THE GROWTH OF METEOROLOGICAL KNOWLEDGE OF THE CANADIAN ARCTIC

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COLD waves, the periodic surge of Arctic masses into the main west-east flow of air in the temperate latitudes, emphasize the indispensable need of the meteorologist for data from Canada's remote northland. A day-by-day knowledge of changes in the Arctic is vital to the interpretation of changes in more temperate latitudes. The advancement of his profession and of the science depend to a large extent on an increased understanding of arctic meteorology.

Almost a quarter of the Arctic cap is Canadian territory (see Fig. 1), an area second only to that controlled by the U.S.S.R. Canada thus carries an international obligation to roll back the meteorological frontiers of the Arctic, for the free exchange of weather data between nations of the northern hemisphere is no longer a courtesy but a scientific necessity. The discharge of this responsibility over a period of two centuries is a romantic and challenging chapter in Canadian history.

While the Arctic is traditionally bounded on the south by the sixty-sixth parallel, considerations of logistics, density of population and nature of the terrain suggest a modification of this definition to include an area which, for purposes of this article, may be designated as the Subarctic. This area lies between the Arctic Circle and an irregular line, roughly along the sixtieth parallel. The term "Arctic" is used loosely in the following article to include both the Subarctic and the true Arctic, in the Canadian sector.

Exploration and Meteorological Observations

As might be expected, the history of meteorological observations in the Canadian Arctic is closely related to the history of exploration. This chronicle of discovery, it must be assumed, is entirely familiar to readers of *Arctic*. While there is some evidence that Leif Ericson discovered Baffinland in the year 1000 A.D., the usual date of the opening of the Arctic is given as 1576, when Frobisher reached the same island. There follows a succession of names—Davis, Hudson, Button, Baffin, Hearne, Mackenzie, Scoresby—each contributing either directly or indirectly to the early meteorological knowledge of the Arctic. In a later period, even greater contributions were provided by the scientific, rather than purely exploratory, expeditions of Parry, Ross and Franklin.

The first organized effort to make meteorological observations in the entire Arctic, including the Canadian sector, came with the establishment of

a Polar Year, August 1882 to August 1883. In the succeeding forty years, famous names, such as Greely, Nansen, Sverdrup, Stefansson, Amundsen, Bernier and Peary, were entered on the Arctic roster. The highlight of the remaining two decades was the organization of a second Polar Year in 1932-33.

Early Arctic Observations

One of the earliest instrumental records in northern Canada was made by Mr. Thomas Hutchins, an officer of the Hudson's Bay Company at York Factory and Severn House, in 1772-73.[1] These short-term instrumental records, together with references to the character of the seasons, drought, snowfall and other climatic phenomena, indicate that during the 18th and 19th centuries the general character of seasonal variations was much the same as during the present century.

An important contribution to our knowledge of the meteorology of the arctic regions is provided by a publication[2] under the authority of the Meteorological Council of Great Britain, printed in the years 1879-1888. Meteorological observations are here recorded from no less than thirty-six expeditions dating from 1819-1858, almost all arising out of the tragic search for Franklin. Four sets of the land-station observations (1845-1854) are a tribute to the indefatigable scientific work of Dr. John Rae, Hudson's Bay factor.

On these searching expeditions, observations were taken for the most part 2-hourly, some hourly, and the others, three, six, eight times a day. The length of the records varies from eight months to twenty-seven months. Observations were generally taken of temperature, including that of the sea, pressure, wind, weather, character of the cloud, thickness of the ice, and in some cases solar radiation.

Establishment of Arctic Stations

The Canadian Meteorological Service (established in 1839) is also indebted for its Arctic data to the factors of the Hudson's Bay Company, to the missionaries of the Roman Catholic Church and of the Church of England, and to members of Canadian surveying parties, as well as to explorers.

During the first Polar Year[3] in 1882-83, three Arctic stations were organized. Canada and Great Britain jointly managed the station at Fort Rae, Great Slave Lake. The United States made a major contribution to the success of the Polar Year when Lieut. Greely[4] established a base at Fort

[1]A. J. Connor, "Canada", Handbook of Climatology, Köppen and Geiger, Vol. 2, Part J.

