Glaciers of North America–

GLACIERS OF CANADA

HISTORY OF GLACIER INVESTIGATIONS IN CANADA

By C. SIMON L. OMMANNEY

SATELLITE IMAGE ATLAS OF GLACIERS OF THE WORLD

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The earliest recorded description of a Canadian glacier was in 1861. Since that time, various glaciological investigations have been conducted in the several glacierized regions of Canada (for example, Coast Mountains, Interior Ranges, *Rocky Mountains, and Arctic Islands), including mass balance, modeling, dendrochronology, climatology, ice chemistry and physics, ice-core analyses, glacier-surge mechanics, and airborne and satellite remote sensing*

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HISTORY OF GLACIER INVESTIGATIONS IN CANADA

By C. SIMON L. OMMANNEY[1]

Abstract

Because of extensive high mountain ranges (peaks nearly 6,000 meters above sea level in western Canada) and high latitude (latitude 83° North in the High Arctic Islands), Canada has a large number of glacierized regions; the area covered by glaciers increases from south to north along the border with Alaska in the west and from Labrador to Ellesmere Island in the east. Glaciers cover an estimated 150,000 square kilometers of the Arctic Islands, three times the glacier cover in western Canada (about 50,000 square kilometers), for an approximate total area of 200,000 square kilometers. The principal glacierized regions of Canada are the mountain groups of the Coast Mountains: St. Elias Mountains, Boundary Ranges, and Pacific Ranges; *Interior Ranges*; Rocky Mountains; and Arctic Islands: Baffin Island, Devon Island, Ellesmere Island, Axel Heiberg Island, Meighen Island, and Melville Island. The first field observations of Canadian glaciers were made in 1861. During the past 140 years, various types of glaciological measurements, from observations in the field to airborne and satellite remote sensing, have been made, for varying periods of time, of 176 individual glaciers, including 13 glaciers in Yukon Territory (St. Elias Mountains), 63 glaciers in the Coast Mountains, 10 glaciers in the *Interior Ranges*, 27 glaciers in the Rocky Mountains, 41 glaciers in the High Arctic, 10 glaciers in the Low Arctic, and 5 glaciers in Labrador (Torngat Mountains). Seven other glaciers have been studied but are outside these mountain ranges and are not discussed. Most of the studies of mass-balance, modeling, dendrochronology, climatology, ice chemistry and physics, ice-core analysis, glacier-surge mechanics, and airborne and satellite remote sensing were carried out during the past 50 years, stimulated by the need for increased knowledge of water resources in the western glacierized basins and to support scientific work during the International Geophysical Year (1945 to middle 1950's), increased knowledge of Arctic Canada, a response to security and sovereignty concerns (middle 1950's to the middle 1960's), and by the International Hydrological Decade (middle 1960's to the 1970's). During the 1990's governmental support of glacier research in Canada waned, but by the beginning of the 21st century, the Geological Survey of Canada initiated a National Glaciology Programme, including a Cryospheric Systems Research Initiative (CRYSYS), motivated by achieving a better scientific understanding of the potential impact of climate change on Canada's water resources and the Arctic region. With the increased availability of the higher spatial and spectral resolution in satellite imagery (including stereoscopic imagery), radar imagery (including InSAR), and laser altimetry, glaciologists will increasingly rely on satellite remote sensing to acquire some of the data needed to monitor changes in area and volume and glacier velocity.

Occurrence of Glaciers

The Canadian landmass, extending from long 53°W. to 141°W. and from lat 42°N. to 83°N., has an area of almost 10 million km^2. The mountains range up to a height of nearly 6,000 m above sea level and contain a variety of environments suitable for the development and maintenance of glaciers. Field, in his memorable study of mountain glaciers, described the glacier

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[1] International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, England (formerly with the National Hydrology Research Institute [now the National Hydrology Research Centre], Environment Canada, Saskatoon, Saskatchewan S7N 3H5, Canada).

