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Technical Papers of the Arctic Institute

Numbers 9 and 10 of this series have appeared. No. 9. A GEBOTANICAL SURVEY OF NORTHERN MANITOBA. By J. C. Ritchie. 1962. 47 pages, 5 tables, 8 figures, 2 folding maps. Price: to members \$1.00; to non-members \$2.00. No. 10. ESKIMO ADMINISTRATION. I. ALASKA. By Diamond Jenness. 1962. 64 pages, 2 figures. Price to members \$2.000; to non-members \$3.00 Copies can be obtained from the Montreal Office.

THE DEVON ISLAND EXPEDITION 1960-64

Preliminary report for September 1961 to September 1962

The Arctic Institute is maintaining a research program on Devon Island, N.W.T., the purposes of which include fundamental studies in geophysics, glaciology, meteorology, and oceanography, with particular attention to the inter-relationships between the marine and glacial environments. Detailed studies in archaeology and geology are also supported. The establishment of the base station and the preliminary ar-

chaeological reconnaissance in 1960 have been reported in *Arctic* 13: 270-71. A summary of the field work of the first full season, 1961, together with several preliminary reports has appeared in *Arctic* 14: 252-65. The field season of 1961 ended on September 12 when the various field parties were taken to Thule, Greenland, by the U.S. Coast Guard icebreaker *Westwind*.

September 1961 to April 1962

Five men remained on Devon Island to carry on glaciological, meteorological, and oceanographic observations through the winter. They were: in glaciology, R. M. Koerner, in meteorology, A. Gill and C. W. Nicol, in oceanography and limnology, S. Apollonio and B. Beck, all of the Arctic Institute. The winter program from September 1961 to April 1962 comprised:

Glaciology; studies on glacier-, lake-, and sea-ice

During the summer and fall of 1961 ice cores were collected at nine stations on a profile extending from the north-

west edge of the ice cap to a point 3 km. above the firn line. The cores varied from 2 m. to 10 m. in length. During the winter a large number of thin sections from these cores were examined in detail for bubble structure, crystal size and shape, and orientation of the c-axes. More than 600 photographs were made in connection with the examination of these sections.

The results include the observation that, though no major concentrations in the orientation of c-axes were detected at or above the ice cap station (located below the firn line), a definite pattern emerges in a core taken near a

shear (?) moraine at the top of a steep slope at the edge of the ice cap. Similar concentrations were found, with c-axes aligned in the direction of bubble stretching, on a ridge of a valley glacier.

Continued study of such cores from the ice cap will reveal in some detail the character of melt seasons in previous years.

The sea-ice study included detailed measurements of thickness, internal temperatures, crystal size and orientation, crystal plate size, brine cell distribution, and ice density. An overall growth rate of 1.1 cm./day was measured and variations in the rate agree with changes in the thermal gradient in the lower 50 cm. of the ice. The ice consisted largely of vertically elongated crystals with horizontal c-axes. The crystal size could generally be correlated with the rate of growth of the ice. No regularity was observed in the variations of the plate thicknesses.

The ice of four lakes was studied. Again, temperatures, crystal size and orientation, and bubble patterns were measured. In all the lakes the crystal size increased rapidly with depth from a diameter of less than 1 cm. to more than 25 cm. at a depth of 70 cm. Crystals longer than 70 cm. were observed. The orientation of the c-axes varied with depth and notably from lake to lake. Water samples were collected to determine the effects of chemical composition on the orientation. Notable variations in bubble structures were also observed from lake to lake.

Meteorology

The meteorological, micro-meteorological and radiation observations were continued at the base camp essentially as they had been carried on through the summer. After October 1 the synoptic surface observations were radioed seven times daily, radio conditions permitting, to the Meteorological Branch, Department of Transport, at Resolute, via Eureka, N.W.T. The micro-meteorological program included measurements of wind and temperature profiles up to 10 metres, and ground and snow tempera-

tures. The radiation program measured total and net, solar and sky radiation at frequent intervals whenever possible.

Oceanography

The coastal waters of Jones Sound froze solidly in early November and an oceanographic station was then established about 2 miles offshore over 80 metres of water. The station was occupied through the winter at approximately 2-week intervals and samples were taken from five depths. Measurements included temperature and salinity, and oxygen, nitrate, phosphate, and silicate concentrations. Zooplankton tows were made from 50 and 80 metres.

The measurements showed the gradual cooling of the Sound and a decline of oxygen content, together with a gradual increase of the nutrient concentrations. A significant inverse correlation between minor phosphate and silicate fluctuations just off the bottom was noted. This persisted until oxygen reached its lowest concentration. The zooplankton tows revealed a typically arctic community with a large number of nauplii through the winter.

