography, chosen to provide as complete information as was practicable (in the time available) on the pattern of flow in what appeared to be the accumulation area of the Gilman Glacier system. The procedure was as follows. The cable and geophones were laid out at stations set at 1000 yard intervals and a pattern of eight separate explosions was set off at chained distances from each station. With a party of three, it was usually possible to complete one station each day, while weather permitted. Usually two or three days were necessary to move camp and equipment from one profile to the next.

Results

Interpretation of seismic records has not yet been completed. Some areas yielded clean, sharp reflections and others none at all. Indications are that the thickness of the ice varies from about 1200 feet 2 miles from the snout to over 2400 feet 6 miles north of the camp. These figures must be accepted as preliminary guesses rather than as final results.

There appears to be a considerable variation in seismic velocity with depth near the surface of the ice. The depth of this variation exceeds by a considerable margin the depth of temperature variation observed (in a bore-hole) during the season, and it most likely represents a progressive compaction of firn. It is not easy, however, to draw a boundary between firn and ice from a diagram of this type. An investigation of the implications of these results to the dynamics of the plastic flow of ice and to its thermo-dynamical behaviour will be one of major undertakings of the interpretation. It is hoped that this may have some relevance to studies on the pattern of flow in the accumulation zone of the Gilman Glacier system.

GLACIOLOGY

G. Hattersley-Smith

Introduction

It may be useful to summarise what was known before the 1957 operation of glacial conditions in northern Ellesmere Island, the most mountainous and heavily glacierized part of the Canadian Arctic.

Northwest of the line Tanquary Fiord - Lake Hazen - Alert, rather more than half of northern Ellesmere Island is covered by ice at the present time. It is perhaps surprising that the second most northerly land in the world is not more extensively ice-covered; the relatively thin and limited ice cover of this region is in striking contrast to the great mass of the Greenland ice cap, centred many miles to the southeast. As in the northernmost part of Peary Land, the reason for the apparent anomaly is the very low precipitation, which averages only about 12 cms. water equivalent at Alert in the northeastern corner of Ellesmere Island.

The highland ice of northern Ellesmere Island (which until 1957 was thought to reach a general level of 7,000 to 8,000 feet (2,135 to 2,440 metres), with nunataks as high as 10,000 feet (3,050 metres)) constitutes a reservoir of ice accumulated in a period of more abundant precipitation. The ice moves out, perhaps in general rather slowly, towards the periphery of the high land, whence some moves in great trunk glaciers down to the long fiords of the north coast, while some escapes through gaps in the mountains to form piedmont glaciers in high plateau regions, and some spills out as glacier tongues into valleys at lower elevations. The glaciers on the south and east sides appear to be relatively inactive compared with those which flow towards the north coast, but there is no field or historical evidence that they have receded in recent times.

In the mountains of the north coastal region, intersected by the fiords, collecting grounds are too restricted and the general elevation not great enough for an extensive ice cover with the present scanty snowfall; glaciers only occur in locally favoured areas. Thus a twenty to thirty miles wide strip along the north coast is predominantly ice-free, although alpine glaciers occur where the mountains exceed 4,000 feet (about 1,220 metres), and small corrie glaciers or masses of snowdrift ice occur at lower elevations in localities with suitable exposure to snow-bearing winds.

Between Cape Columbia and Cape Discovery the north coast is fringed for about 55 miles (90 kilometres) by an ice shelf. Further west as far as Cape Bourne ice shelf occurs discontinuously in most of the fiords and bays. Recent work has shown that the ice shelf originated not through land glaciers pushing seaward, but through the ability of great thicknesses of sea ice to form off this coast and remain fast. In this region sea ice formation is favoured by great winter cold, low summer melt and low precipitation. Upward growth of the ice shelf took place through freezing of sea-water on the lower surface and also through firn formation at the upper surface.

There is evidence that the Ellesmere Ice Shelf is a product of the deterioration in climate which has taken place since the Climatic Optimum, 4,000 to 6,000 years ago. It is also suggested that much of the present land ice cover near the north coast is as recent a development as the ice shelf, and that advances of glaciers on to raised beaches and into V-shaped valleys, and the growth of low icecaps over raised beaches are recent events, which can be regarded as part of a limited reglaciation following the Climatic Optimum. In contrast the highland ice is a survival of the much greater, perhaps complete, ice cover of northern Ellesmere Island in earlier times. Much of the evidence for this former glaciation, such as moraines and striae, is doubtless beneath the sea or has been destroyed by frost action and river erosion.

The present glaciological and meteorological programmes were designed to provide information on the regime of the highland ice, that is the balance between accumulation on the one hand and ablation and movement on the other, about which very little was known. There were indications that the highland ice is in a better state of health than ice caps and glaciers studied in regions further south. It was recognized that, although precipitation is small, not much melting takes place above 5,000 feet (about 1,525 metres); much of the collecting ground is situated at or above this altitude.

Preliminary Field Report on Glaciological Work in 1957

Accumulation Zone

The surveys in 1957 showed that the highland ice of the interior of northern Ellesmere Island maintains a general level of 6,000 to 6,500 feet (1,830 to 1,980 metres) over a wide area, with nunataks rising to 7,500 feet (2,285 metres). Mount Oxford was found to be only 7,170 feet (2,185 metres) high, not 9,000 feet (2,895 metres) as claimed by A.W. Moore who climbed it in 1935; except on the south side, its almost flat-lying sandstones and conglomerates are ice-covered. The highest mountains - possibly as high as 9,000 feet (2,745 metres) - are situated on the flanks of the ice cap, namely between the heads of M'Clintock and

Milne Fiords and near the head of Tanquary Fiord. It is interesting to find that the detail of snow, ice and rock in a photograph taken northwestward from the summit of Mount Oxford in 1957 is almost identical with that shown in a photograph taken by Moore from the same spot in 1935.

Below Mount Oxford on the ice cap at 6,000 feet (1,830 metres) a pit 6 metres deep was dug for accumulation, density and temperature measurements in the firn. In the budget year 1955-56 the net accumulation was 34.5 cms. of firn or 14.5 cms. water equivalent; in 1956-57 the total accumulation, measured before the melt season, was 33 cms. of snow or 11.7 cms. water equivalent. Most of the ice layers observed in the pit were probably annual markers, so that the bottom of the pit corresponded to the early 1930's. Vertical "ice glands", due to the downward percolation of melt water, were also observed. At depths of 4 to 6 metres the firn temperature in the pit remained steady at -23°C which is probably very close to the mean annual temperature at this altitude.

A few miles east of Mount Oxford glaciers descend abruptly to the trough-like valleys at the head of Disraeli Fiord, where melt-water lakes on the glaciers and snow-free valley sides showed that the thaw was well advanced by 25 June. The main northward-flowing glaciers occupy valleys extending far back into the mountains, which were deeply dissected by rivers in preglacial time; they were thus able to channel ice from the highest accumulation areas of the ice cap, and their valleys underwent powerful glacial erosion, which may also have been favoured by rather higher precipitation on the northern than on the southern slopes of the ice cap.

Firn Line

Between Mount Oxford and Gilman Glacier the ice cap falls away much more gradually than to the north, but crevasses up to 30 metres or more in depth occur near nunataks or where there are occasional sharp changes in the slope of the underlying rock.

The firn line is situated at an elevation of from 4,000 to 4,500 feet (1,220 to 1,370) metres). In this general area interfingering of layers of firn and superimposed ice was observed in cores and shallow pits. These differences in deposition were clearly reflected in the crystal structure and density of the ice on Gilman Glacier below the firn line, and possibly also in the banding of the terminal ice cliff. The ice formed from more or less dry firn was granular in texture with crystals up to ½ cm. in diameter and had a density averaging about .75; the ice formed by refreezing of melt water or water-saturated firn had the crystals intergrown and generally larger, up to 2 or 3 cms. in diameter, and had a density averaging about .84. At an elevation of 4,500 feet (1,370 metres) the temperature of the ice at the end of July was as low as -19°C at a depth of 5 metres.

Ablation Zone

Near the Gilman Glacier camp at an elevation of 3,400 feet (1,035 metres) the depth of snow in the spring, averaged from ten stations over the whole width of the glacier, was only 23 cms. or $6\frac{1}{2}$ cms. water equivalent. The net ablation here up to 6 August was 72 cms. of ice or 61 cms. water equivalent. The amount of ablation varied across the glacier, but was generally greater on the east side where on account of wind-drift there was less snow in the spring. Near the snout of the glacier the ablation was probably as much as one metre water equivalent. Temperature studies at the camp down to a depth of 16 metres in the ice indicated a mean annual temperature of about -18°C. The rate of movement here was about 3 metres in two months according to observations by Mr. K.C. Arnold.

