PROJECT "SNOW CORNICE"

The Establishment of the Seward Glacial Research Station

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Introduction

DURING the discussions of those who envisioned an Arctic Institute of North America, the subject of field research assumed its rightful place as the essential ingredient in our recipe for an ever widening knowledge of polar characteristics. Feeling was strong, however, that attainment of such knowledge might best be achieved through the establishment of facilities at which cooperative studies could be carried on in as many fields of interest as the localities selected might afford. Thus, in effect, the efficient study of the environmental elements of a region could be undertaken on a planned basis and the indefinite overlapping margins of allied scientific fields fused. Project "Snow Cornice" proposed to put such a cooperative program into effect.

The area of operations embraced by "Snow Cornice" can be described as the drainage basin of the Seward Glacier together with its only distributary, the Malaspina Glacier. This area is traversed by the international boundary between Alaska and Yukon Territory and, consistent with the North American character of the Institute, personnel representing institutions of both Canada and the United States participated in the project.[1]

For many years work in the fields of snow mechanics and glacier regimen has been pursued with increasing intensity by European scientists employing as laboratories the easily accessible ice streams of the Alps and the more remote glaciers of Iceland and Spitsbergen. Yet in North America interest has been centered in observational comparison of the terminal positions of a few active glaciers, with but scattered examples of detailed and more fundamental studies. In fact it is difficult to recall a single example of studies carried out in North America and devoted to the great areas of snow accumulation. "Snow Cornice" provided an opportunity to initiate such studies.

Certainly a past deterrent to glacier regimen studies has been the inaccessibility of the areas at which significant studies could be made; in planning "Snow Cornice" it was felt that through the application of airborne techniques a solution to this problem would be found. For the safe operation of aircraft a landing area providing unobstructed approaches, absence of crevasses and an even surface is essential. The broad expanse of the Seward Glacier basin (roughly 750 sq. miles) amply fulfills these requirements; and when it is considered that such a site lies only 55 airline miles from the excellent airhead facilities at Yakutat, Alaska, the final piece in the jig-saw puzzle of selection-accessibility was provided. Furthermore the Seward is contained within a very extensive and well defined

basin whose only drainage channel is the very narrow (3½ miles) outlet to the broad Malaspina piedmont. Thus the Seward Basin provides a vast unit whose physical properties, for glaciological purposes, can be accurately defined. In selecting the Seward Basin for glaciological research the merits of the area for meteorological and biological studies also were weighed as was the opportunity for studying techniques of travel and of living.

Specifically, "Snow Cornice" proposed to effect the following:

a) The establishment of a semi-permanent research station within the confines of the Seward Basin.
b) The initiation of a long-range glaciological program.
c) The exploration of the geological structure of the region.
d) The accumulation of standard meteorological data.
e) A reconnaissance of the biology of the region.
f) Studies and experiments contributing to expeditionary efficiency.

The personnel comprising "Snow Cornice" assembled at Yakutat, Alaska, late in June 1948 where, through the unbounded cooperation of the Civil Aeronautics Administration complement, organizational headquarters were provided at the airport. The project was entirely dependent upon airborne operations and on June 30 the Institute's "Norseman" aircraft, equipped with combination ski-wheels for operations on snow and on surfaced runways, made its first landing on the Seward Glacier (5700 feet). Here a temporary camp was established from which reconnaissance towards a site for the fixed installation could be conducted. During the following ten days a satisfactory station site was selected on the corniced rock crest of a nunatak beneath the towering cliffs of Mt. Vancouver

The Arctic Institute's Norseman on the Seward Glacier (5700 ft.) 9 July 1948. All Snow Cornice personnel and equipment were transported to the glacier landing strip and the project was completely maintained by this plane. In foreground is U.S. Forest Service type radio in operation.

(15,720 feet), and to this spot were transported the expedition personnel together with approximately four tons of equipment and supplies. Of this quantity more than half was dropped from the "Norseman", either free or by parachute. During the entire season no instance of parachute failure was experienced and free drop damage was limited to less than 5% of the quantities so delivered. The housing for the research station, a Jamesway hut 16 x 24 feet in floor area, was flown in 45 packages to the glacier landing strip, man hauled 2½ miles, and erected on the nunatak. This structure, weighing 3400 lbs., was used as living quarters and laboratory for an average of seven men and proved successful in every respect. Perhaps the best criterion of its value was the universal opinion of those who labored it into a finished unit that it was worth every ounce of the energy expended in its construction.