[2]"Contributions to our Knowledge of the Meteorology of the Arctic Regions", Vol. I, H.M. Stationery Office, 1885.

[3]J. Patterson, "A Century of Canadian Meteorology", Q. J. Roy, Met. Soc., Vol. 66, Supp. 1940.

[4]Canadian Geographic Journal, Vol. XXX, No. 3, March 1945, p. 144.

Conger on northern Ellesmere Island. The third station was undertaken by the Germans at Kingua Fjord, Cumberland Sound, Baffin Island.

In 1880 the young nation of Canada awoke to the fact that her northern boundaries were only vaguely defined. Accordingly, at her request, the British Government confirmed the transfer to the Dominion of all the Arctic Islands adjacent to the Canadian mainland. The first Dominion exploration party was concerned with the investigation of the Hudson Bay route. Seaborne expeditions went north to Hudson Strait in 1884, 1885 and 1886,[5] and maintained meteorological stations at several points during the two intervening winters.

In 1898, observations were commenced at Dawson in the Yukon. In 1909, a chain of stations was opened along the Mackenzie River to Fort McPherson in the Mackenzie Delta, while a few years earlier observations had been taken on Herschel Island by Bishop Stringer. It is of interest to note that Sir Frederick Stupart, who became Director of the Meteorological Service[6] in 1894, spent the period from July 1884 to November 1885 on an inlet, called in his honour "Stupart Bay", systematically recording weather conditions and the presence and motion of ice floes.

During the period of discovery from 1576 to 1902, there were no less than 49 British expeditions, 13 United States, one Danish and one Norwegian expedition to the Arctic. While the number of expeditions after the turn of the century decreased, their intensity and scope increased, and the Arctic annals record the famous voyages of Ziegler, Stefansson, Sverdrup, Bernier and Amundsen. Names such as Pond Inlet, Winter Harbour, Arctic Bay and Eureka Sound, now prominent in Arctic lore, assume an additional atmosphere of romance when it is realized that temporary settlements were first made in these isolated spots a half century ago.

Hitherto the discussion has been limited to meteorological observations taken at the surface. The first upper-air observations taken in the Canadian Arctic[7] appear to have been made in 1822-23 by Rev. George Fisher and Sir Edward Parry. These men sent aloft, on kites, self-registering thermometers, duly recording that the air was isothermal to 400 feet with a temperature of -24°F. This observation was apparently made at latitude 69° 21′N, longitude 124°W. It was not until the second Polar Year more than a century later that further upper-air ascents in the Arctic were recorded. In 1932, at both Coppermine and Chesterfield, kite ascents were made, and in 1933 the first radiosonde was launched in the north at Coppermine. In 1936 at Fort

[5]"Report of the Hudson's Bay Expedition", 1884-5-6, Lt. A. R. Gordon, R.N., Canadian Government Reports.

[6]Jnl. Roy. Astronomical Soc. of Canada, Vol. 35, p. 137.

[7]Sir Napier Shaw, "Manual of Meteorology", Vol. I, p. 207.