The ice dome two miles north of the Gilman Glacier camp calls for special mention. It is surrounded by ice-free land; its top is situated 500 feet (150 metres) or so below the firn line. Ablation at the top was 21 cms. and at the bottom 48 cms. between 6 July and 8 August. This feature is clearly ephemeral under present climatic conditions, for it is thinning slowly and retreating at the edges. It was interesting to find that it apparently rests on patterned ground.

The dirt layers seen in the marginal ice cliffs of Gilman Glacier and outcropping on the surface for the most part mark disconformities due to changes in climatic conditions, and are not thrust features. In places they melt out to form dirt cones below the cliffs.

Melt Features

The summer melt gives rise to many interesting features. Towards the end of June the exposed rocks of nunataks provide centres of heat from which the melted snow runs down in streams to form lakes on the glaciers, even up to an elevation of 5,000 feet (1,525 metres). By the end of the summer these lakes may be several hundred metres across. In deep cores in suitable places on the ice cap it would not be surprising to find lenses of lake ice reflecting past fluctuations in climate.

The most striking features of the melt streams are the rapidity with which they form in the latter half of June and the way in which they concentrate the melt water to the drainage channels at the sides of the glaciers where large lakes are formed. The surface level of one of these lakes fell 17 metres in one week after the breaching of a snow dam lower down. Near the valley walls lake ice is often superimposed on glacier ice. Since there are no crevasses in the lower eight miles of Gilman Glacier, the melt water cannot reach the floor of the glacier to emerge in subglacial streams. The two main streams which flow on the gravel flats below the glacier snout come from the lateral drainage channels; they are joined by a number of smaller streams which form waterfalls over the ice cliff. In mid-summer below the gravel flats the river is a rushing torrent

Fig. 9 Ice coring at Gilman Glacier camp. 10 May 1957.

30 metres wide and much too swift to ford. The great influx of water into Lake Hazen from this and other rivers is a major factor in causing the melting of the ice on the lake; in 1957 the lake was completely ice-free by the end of the first week in August.

The Snout of Gilman Glacier

Seismic work by Dr. F.S. Grant and survey by Mr. K.C. Arnold showed that Gilman Glacier is about 400 metres thick $5\frac{1}{2}$ kilometres from its snout, which at its lowest part is 414 metres above sea level. The glacier surface falls away very steeply through 200 metres in the last $1\frac{1}{2}$ kilometres, and for the most part terminates in ice cliffs up to 20 metres high. Recent marked changes in areal extent of the glacier should not be expected in view of the great thickness of ice and the probable slow rate of movement, suggested by the complete absence of crevasses in the lower part of the glacier.

Any change in the position of the frontal part of the ice cliff of Gilman Glacier between early June and early August was less than a few centimetres according to an accurate chain survey. Willows, saxifrage and moss grow close to the foot of the ice cliff. On both sides of the snout the marginal streams are eroding heavily into their banks the tops of which are well vegetated and about 30 metres away from the vertical ice cliff. The snout appears to have been more or less stationary over the past few decades or to have advanced slightly. Past stands of the ice are represented by a recessive series of old marginal drainage channels on the hillside 150 to 200 metres above the entrance of the gorge cut by "Gilman River" and up to 4 kilometres from the present glacier snout. This recession took place a very long time ago as shown by the deep gorges cut by the rivers from the present marginal channels. An Eskimo tent ring in the valley to the west of the snout of Gilman Glacier is situated less than two kilometres from the ice cliff of the glacier near the head of this valley. The tent ring has probably been in existence and the valley consequently ice-free for several hundred years.

Regime: Conclusions

From the meteorological records of the weather stations at Alert and Eureka and his own records on Gilman Glacier Mr. J.R. Lotz has observed that the budget year 1956-57 in northern Ellesmere Island was marked by lower precipitation and, in the ablation season, by higher temperature than in an average year. Figures for accumulation on Gilman Glacier below Mount Oxford, summarised above, and data elsewhere on the glacier and ice cap tend to confirm the abnormally low precipitation. It is perhaps worth emphasizing that the amount of precipitation and whether it falls, in summer, as rain or snow, is important not only in determining the amount of accumulation above the firn line, but also in influencing the amount of ablation at the ice surface below the firn line. Ablation of ice will be retarded by an abnormally great depth of snow in spring, or checked by summer snowfall.

The Gilman Glacier station was evacuated on 12 August while ablation was still in progress; the net ablation at the camp in the 1957 summer will therefore not be known until the spring of 1958. But it is unlikely that there were more than a few centimetres of ablation after 11 August.

It is tentatively concluded that Gilman Glacier lost rather more ice by ablation than it gained by accumulation during the budget year 1956-57. A fuller appreciation of the regime of Gilman Glacier and of the ice cap must await further data over a wider area on accumulation, ablation and movement which it is hoped to obtain in the field season of 1958.

METEOROLOGY

James R. Lotz

Summary of Observations

Meteorological observations at the Gilman Glacier camp were begun on 14 May at 0800, and carried out three times a day at 0800, 1400 and 2000. Observations at the six hour intervals comprised screen temperatures by standard thermometer, six-hourly maximum and minimum temperatures, relative humidity in the screen by psychrometer, pressure by aneroid barometer, wind speed at four feet above the surface by hand anemometer, wind direction by a flag on the mast, horizontal visibility, precipitation, cloud types and cover. Continuous thermograph, hygrograph, and barograph records were kept, and readings taken from them at six-hourly intervals, and a daily sunshine record kept.

At 0800 on 9 June a programme of glacial-meteorological observations was begun, which continued until 2200 on 8 August. In addition to the six-hourly synoptic readings, the screen temperature, humidity, wind direction, visibility and cloud cover were recorded at two-hour intervals from 0800 to 2200 daily. On the mast wind speeds at four levels above the glacier surface - 10 centimetres, 1 metre, 3 metres, and 10 metres - were recorded at two-hourly intervals. Beginning at 0800 on 9 June, air temperatures at these four levels were also recorded at two-hourly intervals.

Three ablation stakes were set around the base of the mast, and these were read every day at 2000 from 22 June to 8 August. Six ablation stakes, AS1 - 6, set half a mile down-glacier, were read every Saturday between 22 June and 11 August. Other stakes, M1 - 10, half a mile and a mile up-glacier, served to measure movement and ablation, and were read at intervals.

Temperature

There were considerable daily variations in temperature in the screen before the melting began, and during the early part of the melt season. The melt season began very suddenly, the daily maximum rising from 32.0°F. on 11 June to 42.1°F on 12 June. The warmest day was 24 June, with a mean daily temperature of 40.5°F, and the absolute maximum for the period occurred at 1100 on 25 June, when 46.4°F was recorded. The lowest temperature recorded was 3.4°F at 0300 on 25 May. Sudden rises and falls in temperature of up to 8 degrees in a few minutes were recorded on occasion. Before the melt began, and during the early part of the melt, the daily temperature characteristics were in marked contrast to those during the later part of the melt season. Before 26 June, there were usually two marked maxima during the day (one before noon, and one about 1400), many sudden variations in temperature, and a marked diurnal range. After 26 June, however, the thermograph trace was almost a straight line; there were no marked diurnal variations, and few sudden changes in temperature. These temperatures reflect the stabilizing power of the glacier surface, which endeavours to lower the temperature of the air above it to the same temperature as its melting surface.

The temperature profile above the glacier surface was studied by thermistors at four levels. The sudden rise in the screen temperature that marked the beginning of the melt season was reflected in the mean daytime temperatures on the mast. Before 12 June, the temperatures at 10 cms. and 1 metre were below freezing. On that date, the mean daytime temperatures at these levels rose to 41.7°F and 42.3°F, and remained above freezing (except on two occasions at the 10 cm. level) until the last day of July.

Of the sixty days with complete records of temperature on the mast, thirty-eight showed a straight increase of mean daytime temperature with height, and thirteen showed an increase to 3 metres, then a decrease to 10 metres. Increase of temperature with height tended to be marked on days with north and north-westerly winds dominant. During days with periods of calm, and winds from the south and east, the gradient of increasing temperature with height tended to be disturbed. On Gilman Glacier there was a direct increase of temperature with height 34.0% of the time during the period of observations. In all, increases in temperature from 10 cms. to 10 metres, directly or with intermediate decreases, were recorded 68.2% of the time.