In March two photometers were frozen into the sea-ice and measurements of the natural penetration of sunlight were made at frequent intervals until July.

Limnology

From September until June, frequent measurements were made at several depths of temperature, and oxygen and silicate concentrations. Neither nitrates nor phosphates could be detected in the lake near the base camp. Vertical zooplankton tows were made at regular intervals.

There was a marked drop during the winter in oxygen throughout the lake, but particularly just off the bottom. The silicate concentration increased through the winter, particularly just off the bottom. So close was the inverse correlation between oxygen and silicate that very little of the oxygen depletion can be attributed to faunal metabolism.

The zooplankton tows showed a rather constant population of *Limnocalanus*

macrurus through the winter. Several measurements of respiration were made on adult copepods in the spring.

April 1962 to September 1962

The first field workers arrived on Devon Island on April 20, 1962. The second group reached the island on May 20. Both groups were flown from Resolute in an Otter aircraft chartered from Bradley Air Services piloted by R. M. de Blicquy.

program, making resistivity measurements on similar traverses at 4-mile intervals. At the top of the ice cap detailed measurements were made on the resistivity of firn and ice layers at the site of the glaciologist's deep snow pit.

The summer personnel consisted of:

In mid-August the movement stakes

Geophysics	J. P. Greenhouse	University of British Columbia
	R. D. Hyndman (gravity)	" " "
	R. A. Tansey (survey)	Royal Engineers — U.K.
Glaciology	R. M. Koerner	Arctic Institute of North America
	A. Gill	" " " "
Meteorology	L. Dahlgren	University of Uppsala
	B. Holmgren	" "
	C. W. Nicol	Arctic Institute of North America
	C. Shackleton	" " " "
Oceanography and	S. Apollonio	Arctic Institute of North America
Marine Biology	M. Weinstein	" " " "
Master Mechanic	V. D. Boyd	Arctic Institute of North America
General Assistant	H. D. Suckling	" " " "

Geophysics

The geophysical program included a continuation of the geoelectrical method of depth sounding of the ice cap, together with investigations into its possible application to general glaciological problems; a gravity traverse of the Devon Ice Cap and Sverdrup Glacier; and a levelling survey.

of the Sverdrup Glacier were re-surveyed and a gravity traverse of seven stations together with a levelling survey was carried across the glacier.

A detailed survey of the shape of the northwest edge of the ice cap was then made, occupying 28 stations and measuring stadia distances and vertical angles.

Transportation was by an Eliason toboggan. During the early part of the season Lieutenant Tansey was evacuated by air to Thule AFB hospital for an emergency operation for acute appendicitis. He returned at the end of June.

Glaciology

The party travelled by "Weasel" and continued and extended the 1961 work. The number of accumulation-ablation stakes from the Sverdrup Glacier to the top of the ice cap was doubled, with stakes concentrated near the expected net accumulation line. The profile of stakes was continued over the southeast side of the ice cap at 200-ft. altitude intervals to near the Cunningham Mountains. A line of stakes were set into the Johnson Glacier on the south coast, and 23 stakes were established from the edge of the ice cap near Croker Bay to the top. Finally, 19 stakes were set in from the top of the ice cap

Gravity stations were established at 1.5-kilometre intervals on an 80-kilometre traverse across the ice cap from near Sverdrup Glacier to near Croker Bay. A second 15-kilometre traverse was run from this profile to the top of the ice cap. A levelling survey was made in connection with the gravity stations on the two traverses across the ice cap.

After completion of those traverses the party carried out the geoelectrical

down on to a large glacier entering Jones Sound at 82°W. On all these profiles snow pits were dug at frequent intervals for stratigraphic records, densities, temperatures, and grain sizes. Numerous additional snow depths determinations were made. The work will give a very detailed picture of 1961-62 snow accumulation. Of particular interest was the very much greater amount of accumulation of snow measured on the south side of the ice cap. Snow depths on the southeast side were about 130 cm. as compared with about 30 cm. on the northwest side and 40-50 cm. on the southwest side. Most of the stakes were remeasured and new pits were dug at the end of the melt season in August.

A series of cores 5 metres and 10 metres in length were taken on the snow traverses, and densities, grain size, and stratigraphy were recorded.

A 10-metre pit was dug at the top of the ice cap as control for the cores, and it was extended to 22 metres by coring. The pit penetrated the firm to that deposited in 1938.

Thermocouple sets on the glacier and the ice cap measured temperature variations down to depths of 12 m. and 10 m., respectively.