distribution and reported on much of the work done on them (Field, 1975c); work on the glaciers was last updated by Ommanney (1996). Small glaciers are found on both continental margins, in the Torngats of Labrador (Fahn, 1975), and in the central mountains of Vancouver Island (Ommanney, 1972a). Larger glacier masses are found in the Rocky Mountains (Denton, 1975a), the *Interior Ranges* (Coleman, 1921; Denton, 1975c), and the Coast Mountains (Denton, 1975b). The glaciers get progressively larger as one moves north along the "Panhandle" (Field, 1975a), the boundary between British Columbia and Alaska. The size continues to increase through the Juneau Icefield region up to the Yukon Territory (Ommanney, 1993) and the Icefield Ranges (Field, 1975b, 1990), which contain large glacier systems such as the Seward Glacier [11],[2] (Post and LaChapelle, 1971) (table 1, fig. 1). Some smaller outliers are found in the eastern Yukon Territory and western District of Mackenzie (Northwest Territories) (Horvath, 1975). The variety of the landscapes encountered can be seen in Dunbar and Greenaway (1956), Post and LaChapelle (1971), Slaney (1981), Prest (1983), and Mollard and Janes (1984).

The mean height of the equilibrium line of the glaciers rises steadily as one crosses the mountains from west to east, from about 1,700 m in the Coast Mountains to more than 2,700 m in the Rockies, reflecting a continentality effect. Moving northward, the glaciers increase in size and reach to lower elevations, demonstrating a latitudinal effect due to the lowering of mean annual temperature as one moves toward the North Pole. This effect is best seen in the eastern Arctic, where the mean height of the equilibrium line declines from some 700 m on Baffin Island virtually to sea level at the Ward Hunt Ice Shelf [120] (table 2, fig. 2). Glaciers in the eastern Arctic are distributed along the mountain and fjord coast of Baffin Island (Ives, 1967c), with bigger concentrations of ice in the Barnes [164] and Penny [168] Ice Caps (Mercer, 1975a). Such concentrations become larger and more common farther north. Axel Heiberg Island, Ellesmere Island, and Devon Island are partially covered by large ice fields and ice caps several thousand square kilometers in size (Mercer, 1975b). The regional characteristics of glaciation levels, snowlines, and equilibrium lines throughout Canada have been described by Østrem (1966a, 1972, 1973b), Andrews and Miller (1972), Bradley (1975) and Miller and others (1975).

Figure 1 shows the distribution of glaciers in western Canada. The numbers in this figure refer to those in table 1 and identify the locations of specific glaciers mentioned in the text or for which some historical information is summarized in the table. The numbers are given in the text in square brackets after the glacier names to aid the reader in identifying their geographic location. Figure 2 and table 2 provides the same information for the glaciers of arctic and eastern Canada.

To aid in the management of its glacier resources, the Canadian government initiated a comprehensive inventory of all Canadian glaciers in the 1960's. The inventory was a contribution to the International Hydrological Decade (IHD) and also to the International Hydrological Programme (IHP) (Ommanney, 1980). However, no recent measurement of the total area of Canada's glaciers has been made. A summary of the best available information (Ommanney, 1971a) shows that about three-quarters of Canada's permanent ice masses, some 150,000 km^2, is found in the eastern Arctic, with the balance lying on the mainland, chiefly in the Yukon Territory and British Columbia (Ommanney, 1989) (table 3).

***Figure 1.**—(opposite page) The glaciers of western Canada. Numbers on the map correlate to the numbered glaciers in table 1. The areas shown in darker green are national parks and other protected areas; the areas shown in purple are glaciers. Modified from map in Canadian Geographic (Shilts and others, 1998). Used with permission.*

[2] Numbers in brackets refer to tables 1 and 2 and to figures 1 and 2.


CANADA
ALASKA
U.S.A.
CANADA
YUKON
TERRITORY
Whitehorse
ST. ELIAS MOUNTAINS
Skagway
Juneau
BOUNDARY RANGES
COAST MOUNTAINS
Stikine River
PACIFIC
OCEAN
BRITISH
COLUMBIA
Skeena River
Queen
Charlotte
Islands
Queen
Charlotte
Sound
PACIFIC RANGES
VANCOUVER
ISLAND
Vancouver
Victoria
CANADA
U.S.A.
WASHINGTON
60°N
55°
140°W
135°
130°
125°
50°
N
0
100 km
1
2–6
7
8
9
10
11
12
13
14
15
16–17
18
19
20
21
22–26
27
28
29
30–33
34–35
36–41
42
43–44
45
46
47
48–52
53–55
56–61
62
63
64
65–66
67–68
69–71
72–75
76
Fraser River
COLUMBIA
ROCKY MOUNTAINS
BRITISH
COLUMBIA
ALBERTA
Jasper
Banff
COLUMBIA MOUNTAINS
Columbia River
Kootenay River
87–88
89
90
91–99
100
101
102
103–105
106
107
108
109
110–111
77–79
80–81
82
83
84
85
86
112
113
N
0
100 km