In general, it seems that the control that the glacier has over the actual temperatures above its surface is not very strong. During the period 9 June - 8 August, the temperature at 10 cms. dropped to below freezing only during 21.5% of the observations, and this occurred mainly in the period before ablation began, and during a break in ablation in the early part of August, At the 1 metre level, temperatures fell below freezing only 9.7% of the time, at the 3 metre level only 10.8% of the time, and at the 10 metre level only 4.7% of the time. While the glacier does act as a temperature stabilizer during the ablation season, it appears to have little power to decrease temperature above its surface, even at 10 cms.

Relative Humidity

The air above the glacier surface was very seldom saturated during the period of observations. A reading of 95 - 100% relative humidity was given by the hygrograph for only one long period - that extending from 1400 on 31 July to 2000 on 2 August, during fog. There were considerable variations in relative humidity with drops of up to 55 percent recorded in a matter of minutes. There was no marked correlation between relative humidity and wind direction. This was also noted in the study of temperatures, and would seem to be due to the fact that air moving over the glacier surface from any direction is liable to have been influenced by the glacier surface over which it travelled.

Wind

North-westerly (down-glacier) winds dominated the circulation on Gilman Glacier, and there was also a large percentage of calms recorded. In May, 33.3% of all observations showed winds from the north-west; in June 42.5% and in July 42.0% of all observations showed winds from this direction. In August 17.0% of winds were from the north-west. Calms formed 20.0% of all observations during the period.

In the early part of summer, northern Ellesmere Island lay under the influence of high pressure systems, and later the area lay north of the zone of maximum cyclonic circulation. The usual pressure pattern over the area was one associated with a weak cyclonic circulation, broken by the occasional passage of storms over or near the ice cap.

Winds at all four levels tended to be light, and not to exceed 10 miles per hour. At the 10 centimetre level for the period, only 1.6% of the observations recorded winds over 10 m.p.h.; at the 1 metre level, 5.9% of the winds were over 10 miles per hour, and for the 3 metre and 10 metre levels these percentages were 6.3 and 13.3. Apart from the blizzard that hit the camp on 5 May, when winds reached an estimated 40 m.p.h., the highest wind speed recorded on the mast was 22.5 m.p.h., and this speed was recorded on only four occasions.

Wind speed gradients on the mast showed a straight increase with height 16.7% of the time, and increases with intermediate decreases 36.7% of the time. An increase to 3 metres, then a drop to 10 metres was recorded 20.2% of the time. The pattern of wind speed closely correlated with the pattern of temperature gradient on the mast, where 19.1% of all observations showed an increase in temperature to 3 metres, then a decrease.

Pressure

The pressure during the whole period showed little sudden change. The highest pressure recorded by the barograph was 865.4 mbs. at 0600 on 21 June, and the lowest pressure, 832.2 mbs., was recorded at 0200 on 21 July. The greatest variation in pressure was during the period 20-21 July, when the pressure dropped from 843.0 mbs. at 0600 on 20 July to 832.8 mbs. at 0200 on 21 July. This variation was an unusal one, and was the only "depression" that showed up on the barograph trace.

Any correlation between wind speed and pressure was complicated by the katabatic effect, and the channelling of the wind down glacier, and, even when this is considered, a direct relationship between wind speed and pressure is difficult to determine. The period 27-29 June was characterized by strong winds at all levels, and mean pressure for these three days was 856.6 mbs., 858.4 mbs., and 857.1 mbs. without any marked rises and falls.

Clouds and Cloudiness

The mean of cloudiness for the whole period was only 5.1/10ths, and the first two days of August were the only ones with complete overcast. There was a sharp break in the middle of the summer between a generally cloudless period before 19 June, and a generally cloudy period after that date. For May, the mean cloudiness for the last fourteen days was 4/10ths. For the period June 1-19, the mean daily cloudiness was 2.5/10ths, and for the period June 20-30, 5.7/10ths. July had a mean cloudiness of 6.2/10ths, and the first eight days of August showed a mean cloudiness of 8.4/10ths.

The frequency of different cloud types was as follows:

Cloud Form	Fog	St-forms	Cu-forms	A-forms	Ci-forms
% Frequency	4.4	31.3	11.7	34.6	18.0

The relatively low percentage of Fog and St-forms is notable. The high frequency of A-forms and Ci-forms is associated with the passage of weak storms over and near the glacier.

Fog

Fog at the station, or on the glacier, showed a very small percentage frequency. On only 41, or 6.9%, of the 594 observations was fog recorded at the camp. If fog on the glacier as well as at the camp is included in the percentage of observations, this figure is only 10.8%. Fog was marked in late May, occurred only once in June, but became persistent after 31 July, in association with stratus, rain, drizzle and snow.

Sunshine

During the time that the Expedition was in northern Ellesmere Island, there was continuous daylight. By extrapolation from the sun-cards and the state of the sky at 2200 and 0800, it was possible to get an accurate estimate of the total sunshine, although the recorder only recorded up to a maximum of 18 hours. For the period 18 May - 8 August, the total number of hours of sunshine was 1284.2 out of a possible 1992.0, an average of 15.5 hours daily, and a percentage of 64.5%

possible sunshine - a very high figure compared to records from other glaciers and ice caps. The summer can be divided into two periods - late May to mid-June, with high sunshine totals, and mid-June to early August with lower sunshine totals. In May there was 80.3% of possible sunshine, and in early June, up to the 19th, 88.9% of possible sunshine. The period 20-30 June had 60.0% of possible sunshine, the whole of July 54.4%, and the first eight days of August 24% of possible sunshine.

Precipitation

Neither drifting snow nor hoar frost complicated the readings of precipitation on Gilman Glacier. Hoar frost was noted on 24 May, and a fall of ice crystals was recorded on 27 May.

The first snowfall of the period came on 28 May, and continued through to the 31st, giving the station 1.9" as total precipitation for that month. Snowfalls in early June were associated with lows moving towards the west coast of Greenland, and this general pattern of snow, drizzle, rain, low stratus associated with weak cyclonic flows was general during July and early August. There was a well-defined storm on 21 July, which brought 3" of snow in the early morning. The influence of a large semi-permanent low centred north of the Bering Strait spread to northern Ellesmere Island, and gave the generally bad weather conditions that prevailed during early August.

Accumulation and Ablation

The accumulation and ablation at various places on Gilman Glacier is best summarized as follows:

Location	Mean snow accumulation at beginning of season Cms.	Water equivalent Cms.	Mean of Ice Ablation Cms.
At Gilman Glacier Station Stakes 1 - 3	+24.4	M	-79.7 (To 8 August)
Up-glacier from Station Stakes M1-M10	+22.9	6.6	-68.3 (To 6 August)
Down-glacier from Station Stakes AS1-AS6	+13.6	M	-77.6 (To 11 August)

The ablation season began very suddenly on 12 June, and by 27 June all the snow had been removed from two of the three stakes at the camp. By 24 June, the plateau north of Lake Hazen was already clear of snow. Ablation continued from 27 June to 11 July, and was only broken by the snowfall of 12 July. By 13 July this new snow was already gone, and ice ablation was active until 20 July. On 21 July a heavy snowfall again covered the ice, and snow remained near the ablation stakes at the camp until 30 July. The period 21-31 July can be considered as a second main melting period, when there was ablation of new snow, but little mean ablation of ice. From 1 to 3 August ablation stopped and new snow accumulated which did not all disappear until 6 August. Ablation proceeded at the rate of approximately 1 cm. per day until the camp was abandoned on 12 August. From the temperature trend, however, it would appear that the ablation season had finally ended by that time, or at least was very near its close.

The correspondence of ablation with various meteorological factors showed that, once the melt was under way, the amount of ablation was directly related to the daily maximum temperature. Cloudiness, sunshine, and wind speed showed little definite correspondence.

In the summer of 1957 monthly temperatures were above average during most months at Alert and Eureka, the two weather stations in northern Ellesmere Island for which data is available over a period of years. Precipitation, both during the summer, and during the 1956-57 budget year, was well below the means at both stations.

It would appear that Gilman Glacier was almost in a state of balance during the year 1956-57, losing slightly more by ablation than it gained by accumulation. Further studies during 1958 will help to clarify the problems of the regime of this glacier, and of the ice cap.