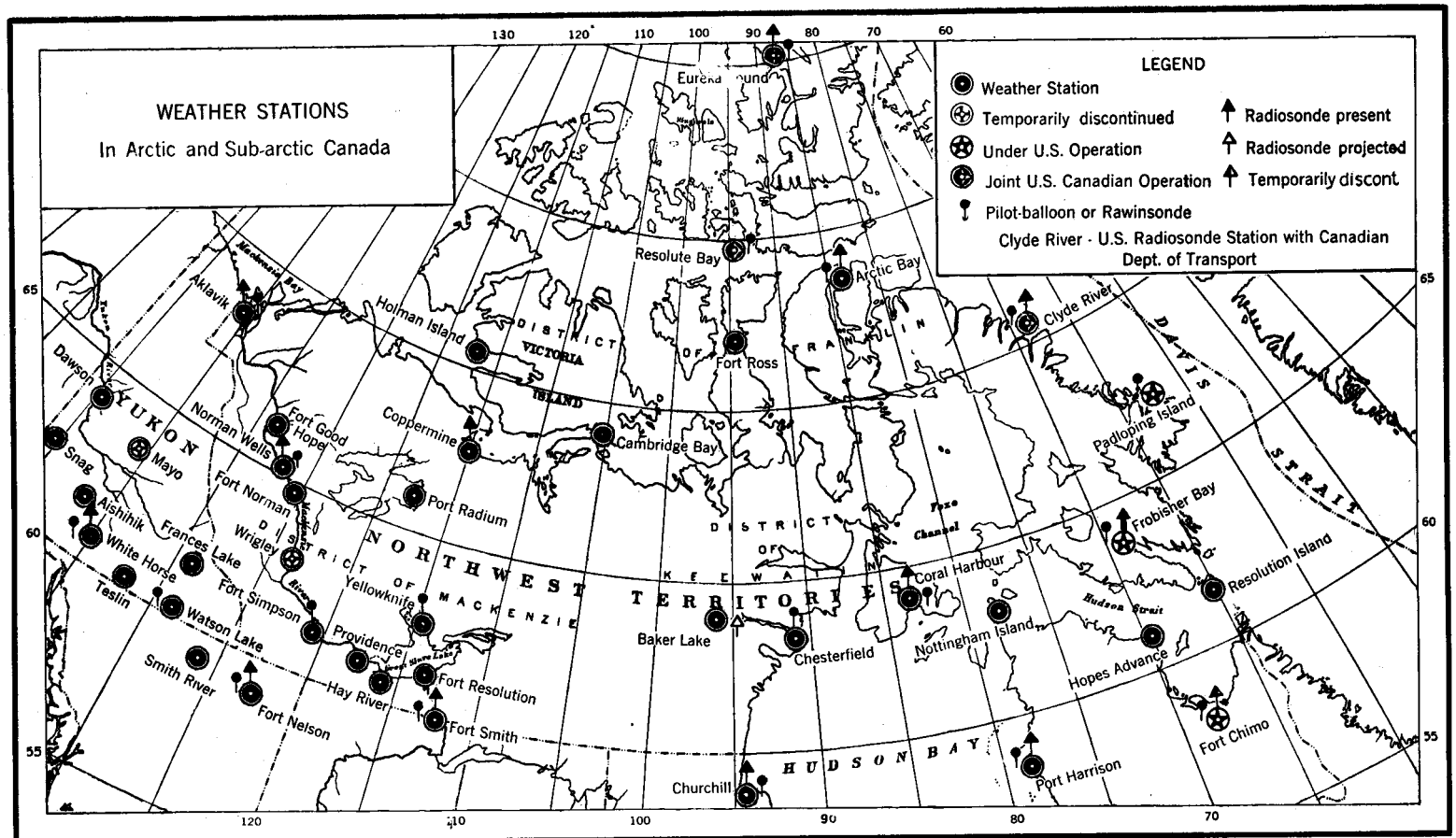

Fig. 1—Distribution of Arctic and Subarctic weather stations in Canada, January, 1948.

Smith extensive aircraft upper-air ascents were made, and in 1942 Aklavik was inaugurated as the first continuously reporting upper-air station in the Canadian Arctic.

The second International Polar Year was organized at the International Meteorological Organization Conference at Copenhagen in 1929, to celebrate the fiftieth anniversary of the first Polar Year. Canada played a more prominent role than formerly, maintaining four stations: Cape Hopes Advance (Quebec), Chesterfield Inlet, N.W.T., Coppermine, N.W.T., and Meanook (Alberta). In addition, the British took observations for that year at Fort Rae, the same site at which they and the Canadians had operated during the first Polar Year.

Development of Arctic Communications

Dating from the 1880's, a series of meteorological stations was progressively opened in the Arctic. It is interesting to note the dates and the records of some of these stations which do not appear on the current roster: Fort McPherson (1909-38), Lake Harbour (1909-37), Fort Hope (1891-1921), Hebron, Labrador (1884-1910), Herschel Island (1899-1918), York Factory (1899-1914), Carcross (1907-42), Swede Creek, Yukon (1918-28). However, most of these stations took reports for climatological records only. Owing to a lack of rapid communication, the reports were of course of no use for current synoptic purposes.