TABLE 1.—*Summary of historical information on glaciers of western Canada (see also fig. 1)*

[x, variations; o, mass balance; *, variations and mass balance; z, other studies; s, other, some mass balance; m, other, some variations; ?, missing glacier area and location data; italicized place-names are variant names and names not listed in the CPCGN/CGNDB[3]]

YUKON TERRITORY	Latitude North	Longitude West	km²		1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
1. Klutlan Glacier	61°30.0'	140°37.0'	1091.		....	....	....	....	....	....	....	.....zz...	.....z....	....	....	
2. Hazard Glacier	61°15.7'	140°21.9'	16.		....	....	....	....	....	....	....	....	.....zz..z	....	....	
3. Steele Glacier	61°14.6'	140°10.6'	99.		....	....	....	....	....	....	....	......zzzz	..zzzzz..z	.z........	....	
4. Trapridge Glacier (*Hyena*)	61°13.6'	140°20.0'	5.5		....	....	....	....	....	....	....	........zz	zzzzz.z...	zzzzzzzzzz	zzzzzzzzz.	
5. Backe Glacier (*Jackal*)	61°12.8'	140°17.9'	3.4		....	....	....	....	....	....	....	........z.	.x........	....	....	
6. Rusty Glacier (*Fox*)	61°12.4'	140°17.9'	4.9		....	....	....	....	....	....	....	.......zoo	zzzzzzz...	....	....	
7. Donjek Glacier	61°03.6'	139°42.8'	290.		....	....	....	....	....	....	....	....	....z....z	....	....	
8. Walsh Glacier	60°53.0'	140°45.0'			....	....	....	....	....	....	.xx.......	....xxx...	....	....	....	
9. Kaskawulsh Glacier	60°45.0'	139°06.0'	700.		....	....	....	....	x	....	....	.zzzzzzzzz	z..zz.....	....	....	
10. Mount Logan	60°34.0'	140°23.0'	?		....	....	....	....	....	....	....	........z.	....zzz.z.	zz....z.zz	....	
11. Seward Glacier	60°25.0'	140°30.0'	?		....	....	....	....	....	xx	....o.....	....zz....	.z........	....	....	
12. Hubbard Glacier	60°22.6'	139°22.5'	?		....	....	....	....	....	....	....	....	....	.z.z.z....	....	
13. Lowell Glacier	60°17.8'	138°17.2'	530.		....	....	....	....	....	....	....	....	xxxxx	xxxxx.....	....	
COAST MOUNTAINS	Latitude North	Longitude West	km²		1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
14. Tweedsmuir Glacier	59°52.0'	138°19.3'	497.		....	....	....	....	....	....	....	....	....xx....	....	....	
15. Nadahini Glacier	59°44.0'	136°41.0'	6.1		....	....	....	....	....	....	....	....x.x.x.	x.x.x.....	....	....	
16. *East Arm Glacier*	59°43.2'	137°35.6'	102.		....	....	....	....	....	....	....	....	....	.x.x......	....	
17. Tats Glacier	59°41.4'	137°46.2'	16.1		....	....	....	....	....	....	....	....	....	........oo	....	
18. Cathedral Glacier	59°20.3'	134° 06.3'	2.0		....	....	....	....	....	....	....	....	.ooo.o....	....	....	
19. Grand Pacific Glacier	59°07.5'	137°08.0'	565.		....	....	....	.....x....	....	......x...	x.......x.	....x.....	....x.....	....	....	
20. Tulsequah Glacier	58°50.0'	133°45.6'	~200.		....	....	....	....	..z.......	....	....	....	....	....	....	
21. Flood Glacier	57°10.7'	131°55.0'	11.		....	....	....	....	....	....	....	....	.........z	zzzzzz....	....	
22. Alexander Glacier	57°06.4'	130°49.1'	5.8		....	....	....	....	....	....	....	....	.........o	oooooo..oo	o.........	