SURVEY

K.C. Arnold

The surveying programme had two ends in view. The first of these was to determine positions and elevations of the points where seismic and gravity observations were taken. The second was to determine the movement of Gilman Glacier.

The control for geophysical work was planned on the basis that both gravimetric and seismic work would be done; the accuracy required of elevations for gravimetric work is rather higher than that required for seismic work. For gravimetric purposes the location of stations was required to a tenth of a minute in latitude. Elevations relative to one another were required to one foot. An accurate knowledge of absolute height above sea level was not required.

The study of glacier movement involved both the absolute movement of stakes along a profile and the relative movement between stakes, both down the length of the glacier and across it.

In addition to these two main tasks, wherever possible prominent points were identified on air photographs and their elevations determined.

Control for geophysical work was based on a subtense bar traverse, starting at a Geodetic Survey of Canada "Shoran" station on Johns Island, Lake Hazen in the position 81° 48' 35.0" N, 71° 16' 07.7" W, and 699 feet above sea level. The instruments used on this traverse were two Wild T.2 second-reading theodolites and a Wild invar subtense bar. The method of extended base was employed, and the procedure for one observation is outlined.

Two theodolites were set up, one at each end of the line to be measured. The subtense bar was set up near one of these theodolites, in such a position that the angle at the near theodolite between the centre of the bar and the distant theodolite was a right angle, and that the distance between the bar and the near theodolite was roughly the square root of the distance between the two theodolites. However, a minimum distance of forty metres was necessary for accurate intersection of the targets on the bar. The bar was then aligned at right angles to the near theodolite by a small sighting telescope provided on the bar. The tripods were used as signals, and rendered more distinct by a strip of fluorescent cloth wound around their heads.

The observer nearest the bar measured the angle subtended by it at his instrument, from which the length of the "extended base" between him and the bar was determined. The distant observer measured the angle subtended by this extended base at his instrument, from which the distance between the two observers was determined. These horizontal angles were measured three times on each face, and, if the abstracted values of the angles had a greater range than six seconds, further rounds were taken.

After the measurement of the horizontal angles had been completed, a message was sent by semaphore to begin the measurement of simultaneous reciprocal vertical angles. These were taken to the top of each observer's tripod, as outlined by the fluorescent cloth. The readings were repeated, and, if the two measurements at any station differed by more than ten seconds, further sets were taken. By making the observations reciprocal, the effect of curvature and the corrections due to the height of the instruments above their tripod heads were eliminated; and by making the observations simultaneous, errors introduced by varying refraction were minimised. After all observations had been satisfactorily completed, the back observer, having left a marker, moved on to the next station and the forward ray was observed.

The method was well suited to the means of travel available, and could be carried out by two men, although the assistance of a third man at the station with the subtense bar saved time. By this method it was not necessary to chain over the intervening ground, which was an advantage especially in difficult or unsafe areas.

In an attempt to maintain an accuracy of about 1/1,000, angles were measured with a standard deviation of one second and lines were kept under four kilometers in length. Sunshots were taken as a check on azimuth, especially during traverses over glacier surfaces, in an attempt to detect errors introduced by different rates of movement in various parts of the glacier. The end of the traverse was sited on a rock outcrop and marked by a bronze plug. It is likely that this survey will be extended in 1958 and it is desirable that elevations may be checked by running the traverse in a loop, or by a closure on sea level.

The subtense bar traverse carried the survey forward from one seismic profile to another. The profiles themselves were laid out with a steel tape and levelled with the theodolite.

To determine the rate of movement of the glacier, two lines of stakes were laid out, one about 500 meters and the other about 1000 meters above the glacier camp. In May and July angles were taken to these stakes from cairns on the hillside. The positions of these cairns were obtained from a small triangulation net starting at a taped base laid out on flat ground near the glacier snout. One end of this base was connected to the subtense bar traverse. At the camp on Gilman Glacier, a movement of about ten feet was observed in two months. In July and August these stakes needed frequent attention to guard against loss by ablation. As the relative movement between stakes, both in the direction of glacier flow and transverse to it, was required to be determined with greater accuracy than the absolute movement, the distances between adjoining stakes in the profile were carefully taped. In August, after the peak of the ablation had passed, stakes were set up between the camp and the snout of the glacier. The position of these was determined by resection from the cairns on the hillside. A line of stakes was also set up near the firn line on the glacier. Repeated observations in 1958 will give the movement in these locations.

The approximate height of Lake Hazen was determined in August, during the evacuation of the summer party by helicopter. Three Wallace and Tiernan surveying altimeters were used, two of which kept a record of pressure changes at the head of Chandler Fiord and at Lake Hazen while the third was ferried between these points in the helicopter. The lake level on 16 August was about 510 feet above sea level. It is possible that a more accurate elevation may be obtained in 1958 by running a level line down the 16-mile long Ruggles River to sea level in Chandler Fiord.

Among the points visited and fixed during the summer was Mount Oxford, the position and elevation of which had been in some doubt since it was first climbed by members of the northern party of the Oxford University Ellesmere Land expedition in 1935. An excellent view was obtained from the summit of the mountain, some 7,300 feet above sea level; it seems doubtful that any of the mountains visible from the summit exceed 9,000 feet in height.

WILDLIFE

R.L. Christie and G. Hattersley-Smith

Vicinity of Lake Hazen. By R.L. Christie

General Remarks

Wildlife observations were made between 2 May and 15 August. The area traversed included the shores of Lake Hazen, the plateau region some 8 or 10 miles east and west of the ends of the lake, 10 to 20 miles up several valleys in the mountains north of the lake, along Ruggles River, Chandler Fiord, Ida Bay, Conybeare Bay, and across Archer Fiord. Wildlife was abundant in the vicinity of Lake Hazen, particularly when compared with that observed on the north coast of Ellesmere Island in 1954.

Numbers of Species Observed

Muskox		150
Wolf		8
Caribou	none	
Fox		5
Hare		70
Lemming	thousands	
Weasel		4
Snow Goose		140
Owl		20
Eider Duck		2
Ptarmigan		10
Knot	many hundreds	
Turnstone	do	
Snow Bunting	do	
Seagull, Jaeger, Tern	many hundreds	
Red-throated Loon		1 or 2 dozen
Fish	some hundreds	
Mosquitoes	numerous	

Notes on Species

Muskoxen (150) were seen in herds and singly throughout the season. They apparently travelled little during the season. They seem to prefer small alps in the mountains and foothills during the spring, and the relatively lush stream-valleys and draws during the summer.

In mid-summer small families, including calves, were observed to move from one valley-mouth to another, and 12 miles or so up the valleys in about 5 days. A herd of 24 moved about 2 miles in a day. On no occasion did muskoxen appear to be 'on the move' - that is, travelling rather than grazing. Only one game trail was discovered; this was along the lowest part of "Gilman River" and traceable for about 2 miles. Calves made up about one third of the herds in the summer. One group consisted of 4 adults and 4 calves.

Wolves (8) were frequently seen; they were bold and occasionally troublesome. A pair circled one member of the expedition for an hour, coming within 60 feet, and late in the summer, a pack of five surrounded another member and attacked a Greenland sledge dog which was accompanying him.

Caribou were not seen, but antlers were found over a wide area. Dried flesh on a skullcap and antlers was the only evidence of recent presence of caribou. All other antlers were well-weathered.

A few (5) foxes were seen in the summer. These were brown or tan on the back, head, and legs, and light tan or yellowish under the body.

Hares (70) were ubiquitious but not abundant in the spring. They appeared to increase greatly in numbers with the progress of the summer season, and to run in flocks. In August,20 were sighted in a day, and flocks of 8 animals were seen.

Lemmings were present everywhere, and in thousands. They were conspicuous and active during the snow season, and it was possible to count dozens from almost any standing position.

Birds were very abundant during the whole season. Snow Buntings, knots, turnstones, jaegers and terns numbered many hundreds. Knots and turnstones were particularly abundant and noisy along the lakeshore and the creeks (such as "Gilman River") in late May, when they appeared to be mating. Knots and turnstones flew in mixed flocks during much of the summer. Jaegers were active and conspicuous the whole season. Seagulls were present in modest numbers, and were found nesting on small islands in Lake Hazen.

Ptarmigan were not plentiful; perhaps a dozen or so were seen.