It was in the 1920's that a chain of government wireless stations was first begun in the Northwest Territories. In those early years the stations were primarily for the gathering and transmitting of meteorological data for the Canadian Meteorological Division, but they handled commercial messages as well. By 1941, besides a dozen stations maintained by the government, all the larger Hudson's Bay Company trading posts in the Northwest Territories had short-wave key and telephone transmitters, while flying and mining companies had radio equipment wherever it was needed.

The period of modern meteorological observations can be said to date from the introduction of the radio in the North. Observations are now taken not only by personnel of the Meteorological Division but by those of the Royal Canadian Corps of Signals, the Radio Telegraph Branch of the Department of Marine, the Royal Canadian Mounted Police, Hudson's Bay factors, missionaries, and employees of commercial and mining companies.

Wartime Expansion of Observing Network

The outbreak of war in 1939 involved the Meteorological Division in many new tasks, among them the difficulty of maintaining an expanded network of far northern stations. Military flying mushroomed, and civil aviation continued its rapid growth. At this stage the outstanding deficiency of the

Photos: National Film Board, Canada.

Top: Observer at Radiosonde station, Arctic Bay, Baffin Island, Canada, releasing meteorological balloon.

Bottom: Staff Sergeant of the Royal Canadian Corps of Signals recording temperature observations at a Mackenzie Valley weather station, N.W.T., Canada.

observational network throughout Canada—in the south as well as in the north—was the scarcity of upper-air data, especially temperatures and humidities. The recent development of an extensive radiosonde network in the United States and Alaska had shown the value of such observations. To meet this need for upper-air data, development work on a Canadian radiosonde was pushed to completion and mass production was begun on a scale which made possible the establishment of regularly reporting radiosonde stations by 1941. During this period of conversion to a wartime footing the Division began surface observations at Whitehorse Airport and Holman Island and re-opened the station at Cambridge Bay.

The entry of the United States and Japan into the war in 1941 marked the real beginning of wartime expansion of Canadian meteorological services in the Arctic. Aircraft in an ever-increasing stream were ferried to Alaska, the Aleutians and the U.S.S.R. by way of northwestern Canada, and to the United Kingdom, Iceland and Greenland by way of Newfoundland, Labrador and northeastern Canada. Many new airports appeared almost overnight to provide the basic ground services, including weather information, for these new air-routes.

If upper-air observations in the north had previously been desirable as an aid to forecasting in southern Canada, they were now vital to flying within the arctic area itself. The Meteorological Division's first regularly reporting radiosonde station had been established in September 1941 at Gander, Nfld. During 1942, Fort Nelson, B.C.; Aklavik, N.W.T.; Prince Albert, Sask.; and Moosonee, Ont.; were added to the network. Radiosonde reports from these stations were supplemented by pilot-balloon observations of upper winds from several northern stations.

By way of assistance to the Canadian Department of Transport and to the Allied war effort in general, the United States provided radiosonde equipment and personnel for new upper-air stations at Arctic Bay, Frobisher Bay, Clyde River, Padloping Island, Fort Smith, Norman Wells, Churchill, Whitehorse, Fort Chimo, Coral Harbour and Southampton Island in the arctic area, and at Edmonton, Prince George and Grande Prairie farther south. In addition, the U.S. government supplied radiosondes for two Canadian-operated stations, Nitchequon and Port Harrison, both established in 1943. Some of these stations were also provided with radio equipment for determining upper winds.

Post-war Programme

Of the U.S. weather stations set up in northern Canada during this period, Arctic Bay, Fort Smith, Norman Wells, Prince George, Churchill, Coral Harbour and Whitehorse were taken over by the Department of Transport either before the close of the war or just after it. Others were

WEATHER REPORTING STATIONS IN ARCTIC AND SUBARCTIC CANADA, AS AT JANUARY 1, 1948.