23. Natavas Glacier	57°03.6'	130°49.6'	3.1		....	....	....	....	....	....	....	....	....	zo........	....	
24. Yuri Glacier	56°58.0'	130°42.2'	3.6		....	....	....	....	....	....	....	....	........oo	oooooo..oo	o.........	
25. Andrei Glacier	56°55.7'	130°55.6'	92.		....	....	....	....	....	....	....	....	........oo	oooooo..oo	o.........	
26. *Forrest Kerr Glacier*	56°54.1'	130°05.6'	99.		....	....	....	.......x..	.x..x.....	.....xxxx.	....	....	........oo	ooo.......	....	
27. Great Glacier	56°50.9'	131°52.0'	~175.		....	....	....	....	....	....	....	....	....	....	....	
28. *Ridge Icefield Glacier*	?	?	?		....	....	....	....	....	....	....	....	....	....	.z........	
29. *Tim Williams Glacier*	56°33.4'	130°00.0'	8.		....	....	....	....	....	....	......z...	....	....	.........z	....	
30. Leduc Glacier	56°14.0'	130°22.0'	12.3		....	....	....	....	....	....	....	.....z....	.	....	....	
31. Frank Mackie Glacier	56°19.5'	130°10.0'	153.		....	....	....	....	....	....	....	.....z....	....	....	....	
32. Berendon Glacier	56°14.8'	130°05.0'	33.4		....	....	....	....	....	....	....	.....z.ooo	oooooo....	....	....	
33. Salmon Glacier	56°08.6'	130°04.0'	35.		....	....	....	....	....	....	......zz.z	.....z.zzz	z.........	....	....	
34. New Moon Glacier	53°55.3'	127°46.5'	1.0		....	....	....	....	....	......x...	....x.....	.......x..	.x...x..x.	...x......	....	
35. UTEM Glacier	53°54.5'	127°46.7'	1.2		....	....	....	....	....	....	....	....	....	...x......	....	
36. Purgatory Glacier	52°09.0'	126°22.0'	13.9		....	x.........	....	....	....	.......x..	....x.....	....x.....	........x.	....x.....	....	
37. Atavist Glacier	52°09.0'	126°09.0'	5.5		....	x.........	....	....	....	....	.x..x.....	....x.....	........x.	....x.....	....	
38. Noeick Glacier	52°06.5'	126°16.7'	8.9		....	x.........	....	....	....	....	....x.....	....x.....	........x.	....	....	
39. Fyles Glacier	52°06.0'	126°13.6'	15.9		....	x.........	....	....	....	.......x..	....x.....	....x.....	...x....x.	....mmm...	....	
40. Ape Glacier	52°04.3'	126°12.2'	8.1		....	x.........	....	....	....	.......x..	.x..x.....	....x.....	...x....x.	....x.x...	....	
41. *Deer Lake Glacier*	52°04.0'	126°10.0'	4.6		....	....	....	....	....	....	....	....	...x......	....	....	
42. Bench Glacier	51°27.0'	124°56.0'	10.		....	....	....	....	....	....	....	....	....	.ooooo..oo	o.........	
43. *Tsoloss Glacier*	51°23.5'	123°52.0'	1.1		....	x.........	....	....	....	....	.x........	....	....	..x.......	....	
44. *Elkin Glacier*	51°22.5'	123°51.0'	1.5	...	....	....	....	....	....	....	.x........	....	....	..x.......	....	
45. Tiedemann Glacier	51°19.5'	125°00.0'	63.	...	....	....	....	....	....	....	....	....	....	.ooooo..oo	o.........	
46. Franklin Glacier	51°14.5'	125°28.0'	132.	...	....	....	....	.......x..	.x..x.....	.....xxxx.	....	....	....	....	....	
47. Cumberland Glacier	51°12.0'	124°23.3'	2.8	...	....	....	....	....	....	....	....	....	....	...z......	....	
48. Miserable Glacier	51°04.2'	123°52.0'	3.3	...	....	x.........	....	....	....	....	.x........	....	.....x....	....	....	