Snow Geese (140) were seen in modest numbers at many places near the lakes and streams. They fed in pairs along the main streams in May, and probably nested there. A (goose?) nest found on a bench above one stream contained the remains of 6 or 8 large eggs coloured white with a few brown specks. Families including 5 goslings were seen on streams and on the lakeshore. In mid-August the geese flocked on the ground (100 were observed in one flock), and took off and circled in flocks when disturbed.

Large Snowy Owls (20) were present in small numbers along all the major streams. Their nests, with 8 eggs or owlets, were invariably at the edge of a bank or bench above a stream or lake. A single large grey owl and a (young?) small, downy grey owl were observed. The small owl was seen on 14 July near a nest of unhatched eggs with 2 adult white owls nearby.

Perhaps one or two dozen Red-throated Loons were seen. These birds were found both along and in association with more numerous, smaller water birds (Old-squaw Ducks?).

Two brightly marked Eider (?) Ducks were observed at the head of Ida Bay.

About a dozen fish up to about 18 inches long were caught in Lake Hazen, and hundreds of fish 6 to 12 inches long were seen feeding at the surface at the mouths of small streams.

Insects were abundant, but were not carefully observed or recorded. Mosquitoes were active and in sufficient numbers from about late June to mid-July to be a nuisance to men working outdoors, and to cause the dogs great discomfort.

Vicinity of Gilman Glacier. By G. Hattersley-Smith

Mammals

About twenty muskoxen were seen in late June in the valleys to the west and south of the snout of Gilman Glacier and colour photographs were obtained. In one group of eleven five were calves. In early May a few muskoxen were seen grazing near the gravel flats at the foot of Gilman Glacier above the banks of the river. Muskox faeces were noticed on the nunatak three miles southeast of camp. A muskox must have negotiated the steep snout of Gilman Glacier and travelled at least five miles over the glacier to reach the nunatak.

No caribou and no caribou tracks were seen, but a few pieces of ancient antlers were picked up.

A wolf was seen near the glacier camp on two occasions during May, and a wolf was seen in the valley near the snout of Gilman Glacier in early June. Fox tracks were observed on the nearby nunataks during the spring, and in late May a fox was seen on the glacier close to the terminal ice cliff.

A pair of hares were seen in July on the nunatak three miles southeast of camp; leverets were not observed. Hare droppings were commonly seen on the nunataks east and west of Gilman Glacier even up to a height of 4,300 feet. A hare paw was found at a height of 6,000 feet below Mount Oxford, but it may have been carried up by a large bird.

Lemmings were very common in the valley below the glacier snout. Signs of lemming were seen on the nunataks near camp, and a dead one was picked up. One was seen on the glacier near the snout.

Birds

Jaegers were seen singly on occasion around the camp from early June onwards and on the nunataks. A pair of jaegers frequented the nunatak three miles southeast of camp. The first Snow Bunting was seen on 18 May on the nunatak due west of camp. Snow Buntings were often seen near the camp; they frequent the nunataks near the glacier and presumably nest there. A Snow Bunting was observed in flight at 7,000 feet near the top of Mount Oxford. A ptarmigan appeared near the camp on 8 May, and two ptarmigan were seen on the nunatak three miles southeast of camp on 15 May; this pair later raised nine chicks. It was noticed that the cock was later, by perhaps two weeks, in changing to summer plumage than the hen bird. A Snowy Owl was seen in late May in the valley south of Gilman Glacier, and a pair of turnstones were seen on the gravel flats below Gilman Glacier in early June.

Insects

Clouded Yellows and fritillaries were common in late June in the valley west of the snout of Gilman Glacier.

Plants

From the nunataks east and west of Gilman Glacier at heights of about 3,500 feet a small collection of plants was made for the National Herbarium. Dr. A.E. Porsild has identified 27 species in the collection, and states that it is interesting to find such a relatively rich vegetation at these altitudes. At a height of nearly 5,000 feet a few Arctic Poppies and some mosses were growing. Apart from lichens, no plants were seen at any higher altitude.

METEOROLOGICAL EQUIPMENT

James R. Lotz

Packaging and Condition of Instruments on Arrival at Lake Hazen

The meteorological instruments from the Department of Transport arrived packed in cardboard boxes. None were damaged, but it is suggested that in future, for operations of this kind, instruments should be packed in wooden crates.

It is also suggested that the instruments be packed as complete weather stations. When the instruments arrived at Lake Hazen in late April 1957 they had to be unpacked and reboxed, as each box contained two of the same type of instrument.

It is also suggested that its contents be listed on the outside of each case, or put in an envelope stapled to the case.

Instruments

The following instruments were taken up to Gilman Glacier on 3 May. (The instruments at base camp, their serial numbers and condition, were to be listed by the winter party).

(i) One Rain Gauge. Mounted on a box.

(ii) One Barograph. MSC Type B 312-56. Serial Number B403. Located in Met. tent.

(iii) One Hand Aspirated Psychrometer. Psychrometer Model HA-2. Friez Instruments Division. Bendix Aviation Corporation. Dry and Wet Bulb thermometers No. P-502710 FRIEZ. Located in screen.

(iv) One Hand Anemometer (Kelvin and Hughes) AX 190 DOT. Type KB 472/01. Located in Met. tent, used at base of mast.

(v) One Rain Measure.

(vi) One Thermograph (Negretti and Zambra) Serial No. R/25433. Clock No. 005424. Range -40/+120'F. Located in screen.

(vii) One Hygrograph (Negretti and Zambra) Serial No. R/25368. Clock No. 03162. Range 10/100%. Located in screen.

(viii) One Snow Rule. Type 2.

(ix) One Sunshine Recorder. (Casella) Campbell-Stokes type Base No. 2404. Recording Sphere (Chance Brothers Limited) Focal Length 2.946, diameter 4.018. Located on top of screen, levelled off.

(x) One Ordinary thermometer (Zeal) R-10744. Located in screen.

(xi) One Minimum Thermometer (Zeal) N51013. Located in screen.

(xii) One Maximum Thermometer (Zeal) X31304. Located in screen.

(xiii) One Aneroid Barometer (Wallace and Tiernan) U.S. Army No. 6 - WP 52023. -1000 to 7000 feet. Located in Met. tent.

(xiv) One Sunshine Scale.

(xv) One Stevenson Screen.

Micrometeorological Equipment

(i) Four Electric Contact Anemometers, English reading, long stem pattern as M70 but without battery boxes, batteries or wire (Casella) Nos. 3505, 3521, 3546, 3547.

(ii) One Battery Box complete with batteries and 50' of wire for use with above.

(iii) Two wind vanes Type M134 (Casella).

(iv) Four thermistors Serial No. 22A 2/57, used with "Nicols" Model 142 SP Geophysical Potentiometer, Single Range 0 - 1.1v.

Behaviour of Instrument

All self-recording instruments were adjusted at six hour intervals during the day.

1. The Hand Aspirated Psychrometer

Although it is difficult to measure relative humidity at low temperatures, a hand aspirated psychrometer of this pattern makes it even more difficult. The divisions on the thermometer scales are not fine enough, and can only be used with the psychrometric tables to within 0.5 of a degree. Eventually this psychrometer was read by wetting the wet bulb or refreezing the ice bulb at each observation, and using the instruments as an ordinary unventilated wet bulb/dry bulb psychrometer.

Good results were obtained at the base camp by using the sling psychrometer. It is suggested that in future a sling psychrometer be used on the glacier, and that at temperatures below freezing it be used as an ordinary psychrometer by refreezing the wet bulb at each reading. It should be used with the Psychrometer Tables issued by the Department of Transport, Meteorological Division (Form 2240) for greater accuracy.

2. The Thermograph

Despite adjustment this ran two hours slow, and also tended to run down after five or six days. The clock, No. 005424, was taken down to base camp to replace the clock there that was persistently stopping.

3. The Hygrograph

Despite adjustment this ran two hours fast. Because of difficulty in getting an accurate reading from the psychrometer at temperatures below freezing, the hygrograph was set at 97% at 2000 hours on 24/5/57 when dense fog moved into the camp. Cross checks with the psychrometer showed this to be an accurate setting.

4. The Sunshine Recorder

This was located on top of the Stevenson Screen, and great difficulty was encountered in levelling it off due to the settling of the base of the screen as it was undercut by a melt stream. The sunshine indicator had to be continually adjusted so that the sun centred on the card at 11:40 a.m. local time. The latitude adjustment was set at its maximum position - approximately 67°N.