Run-off measurements were made from July 14 to August 11, during the main melt period on the Sverdrup Glacier, using dilution equipment lent by the Jacobsen-McGill Arctic Research Expedition to Axel Heiberg Island. These measurements were supplemented by readings with an Ott water level recorder and an Ott current meter. The program during the melt period included meteorological observations on the glacier, and detailed run-off measurements were made at times when they could be correlated with radiation observations on the ice cap and at sea-level. Ablatometer measurements supplemented the direct run-off observations and the catchment area was surveyed by the geophysical party.

Much higher ablation was recorded in 1962 than in 1961, but data from the pit studies suggest that ice layers were more characteristic for the 1960-61

summer.

There was relatively little altitudinal variation in the amount of ice removed from the Sverdrup Glacier, but the ablation at any altitude on the glacier could be correlated with the crystal structure of the ice.

Meteorology

The program continued and extended the meteorological, micro-meteorological and radiation observations of 1961. Comparable observations were made at the base station near sea-level and at the ice cap station. The base station continued to radio its surface synoptic observations to Resolute. Both stations measured low-level wind and temperature profiles using continuously recording anemometers and ventilated thermometers on 10-metre masts. Radiation observations were made with Eppley, and Angstrom pyrreheliometers and Beckman-and-Whitley radiometers. Upper-air wind observations were made with pilot balloons at both stations.

Oceanography and Marine Biology

In May an oceanographic station measuring temperature, salinity, nitrates, phosphates, and silicates at standard depths was occupied inside the threshold of Grise Fiord, Ellesmere Island. Constable R. Bacchus, RCMP, assisted with this work, and transport between Devon Island and Ellesmere Island was provided by the Eskimos Isaac and Moses. The fiord water apparently is rather warmer and contains smaller quantities of the nutrient minerals than water on the south side of Jones Sound.

During the summer regular and frequent measurements were made in the coastal waters of phytoplankton production by two or three methods, light penetration and water transparency, temperature, salinity, oxygen, nitrate, phosphate, silicate, and chlorophyll variations. Phytoplankton samples were routinely preserved.

In August measurements were made of the various oceanographic parameters within the water directly off the Sverd-

rup Glacier, to determine the glacial effects on oceanography.

The field parties were taken off Devon Island on September 30 and to Resolute, N.W.T., by CCGS *Labrador*, and by a Helio-Courier aircraft piloted by R. Ragle and P. Upton, Arctic Institute of North America. The program will resume in April 1963.

Dr. Fritz Müller, leader of the Jacobson-McGill Arctic Research Expedition to Axel Heiberg Island, visited Devon Island in June for over a week. The expedition members are particularly indebted to him for discussions on the ice cap concerning glaciological and geophysical problems, for the loan of instruments, and for the use of the Super Cub aircraft chartered by his

expedition. The entire scientific program benefited from his visit.

The work is supported by funds and equipment from the Canada Department of Northern Affairs and National Resources, the Defence Research Board of Canada, the Meteorological Branch, Canada Department of Transport, the Geophysical Research Directorate of the U.S. Air Force, the Hudson's Bay Company, Massey-Ferguson Ltd., the National Science Foundation, the Office of Naval Research, Department of the Navy, the U.S. Army Quartermaster Corps, the United States Steel Foundation, the U.S. Weather Bureau, and several private contributors.

SPENCER APOLLONIO

Reviews

THE WORLD OF ICE.

By JAMES L. DYSON. *New York: Alfred A. Knopf. 1962. 9½ x 6½ inches, xvii + 292 + xiii pages, 62 plates. \$6.95.*

The lands covered with perennial snow and ice are the only uninhabited regions of the world. Except for a few scientific and military installations, not a single permanent settlement occurs in this vast area, which embraces about ten per cent of the land surface of the earth. Scientific and popular interest in glaciers and ice caps has, however, been long maintained at a high level. This is due to a number of different factors, such as the romance of exploration in difficult and uninhabited areas, the large geographic extent of ice, and the interesting and unique phenomena connect-

ed with moving ice. With the great exploration, logistic, and scientific excitement of the International Geophysical Year came increased public interest in the lands of perennial ice and snow. Several popular writings about the field of glaciology have appeared in response to this heightened interest. The most complete so far is by James L. Dyson, head of the Department of Geology and Geography at Lafayette College, Easton, Pennsylvania.

Professor Dyson has produced a rather rambling but highly readable survey of glaciers, ice sheets, sea-ice, and permafrost, emphasizing the influence of ice on human activity. Discussion of snow, snowlines, and the development and classification of glaciers leads into a brief description