TABLE 1.—*Summary of historical information on glaciers of western Canada (see also fig. 1)*—Continued

[x, variations; o, mass balance; *, variations and mass balance; z, other studies; s, other, some mass balance; m, other, some variations; ?, missing glacier area and location data; italicized place-names are variant names and names not listed in the CPCGN/CGNDB[3]]

COAST MOUNTAINS	Latitude North	Longitude West	km²		1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
49. Pathetic Glacier	51°03.4'	123°47.5'	0.1	...	....	x........	....	....	....	....	.x.......	....	.....x....	....	....	
50. Friendly Glacier	51°03.0'	123°51.4'	4.4	...	....	x........	....	....	....	....	.x.......	x	.....x....	..x.......	....	
51. Hourglass Glacier	51°01.6'	123°46.0'	4.2	...	....	x........	....	....	....	....	.x.......	....	.....x....	....	....	
52. Tchaikazan Glacier	51°01.2'	123°47.3'	21.4	...	....	x........	....	....	....	....	.x.......	........x.	.....xx...	..x.......	....	
53. *Sykora Glacier*	50°52.7'	123°33.8'	25.	...	....	....	....	....	....	....	....	....	00000	000000....	....	
54. Bridge Glacier	50°49.4'	123°33.0'	83.5	...	....	....	....	....	....	....	....	....	00000	000000....	....	
55. *Zavisha Glacier*	50°48.4'	123°25.3'	6.5	...	....	....	....	....	....	....	....	....	00000	000000....	....	
56. Berm Glacier	50°33.0'	123°59.0'	1.1	...	....	....	....	....	....	.......xx.	.x.......	....	x......x.x	....	....	
57. Havoc Glacier	50°30.3'	123°52.3'	9.5	...	...x......	....	....	....	....	.......x..	.x.......	....x.....	x......x.x	....	....	
58. Wave Glacier	50°30.0'	123°59.0'	4.4	...	....	....	....	....	....	.......xx.	.x.......	....x.....	x......x.x	....	....	
59. Surf Glacier	50°29.7'	123°58.1'	1.0	...	...x......	....	....	....	....	.......x..	x........	....x.....	x......x.x	....	....	
60. Terrific Glacier	50°26.4'	123°57.8'	4.6	...	....	....	....	....	....	.......x..	.x.......	....x.....	x......x.x	....	....	
61. Clendenning Glacier	50°25.2'	123°54.1'	26.5	...	...x......	....	....	....	....	.......x..	.x.......	....x.....	x......x.x	....	....	
62. Place Glacier	50°25.3'	122°36.0'	3.8	...	....	....	....	....	....	....	....	00000	0000000000	0000000000	0000000000	
63. Wedgemount Glacier	50°09.2'	122°47.8'	2.6	...	....	x........	....	x........	....	.......x.x	.x.......	....x....x	..xx.xzxxx	x* *xxx....	x...xx....	
64. *Caltha Lake Glacier*	50°08.7'	122°17.0'	0.1	...	....	....	....	....	....	....	.x.......	x	....	x..x.x....	....	
65. Boomerang Glacier	50°07.2'	123°15.8'	4.0	...	....	....	....	....	....	....	....	....	..z.......	....	....	
66. *Brandy Bowl Glacier*	50°07.1'	123°14.7'	1.5	...	....	....	....	....	....	....	....	....	..z.......	....	....	
67. Horstman Glacier	50°05.8'	122°53.0'		...	....	....	....	....	....	....	....	....	....	....	....	
68. Overlord Glacier	50°01.2'	122°50.0'	2.6	...	....	x........	....	........x.	....	....	.x.......	....	..x.......	....	x.xx.x....	
69. Helm Glacier	49°57.8'	123°00.0'	3.1	...	....	....	..x.......	........x.	.....xxx..	xxxxx	x.x.x.x.x.	x.........	00000	0000000000	000000....	
70. Sphinx Glacier	49°55.0'	122°57.5'	4.7	...	....	....	.x........	....	.....xxx..	xxxxx	x.x.x.x.x.	x...x.x.x.	x.x...0000	000.......	....	
71. Sentinel Glacier	49°53.6'	122°58.9'	1.8	...	....	....	....	....	.....xxx..	xxxxx	x.x.x.x.x.	x...x0*0*0	*0*0000000	0000000000	....	
72. Thunderclap Glacier	45°51.0'	122°39.0'	2.7	...	....	....	....	....	.x........	....	.xx.......	......x..x	..x....x..	....	....	
73. Griffin Glacier	49°51.0'	122°38.0'	2.1	...	....	....	....	....	.x........	....	.xx.......	......x..x	..x....xx.	....	....	