At base camp a 24 hour sunshine recorder was made by Prof. Deane and Mr. Christie. The recording sphere was set in the centre of a scale made of sections of cans encircling it, to which cards were attached. This improvisation gave excellent results, and it is suggested that something similar be used on the glacier next year. If such a device is used, then twice the number of sunshine cards will be needed.

5. The Minimum Thermometer

This was found to be inaccurate, upon extensive checking and correlating with the dry bulb thermometer in the screen. The correction varied over the scale, but it was possible to work out minimum temperatures accurately enough by using this thermometer and the thermograph.

I suggest that the thermometers be checked at base camp before being sent up to the glacier, and that one spare minimum be carried at each station on the glacier.

6. The Maximum Thermometers

This also proved to be inaccurate on checking with the dry bulb, and would not shake down properly. Maximum temperatures were taken from the thermograph after this thermometer was broken in shaking down.

Maximum thermometers should be checked at base camp, and spares carried on the glacier.

7. The Anemometers

The anemometers were strapped to pieces of 2" x 4" which were bolted to the mast. It is suggested that in future these anemometers be mounted on metal brackets that bolt to the mast, or that can be attached to it in some other way.

The anemometers were checked with the hand anemometer, and the ones mounted at 10 cm. and 1 metre were found to be reading incorrectly. Subsequent readings at these levels were taken with the hand anemometer.

At 0030 on 30 July, the mast collapsed, damaging the 10 metre anemometer cups and spindle. These were replaced by ones taken from the lower levels; the anemometer was checked and found to be working correctly. At 1500 on 8 August, the mast again collapsed, damaging the anemometers. Details of the damage are given in the section on present location and condition of the instruments.

New batteries will be needed for the anemometer buzzer box. The box holds two Siemens Inert Cells Size No. 57 (155).

8. The Thermistors

The thermistors were mounted at the various levels on pieces of bamboo pole lashed to the mast. It is suggested that brackets for the thermistors should be supplied with the mast.

The thermistors arrived attached to varying lengths of wire, the longest of which was 30 metres. Because of this all readings had to be taken at the foot of the mast. It is suggested that each thermistor be attached to 150 feet of wire so that it can be read in the meteorological tent.

The thermistors had to be recalibrated in the field as it appeared they would not read the temperatures on the mast at the standardization given (850 mv). At 850 mv. the lowest reading is about 22°F. It would be advisable to check these thermistors down to about -10°F if they are to be used on the glacier next year.

9. The Wind Vanes

These were found to be too heavy and cumbersome to erect, or fix to the mast, and wind direction was found from an azimuth and a flag on the mast.

10. Solarimeter

This was sent up in a plane that arrived in early June. It was in a box labelled "Tractor Parts", and so was not uncrated until after the sledge party left base camp to return to the glacier. It was brought up to the icecap station by Prof. Deane on 26 June.

The Solarimeter was a Kipp type Cat. No. G18 - G19 (Solarimetric thermopile No. 1080 without base and without screen) with Galvanometer A70 No. 1987 (10011).

On connecting the galvanometer to the battery it was found that the light would not shine on the scale. A new bulb was fitted, and the battery recharged, but the lamp still would not light. It was sent back to the base camp with Mr. Christie on 16 July.

I suggest that the solarimeter be carried always as personal baggage by a member of the expedition as the safest means of transporting it without damage.

11. The Stevenson Screen

The screen supplied was a small size one, and would not at first hold all the instruments. It was adapted so that it held the maximum and minimum thermometers, the dry bulb thermometer, the thermograph and the hygrograph. Although it was a little cramped, it seemed advisable to have a separate thermograph and hygrograph, rather than a thermo-hygrograph. Separate traces on separate sheets, less difficulty in adjusting and greater accuracy of reading can be achieved by using separate instruments.

12. The Mast

The type of mast used on the glacier was totally unsuitable for glacial-meteorological work. It collapsed on 30 July, but was re-erected without interrupting the observations. It fell again on 8 August, and was re-erected without its base, which tended to melt out quickly and to slide from underneath the mast. On 11 August, the mast again fell, damaging the base section.

The following design is suggested as being most suitable for this type of work.

A tubular mast in three or four sections. Total length - 37 to 40 feet. It should have a diameter of 4" or less so that an ice corer can be used to set it into the glacier. It should be sunk in at least four feet, preferably six feet. It should be hinged near the base to allow easy erection and dismantling, and should be guyed by at least six wires. Dead men for the guys should be pieces of tubing, about 6 feet long. Strong brackets clamping on to the mast should be fitted to hold the anemometers, and smaller brackets made for the thermistors.

13. Recording Instrument Nibs

These were cleaned when the meteorological equipment was packed away, but it will be advisable to take spare nibs next year for each instrument.

Land Temperatures

Readings from a thermograph installed on the land at the side of the glacier, or maximum and minimum thermometers laid out there, and checked each week, would be useful for comparison with temperatures at the glacier station.

Meteorological Equipment Stored on Gilman Glacier

(i) One Barograph MSC Type G 312 - 56. Serial No. B403. In full working order.

(ii) One Rain Gauge.

(iii) One Hand Aspirated Psychrometer. Model HA-2. Friez Instruments Division, Bendix Aviation Corporation. Serial No. P-502710 FRIEZ. Complete with instructions. Requires new bulb.

(iv) One Hand Anemometer (Kelvin and Hughes) AX 190 DOT Type KB 472/01. One cup broken off - could be soldered on.

(v) One Thermograph. (Negretti and Zambra) Serial No. R/25433. Range -40/+120'F. In full working condition, less clock.

(vi) One Snow Rule, Type 2.

(vii) One Sunshine Recorder (Casella) Campbell-Stokes pattern. Base No. 2404. Recording Sphere (Chance Brothers) Focal Length 2.946; diameter 4.018. Ref. No. D4829/E. In full working order.

(viii) Four Contact anemometers. Electric contact type, long stem pattern (Casella) Nos. 3505, 3521, 3546, 3547. No. 3546 intact, but others have broken and twisted cups and cup arms, and damaged stems. One battery box for the above.

(ix) Two complete wind vanes. Type M134. Intact.

(x) One Stevenson Screen and Base. Modified and dismantled.

(xi) One Rain Measure. Intact.

(xii) One Hygrograph (Negretti and Zambra). Serial No. R/25368. Clock No. 03162. Range 10/100%. In full working order, but runs two hours fast.

(xiii) Four batteries and meter for Nichols Model 142 SF Geophysical Potentiometer.

(xiv) Stored in the barograph drawer are the following:

39 Barograph Sheets MSC 257
18 Hygrograph Sheets H/W1750 X
15 Thermograph Sheets 6/W/1303
1 Tube Violet Ink ($\frac{3}{4}$ full)
6 Summer Sunshine Cards

One copy of "Psychrometric Tables for obtaining the vapor Pressure, Relative Humidity, and Temperature at Dew Point" by C.F. Marvin. Issued by US Department of Commerce Weather Bureau.

One set each of Instructions on Sunshine Recorders, Anemometers, and Stevenson Screen Erection.

(xv) The Mast.

The lower portion of the base section is bent, and would have to be sawn off with the loss of about one foot. Many of the rivets securing the sections were sheared off, and need replacing.

All meteorological equipment is stored in one of the pyramid living tents, and the mast was re-erected before the camp was abandoned, without the lower section and the base plate.

Meteorological Equipment Stored at Lake Hazen Base Camp

1. Clock No. 005424, used with thermograph Serial No. R/25433 on the glacier. This clock was to replace a defective one at base camp. It was run in, and seemed to work all right in the base camp thermograph; the other clock, suitably tagged, was put in the store hut.

2. One ordinary thermometer (Zeal) R-10744, with correction card. This thermometer was broken en route to the camp, the top snapping off, but the mercury staying in the tube. It was checked against the dry bulb in the screen at the base camp, and will be serviceable if kept upright.

3. One Minimum Thermometer (Zeal) N51013 with correction card. This is to serve as a spare at base camp, although it is not very accurate.

Meteorological Equipment Returned to Ottawa

One Aneroid Barometer. US Army No. 6 - WP 52023. This was the property of the Canadian Army Survey.

Meteorological Equipment Brought Back to Montreal

1. Four thermistors Serial No. 22A 2/57.
   Nichols Model 142SP Geophysical Potentiometer.
   Single Range 0 - 1.1v.
   For accurate calibration.