Name of Station	Latitude N. ° ′	Longitude W. ° ′	Altitude ft.	Types of Observations	Year 1st surface observations made.
Aishihik, Y.T.	61 35	137 18	3170	S(H)	1943
Aklavik, N.W.T.	68 14	134 50	25	SI PR	1926
Arctic Bay, Baffin I.	73 16	84 17	15	S PR	1937
Baker Lake, N.W.T.	64 18	96 05	30	SI r)	1946
Cambridge Bay, Victoria I.	69 05	105 00	.....	SI a) b)	1928
Chesterfield, N.W.T.	63 20	90 43	13	SI P	1921
Churchill, Man.	58 45	94 07	115	SH PR b)	1884
Clyde River, Baffin I.	70 25	68 17	10	SH PR a)	1942
Coppermine, N.W.T.	67 49	115 10	13	SR R	1930
Coral Harbour, Southampton I.	64 11	83 21	193	SI PR	1933
Dawson, Y.T.	64 04	139 29	1062	S (I)	1898
Eureka Sound, Ellesmere I.	79 59	85 56	8	S PR	1947
Fort Chimo, Que.	58 06	68 25	50	SH PR b)	1921
Fort Good Hope, N.W.T.	66 15	128 38	251	S (H)	1897
Fort Nelson, B.C.	58 50	122 40	1230	SH PR	1934
Fort Norman, N.W.T.	64 54	125 30	30	S	1908
Fort Resolution, N.W.T.	61 09	113 37	519	S (H) b)	1914
Fort Ross, N.W.T.	72 02	94 03	50	(S)	1937
Fort Simpson, N.W.T.	61 52	121 21	415	S (H) P	1897
Fort Smith, N.W.T.	60 01	120 00	665	S (H) PR	1913
Frances Lake, Y.T.	61 17	129 24	2425	(S) (H)	1941
Frobisher Bay, Baffin I.	63 44	68 22	76	SH PR	1942
Hay River, N.W.T.	60 51	115 46	529	S (H)	1893
Holman Island, N.W.T.	70 30	117 38	30	(S)	1940
Cape Hopes Advance, Que.	61 05	69 33	240	SI b)	1928
Mayo, Y.T.	63 35	135 51	1625	d)	1927
Norman Wells, N.W.T.	65 17	126 47	290	SI PR	1944
Nottingham Island, N.W.T.	63 07	77 56	54	SI	1928
Padloping Island, N.W.T.	67 06	62 22	130	S (H) Pr)	1941
Port Harrison, Que.	58 25	78 08	66	SI PR	1921
Port Radium, N.W.T.	66 05	118 02	600	SI	1942
Providence, N.W.T.	61 20	117 40	529	S (H)	1942
Resolute Bay, Cornwallis I.	74 41	94 05	.....	S (I) PR	1947
Resolution Island, N.W.T.	61 18	64 53	127	SI	1928
Smith River, B.C.	59 30	126 30	2208	SH	1944
Snag, Y.T.	62 22	140 22	1925	SH	1943
Teslin, Y.T.	60 08	132 40	2300	SH	1943
Watson Lake, Y.T.	60 08	128 47	2248	SH P	1937
Whitehorse, Y.T.	60 42	135 07	2289	SH PR b)	1904
Wrigley, N.W.T.	63 13	123 26	511	d)	1943
Yellowknife, N.W.T.	62 28	114 20	656	S (H) P	1941

SYMBOLS:

a) Position approximate
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d) Observations temporarily discontinued
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P Pilot balloon or radio wind observations.
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closed when the particular air routes they served were abandoned. Fort Chimo, Frobisher Bay and Clyde River are still operated by the United States.

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The table on page 41 lists the names, positions and altitudes of the weather stations which were reporting regularly on January 1, 1948, within the arctic and subarctic areas (two stations which have been closed temporarily are included). In the case of stations where separate sets of observations are currently being made at an airport and at another site, the coordinates given are those of the airport. The second last column lists the types of observations currently being made. The dates given in the last column are the year in which the first surface observations were made, or, in the case of some of the earlier observations, the first year in which a complete set was made. When observations have been made at different sites in the same vicinity, the date given refers to the first observations made.

Reliability of Arctic Meteorological Data

It may be said that meteorological observations have kept pace with geographical exploration. However, there remain large gaps in the coverage of weather reports in the Arctic. Whereas the Mackenzie Valley and the Eastern Archipelago are well represented, there is a sparsity of stations in the central area of the Northwest Territories and in the Western Archipelago to the immediate north, an area of approximately a half million square miles.

It must be noted in assessing the value of meteorological data of the Arctic that the periods of observations were of different lengths at different stations and therefore should not receive equal weight. Further, as already noted, there is an uneven concentration of stations in the Arctic. Moreover, not all observations—especially in the early days—were taken simultaneously.