During the months of July and August those responsible for the various phases of the project pursued their investigations. Their activities ranged from static studies of surface phenomena to protracted sledge journeys over the eastern third of the Seward Basin; from 80-90 feet below the surface in crevasses to 13,500 feet on the great north ridge of Mt. Vancouver. The scientific harvest still reposing within the pages of field notebooks and on the undeveloped emulsions of photographic plates will be reported on later. At this time it is possible to draw only broad conclusions from the first field season.

Scientific Program

The glaciological and geological program was developed and carried out by Prof. R. P. Sharp, California Institute of Technology, assisted by Leighton, Miller, Rigsby and Steenson. Collaborating with Sharp were two groups representing the National Research Council of Canada and composed of Baird, Bruce-Robertson and Salt; and Northwood, Simpson and Potter.

Due to unavoidable delays it was possible to commence studies of thermal regimen only in mid-July. Borings sunk by electrically heated hot points to a depth of 204 feet in the firn and to which thermohms and wheatstone bridge were applied resulted in temperatures of O°C. at all levels. By this early date then, the winter cold wave had been completely dissipated from the firn. In a pit dug to a depth of 50 feet, densities increased regularly (excluding ice bands) from ±0.50 near the surface to 0.85 at 50 feet. Blue ice band densities approximated 0.90. It is interesting to note the abnormally high surface density of 0.50 which demonstrates that in mid-July all accumulated snow has been converted to firn.

One of the most striking features of the Seward Ice Field in summer is the amount of meltwater circulating through the firn. At times specific layers produced several hundred cubic centimeters of water per meltwater pan, 1,437 sq. cm. in area. Crevasses in the central portion of the ice

Looking South to Mt. Cook (13760 ft.) from the snow ridge of "Indian Head Nunatak". Tracks in the foreground lead to the rocks on which the Research Station (6100 ft.) was constructed.

field were filled with water at depths between 60-70 feet. Thermal drilling also suggested that the firn was saturated at about 65 feet and this condition raises the interesting possibility of a "ground water" table at this depth which may not freeze in winter. Typical blue ice bands were common in the firn, but more impressive were nearly vertical columns of coarsely crystalline ice called "firn pipes". Recognizable as bumps or pimples on the surface, the pipes end at a blue ice band or serve to connect two such bands. They are probably old meltwater channels but they may also be formed by vapor exuded from the firn.

The excess of accumulation over ablation for the year 1946-47 was 17.5-17.9 inches of water, provided dirt layers observed in the central part of the ice field mark the summers of 1946 and 1947 as is believed to be the case. Since wastage appeared to have ceased in late August 1948, the net accumulation for 1947-48 is somewhat higher; 22-23 inches of water. Ablation approximated 16 inches of firn (density 0.50) per month during mid-summer.

Initial results from radar soundings were encouraging. Many echoes were obtained, presumably from ice bands and other irregularities, but a distinctive echo appeared to record the rock floor. A profile across a small valley glacier was obtained but, unfortunately, it was impossible to check its accuracy by other geophysical means. The seismic and accoustical programs, on the other hand, yielded less satisfactory results due to the difficulty of projecting sufficient energy into the firn, although some hopeful results were achieved by accoustical methods to a depth of 200 feet.

Geological reconnaissance showed the predominating bedrock to be an igneous-metamorphic complex. Although complicated and of considerable lithologic variety, the metamorphic rocks can be divided into several

mappable units. A fossiliferous quartzite-limestone series was also discovered whose approximate age should be determinable from the fossils collected.

An extensive collection of flowering plants, shrubs, mosses, lichens and grasses was made for future examination and identification. All outcrops visited showed roughly similar plant life which, due to environmental differences, varied significantly in respect to date of bloom. Botanical specimens were collected at altitudes ranging from 5700 to 9000 feet by John Ross with the assistance of other members of the expedition.

Rock rabbits inhabited all nunataks visited and were the only permanent residents observed. It is intriguing to speculate on how these small animals came to their present abode since rock outcrops were in all instances isolated from the coastal fringe by 20-30 miles of glacier surface.