2. Solarimeter. Kipp type. Cat. No. G18 - G19 (Solarimetric thermopile No. 1080, without box and without screen).
   Galvanometer A70. No. 1987 (1011).
   This has been repaired at the Physics Department, McGill University.

Meteorological Equipment Broken During the Summer

One maximum thermometer (Zeal) X31304. Correction card, with account of accident to thermometer, was returned to Toronto on 9 September 1957.

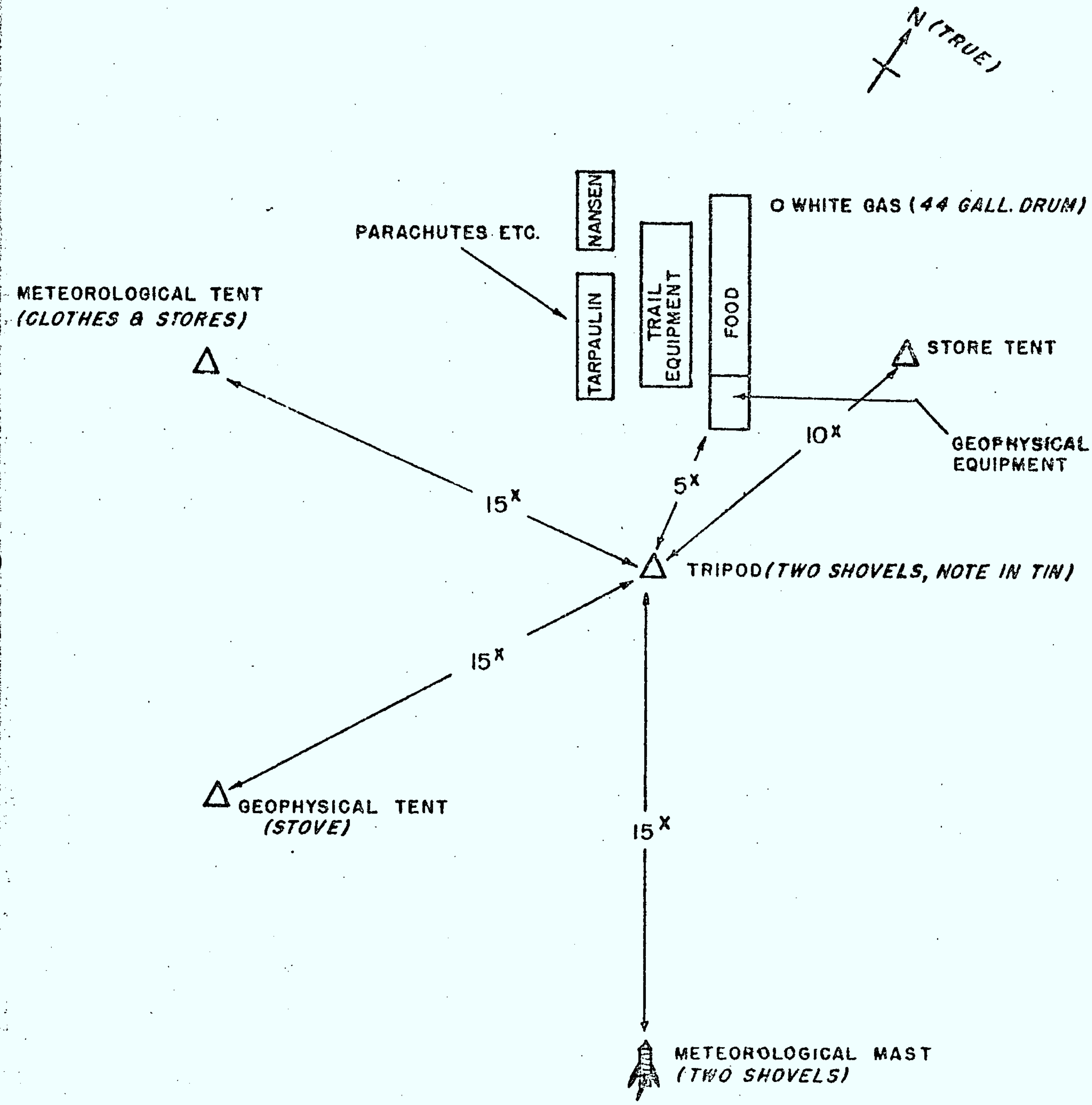
Summary

Synoptic observations at the Gilman Glacier station were begun on 18 May 1957, and continued through until 8 August. Micro-meteorological observations were begun on 9 June and continued until 8 August.

The main headache during the summer was the mast which was in constant danger of toppling as its base melted out.

It would be advisable for all the meteorological equipment to be unpacked and checked next year before it goes up to the glacier. Checking could be done against the instruments at base camp.

GILMAN GLACIER CAMP *(12th AUGUST 1957)*



SELECTED ITEMS OF ARMY CLOTHING AND EQUIPMENT

G. Hattersley-Smith

Boots, mukluk, 1953

These were used from the end of April until the middle of June in temperatures down to -30°F. Worn with the double duffle sock and mesh and felt insoles the mukluks are very warm comfortable footwear. The soles are rigid enough and tread good enough for the mukluks to be worn safely on quite steep snow slopes. In this way they are superior to a sealskin boot or moccasin. Rubber ("Siple") socks were worn successfully under the duffles. With rubber socks the duffles did not have to be dried at night, and the feet were warmer. After six weeks' wear it was found that the rubber had been torn away from the nylon upper in several places. A serious disadvantage of the mukluks for a long-legged man is that they are up to three inches too short in the leg, which means that the drawstring comes around the calf instead of just below the knee. The mukluks soon slip down on the trail and snow gets into the duffles.

Boots, insulated, Cl

These are very good boots for the spring and summer in northern Ellesmere Island, where the temperatures may be as low as -30°F, and as high as +60°F. Their insulation makes them rather too warm on the warmest days; on the other hand the insulation is desirable when feet are liable to get wet from stream crossings. The boots can be worn with snowshoes, skis, and crampons, which makes them an excellent all purpose boot. With crampons, however, great care must be taken that the insulation is not punctured by the spikes. It would be an advantage if these boots could be made a little lighter, as are the latest U.S. version of the same boot.

Boots, ski, arctic

These are good boots for arctic use in spring and summer. They are of soft leather, and comfortable and flexible to the foot in walking and climbing. They are preferable for mountain skiing to the very stiff and expensive boot favoured by the downhill experts.

Bottle, vacuum, 15 oz.
Cover, vacuum, Arctic, 15 oz.

The bottles and covers were very satisfactory except that the method of fastening the cover is unnecessarily complicated, so that fastening is quite impossible with cold fingers. Of six bottles taken to the icecap and used extensively under rough conditions only one was smashed.

Goggles, browrest, modified

These were very useful for limited periods in the open and as an emergency pair of goggles. The adjustable plastic-covered ear-pieces are a great improvement on the old metal ones. For long hours in the open in the exceptionally bright conditions of spring in northern Ellesmere Island darker goggles were preferred, which cover the top part of the face and shut out light from the sides.

Outfit, repair, cold weather

This proved to be a most useful item of equipment. All the tools were in frequent use and the very varied assortment of nuts, screws, nails, etc. was invaluable.

Parka w/liner

As on the windpants the sewing along the seams is shoddy. The parkas were found satisfactory down to temperatures of 30° below. Something warmer is required for the temperatures of 60° and 70°F below likely at Lake Hazen in winter. It is a pity that the fur ruff around the hood has been discontinued.

Shovel, hand, snow, XCl

These shovels became bent very easily, as they are not strong enough for digging into hard-packed snow. It is a false economy to save weight by not getting a good workman's shovel (with shortened, ash D-handle).

Sleeping bag, arctic, 1951

These are very good bags for temperatures down to at least -30°F. Only the inner was necessary after the middle of June when the temperature rose to about freezing point. The simple, open-at-the-end design is preferable to any mummy or zipper type, but the draw strings are unnecessary.

Snowshoe bindings, X56A

Snowshoes were not used very much, and the new harnesses could not be fully tested. However, the harnesses would seem to be both more rugged and easier to handle in the cold than the old leather type. The metal tags which have to pass through the snowshoe mesh should be made slightly narrower, say not more than 3/8 inch.