Observations of humidity have been for the most part made by means of dry and wet thermometers. During the winter months the observations by this means, especially in the far north, have been very untrustworthy.

Difficulty of transport of mercurial barometers, as well as the lack of communications for long periods, rendered the establishment of satisfactory pressure stations, especially in the early days, almost impossible. Errors were not known until data were received many months after observations. Changes

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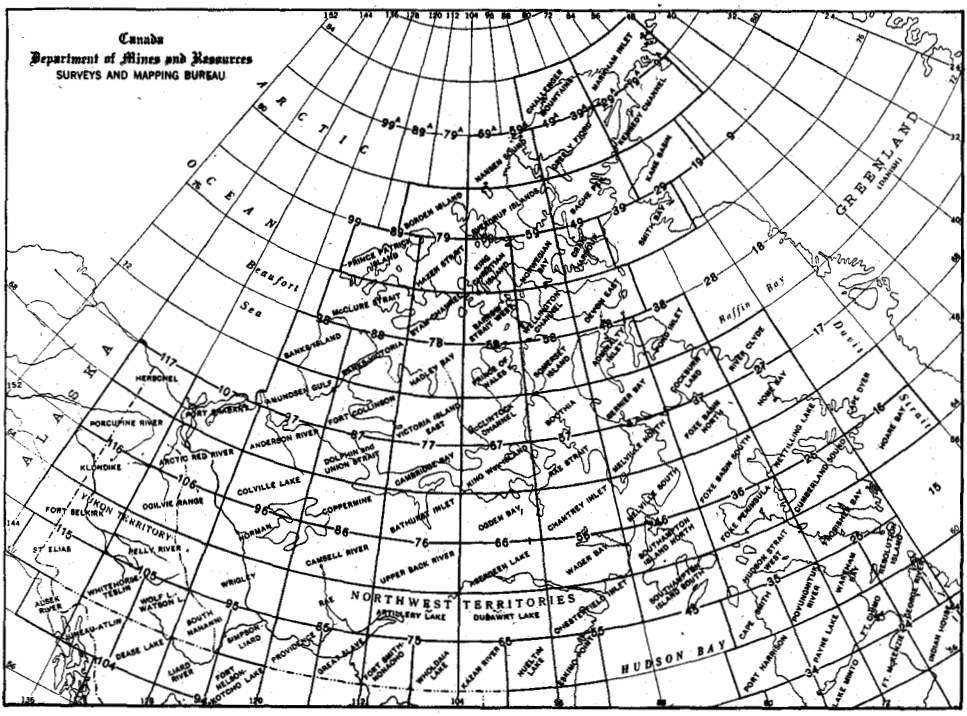
of personnel, observations made by poorly instructed men or substitutes, the long delay before the breakage of instruments could be remedied, the practical impossibility of inspection of the staff by Head Office—all these difficulties have been overcome, but have adversely affected pressure observations in the hinterland in the past.

The maintenance of an arctic network of meteorological stations is exacting and expensive. Nevertheless, it must be not only continued but expanded. The consensus of meteorological opinion the world over holds that in the arctic data lies the clue to both more accurate short-range forecasts and to the development of long-range forecasting techniques. To this must be added a recent requirement for meteorological services to new trans-arctic air-routes. The responsibilities of Canada in this connection are definite and unavoidable—it may be safely said that her meteorological eyes are and will be turned to the Arctic for several years to come.

MAPS OF NORTHERN CANADA



INDEX TO THE EIGHT MILE MAPS COVERING THE ARCTIC REGIONS

The above index shows those eight mile sheets of the National Topographic Series which cover northern Canada. All are drawn to the same scale on the Transverse Mercator Projection with each sheet fitting its neighbour. Owing to the lack of known ground elevations, most of the sheets are not contoured, and are at present printed in only two colours, black and water blue. As the necessary information regarding ground relief is obtained the proper hypsometric tints to indicate changes in ground elevation will be added. These maps may be obtained from the Surveys and Mapping Bureau, Department of Mines and Resources, Labelle Bldg., Ottawa, for 25 cents per sheet. It is hoped to publish corresponding diagrams of Greenland and Alaska in subsequent issues of *Arctic*.