Birds were commonly observed, the most striking visitors being humming birds which were seen on numerous occasions at the research station. Numerous winter wrens were seen as were several members of the warbler family. No predatory birds were reported. Unfortunately each cold snap brought its toll of casualties and dead birds were frequently found sheltered under expedition equipment. A migratory tendency from the Pacific coast to the Yukon plateau seems probable in view of the general northerly direction of flight across the Seward-Hubbard Glacier divide.

The United States Weather Bureau and the Dominion Meteorological Service provided standard instruments for the collection of weather data. Standard observations made thrice daily by Ross, P. Wood and Hall were communicated to the first order U.S. Weather Bureau stations at Anchorage and Juneau for incorporation in marine and general weather forecast data. Summer temperatures were found to be higher than the altitude (6000 feet) and the glacier environment had led us to expect they would be. At the research station the mean maximum temperature for July was 50° F. While the mean minimum for the same period was 32° F. July provided 9 clear days, 8 cloudy days, and 14 overcast days. Precipitation fell on 8 days in July mostly in the form of rain, and to a total water equivalent of 2.04 inches. These data are believed to be generally applicable to the basin as a whole with the exception of temperatures which averaged 6°-10° F. lower for equal elevation at points on the glacier remote from rock surfaces. For example, minimum temperatures at the glacier airstrip 350 feet lower and 2½ miles from the research station were found to be as much as 15° F. lower than those observed at the station. Of special interest is the discovery of an apparent climatic frontier constituted by the low rock ridge which separates the Seward and Hubbard glacier systems. On repeated occasions the weather was noted to be sharply divergent on opposite sides of this ridge, the Hubbard sector giving an impression of semi-aridity as compared with the moist and heavily snow-

covered topography constituting the Seward sector.

Mapping operations, which were conducted by W. A. Wood with the assistance of McCarter and Ross, were divided into two categories; the establishment of local ground control and ground stereo-photogrammetric survey. The proximity of the United States-Canada International Boundary Survey provided a wide selection of fixed points from which a local network could be established. Stereo-photogrammetric survey was limited to the eastern third of the Seward Basin and was applied specifically to features of glaciological significance. Twelve bases were established in such a manner that they may be reoccupied in succeeding seasons and, when results have been plotted, provide a comparison of glacier behaviour.

Future Considerations

In its first field season "Snow Cornice" was essentially an experiment. Due to the untiring efforts, constructive suggestions and practical experience of its "charter members", it was a successful experiment. Thus the foundations, both physical and scientific, have been laid upon which to build in future years. Already a well-rounded scientific program has been proposed for 1949 which, far from excluding investigations unrepresented in 1948, seeks only the fullest cooperative interpretation of the environmental elements, which comprise this truly magnificent region.

[1]Personnel comprising "Snow Cornice" were:

P. D. Baird	Arctic Institute of North America; glaciology.
A. Bruce-Robertson	Geophysics and Medical Officer.
Dean Goodwin	Juneau, Alaska; air advisor.
G. R. Hall, 3rd	Meteorology and Botany.
Maurice King	Pilot; in charge of air operations.
B. Leighton	California Institute of Technology; glaciology.
R. S. McCarter	Harvard Mountaineering Club; logistics.
F. P. Magoun	Harvard Mountaineering Club.
M. M. Miller	American Geographical Society; geology and glaciology.
T. D. Northwood	National Research Council of Canada; geophysics.
J. G. Potter	National Research Council of Canada; geophysics.
G. P. Rigsby	California Institute of Technology; geology and glaciology.
J. H. Ross	Harvard Mountaineering Club; meteorology and botany.
D. J. Salt	Geophysics.
R. P. Sharp	California Institute of Technology; Senior Scientist in charge of geological and glaciological studies.
F. W. Simpson	National Research Council of Canada; geophysics.
B. O. Steenson	California Institute of Technology; geophysics.
Sir Hubert Wilkins	Arctic Institute of N.A. Equipage and organization.
F. H. Wood	Equipage and photography.
P. H. Wood	Meteorology and botany.
W. A. Wood	Arctic Institute of N.A., Director, Project "Snow Cornice".