Stove, gasoline, 1-burner, M1950

This is a rugged and reliable stove which gave good service. It has two disadvantages. The first could be serious, namely that an inexperienced man may easily turn on the gas too early and set fire to the tent. The second is that there is no lever to control the rate of burning. This means that more gas is burnt than necessary and that food may be burnt. The latter effect can be avoided to some extent by placing a tin lid on top of the flame to dissipate the heat.

Tent, lightweight, arctic, 5-man

As store tents at a permanent or semi-permanent camp these are very useful and quite satisfactory. Two of the four tents were used on the icecap for this purpose. They only had to be repitched once in 4 months. During the melt period $\frac{3}{4}$ inch bamboo poles drilled 18-24 inches into the ice, where they froze in, were used as tent pegs. These had to be reset about once a week during the height of the melt. For living and travelling the 5-man tent is not to be compared for warmth and general comfort and for ease of pitching with the 2-man pyramid tents used on the ice cap. The latter are shaped so that the maximum warming effect is derived from the stove used in cooking. They can be pitched, if necessary, by two men in a 60 m.p.h. wind.

Toboggan, cargo-carrying, magnesium, 100 lbs. capacity

Useful over short distances in the camp area. But the sliding friction is high.

Toboggan, cargo-carrying, magnesium, 200 lbs. capacity (w/cargo pack)

This toboggan was used for moving light equipment and stores for short distances in the camp area and proved very useful. The transom of the pulling handle broke in two during the first two weeks of use. However the friction of this toboggan on snow is very high, as compared with a ski-sled with a bakelite running surface.

Trousers, windproof, nylon, olive-drab

These are very useful trousers, comfortable and with plenty of pocket space. Unfortunately they are marred by extremely shoddy sewing along all the seams.

SELECTED ITEMS OF FOOD

G. Hattersley-Smith

Dehydrated Steaks, Pork Chops, and "Instant Chicken"
(prepared by the Defence Research Medical Laboratories)

It was unanimously agreed by the eight members of the summer party that the dehydrated steaks and pork chops are a most excellent luxury item of diet. More than half the supply was saved for the winter party of four who it was felt would appreciate them under the circumstances even more than the summer party. All the "instant chicken" was saved for the winter party.

The steaks were eaten both at the main camp and at the advance camp, where six members of the party lived in tents. The instructions - "soak in water for five minutes and cook as fresh steak" - were followed, and the steaks were always fried, rather than grilled. With a little flour and water quite a good gravy was made in the frying pan. The steaks were equally good whether fried over the oil burning stove at the base camp or over a Coleman stove in a tent. It was found that the rib steaks were generally more tender than the round steaks, but the round steaks were certainly not tough. Towards the end of the summer the fat on the steaks was inclined to be a little rancid. However, there was very little fat on any of the steaks, and not much was lost if the fat was discarded.

The value of these steaks is not to be measured only in their food value and palatability: at an isolated station there is considerable morale value in serving steaks which are virtually indistinguishable from fresh ones.

Fruit Cake
(prepared by Wonder Bakery Ltd., Toronto to the specifications of the Defence Research Medical Laboratories)

This is very filling, very palatable, and very good as a quick source of energy on the trail or after a hard day. The only criticism of this excellent cake is that in more than a small quantity it is a little too rich for some tastes. But this is not a valid criticism as the cake is specially designed to be very rich. For this reason it is a tribute to the success of the cake that people seldom ate more than one slice at a time.

The rum soaking undoubtedly improves the keeping qualities of the cake. Next summer it will be interesting to note the condition of the cake stored on the icecap for a full year.

Meat Bars

These were used extensively during the four-month season, and probably made up half the meat intake of the party of six on the icecap. They were very palatable in stews, especially when flavoured with onion or a little curry powder. They were also frequently eaten from the packet on the trail.

The difference between these bars, made under license by Canada Packers, and the original bars made by Ministry of Food (U.K.), Aberdeen, was noticeable but not specially remarkable. The Canada Packers' bars have a slightly gritty texture and do not have as good a flavour as the M. of F. bars. The flavour is not objectionable but rather nondescript.

Oatmeal Blocks

This is another good item for trail lunches, but less popular than the shortcake bar for quick nourishment because harder to eat.

Shortcake Bars

These bars were used in 1954, as well as last summer. They were much appreciated by all members of both parties. They make an excellent trail lunch item in convenient form. Two of these bars and 3-4 ozs. of milk chocolate commonly made up a lunch. The packaging in cellophane paper is perfectly adequate for arctic conditions.

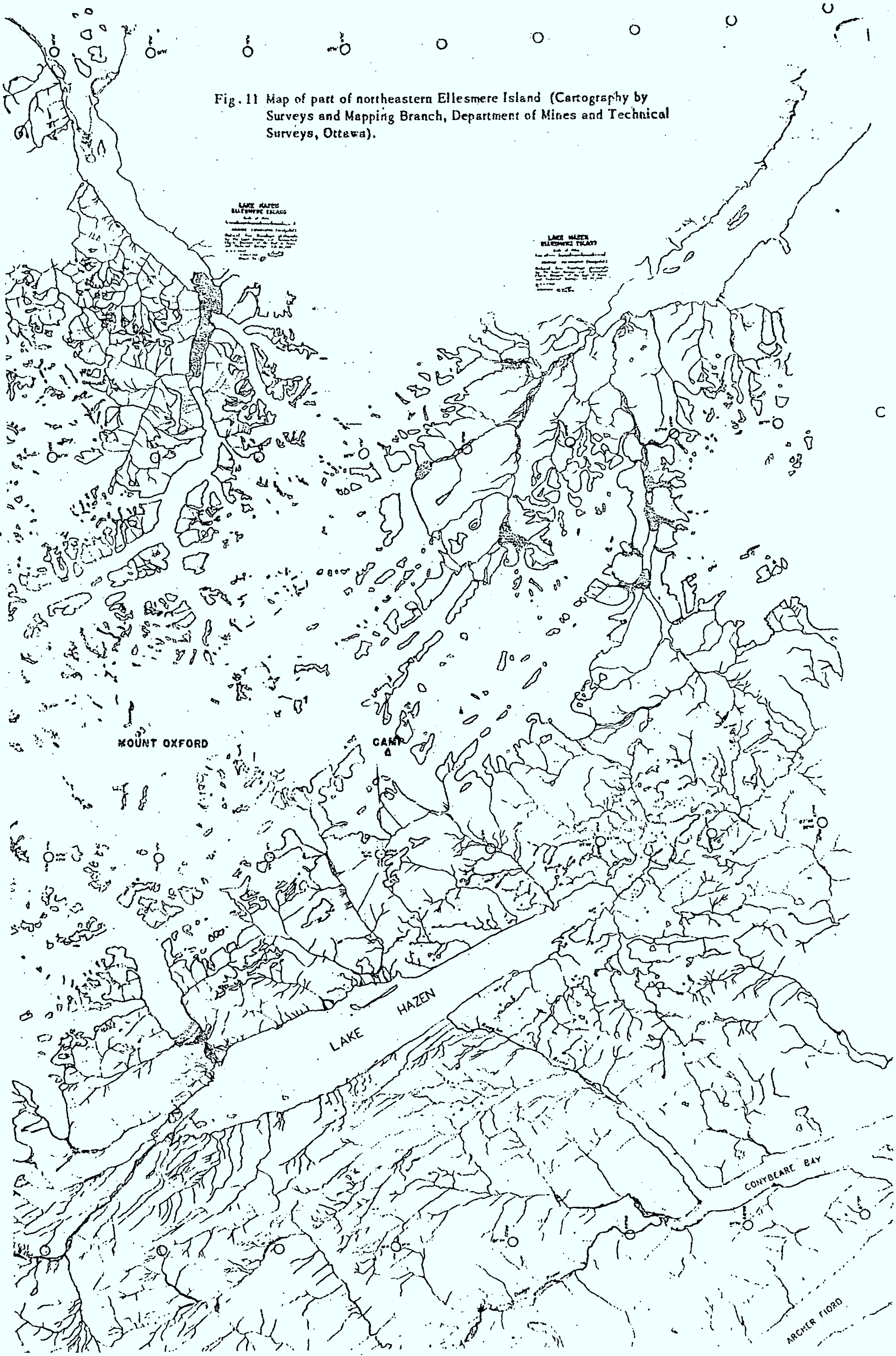


Fig. 11 Map of part of northeastern Ellesmere Island (Cartography by Surveys and Mapping Branch, Department of Mines and Technical Surveys, Ottawa).