74. Staircase Glacier	49°51.0'	122°37.0'	1.6	...	....	....	....	....	.x........	....	.xx.......	......x..x	..x....xx.	....	....	
75. Gl. de Fleur des Neiges	49°51.0'	122°36.0'	0.4	...	....	....	....	....	.x........	....	.xx.......	......x..x	..x....xx.	....	....	
76. Moving Glacier	49°33.0'	125°23.2'	1.2	...	....	....	....	....	.x........	....	....	..x.......	....	.x........	....	
INTERIOR RANGES	Latitude North	Longitude West	km²		1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
77. Silvertip Glacier	51°42.2'	117°54.2'	3.5	...	....	....	x.x.......	....	....	x	.x...x....	......x...	.....x.x..	....	....	
78. Haworth Glacier	51°41.6'	117°54.3'	4.1	...	....	....	x.x.......	....	....	x	.x...x....	......x...	.....x.x..	....	....	
79. Sir Sandford Glacier	51°40.3'	117°54.0'	10.4	...	....	....	x.x.......	....	....	x	.x...x....	.x....x...	.....x.x..	....	....	
80. Illecillewaet Glacier	51°14.2'	117°26.5'	6.4	xx.	x.......xx	xxxxxxxxxx	xxx......	....	.x........	xxxxx	x.x.x.x.x.	x.........	....	....	....	
81. Asulkan Glacier	51°12.4'	117°27.3'	1.2	...	xx	xx.xxxxx.x	xxx.......	....	.x........	....	....	....	....	....	....	
82. Woolsey Glacier	51°07.5'	118°02.5'	3.9	...	....	....	....	....	....	....	....	00000	000000....	....	....	
83. Bugaboo Glacier	50°43.8'	116°46.5'	5.	...	....	....	....	....	....	....	....	....x.x.x.	x.x.x.....	....	....	
84. Commander Glacier	50°25.7'	116°32.5'	6.0	...	....	....	....	x.........	....	....	....x.....	x.........	....	....	....	
85. Toby Glacier	50°13.7'	116°32.0'	8.	...	....	....	.....x....	.x..x...xx	....	....	....	....	....	....	....	
86. Kokanee Glacier	49°45.0'	117°08.5'	3.1	...	....	....	....	...x......	....	xxxxx	x.x.x.x.x.	x...x.x.x.	x.x.......	....	....	
ROCKY MOUNTAINS	Latitude North	Longitude West	km²		1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
87. Robson Glacier	53°08.5'	119°06.0'	13.		....	........x.	.x.x......	..x.......	.x........	....	...x......	....	....	....	....	
88. *Small River Glacier*	53°06.0'	119°17.0'	5.8		....	....	....	....	....	....	....	....	....	....	...z.z....	
89. Angel Glacier	52°41.0'	118°04.0'	0.9		....	....	....	....	....	.....xx...	z.........	....	....	....	....	
90. Scott Glacier	52°26.0'	118°05.0'	16.		....	....	....	....x.....	....	....	...x......	....	....	....	....	
91. *East Chaba Glacier*	52°12.5'	117°40.8'	1.7		....	....	....	.......x..	......x...	....	....	......x...	x.........	....	....	
92. Saskatachewan Glacier	52°12.5'	117°08.2'	30.	(1824–62)		....	..x.......	.....x....	....	xxxxx	x.xxx.x.x.	x.xxxxxxxx	xxxxxxxxxx	....	.mmmmmmmm.	
93. Athabasca Glacier	52°11.7'	117°15.0'	15.	(1843–44)		....	....	..x.......	....	xxxxx	x.xxx.x.xm	mmmmxzmmmm	xxxxxxxxxx	.x..xx....	.mmmmmmmm.	
94. Columbia Icefield	52°10.0'	117°20.0'	285.		....	....	....	....	....	....	....	....	........z	zz........	....	
95. Columbia Glacier	52°09.5'	117°23.0'	16.	(1698–1739)		....	x	....x.....	....	........x.	...x......	......x...	x.x.......	....	....	

TABLE 1.—*Summary of historical information on glaciers of western Canada (see also fig. 1)*—Continued

[x, variations; o, mass balance; *, variations and mass balance; z, other studies; s, other, some mass balance; m, other, some variations; ?, missing glacier area and location data; italicized place-names are variant names and names not listed in the CPCGN/CGNDB[3]]

ROCKY MOUNTAINS	Latitude North	Longitude West	km²	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
96. *Boundary Glacier*	52°11.5'	117°11.4'	1.5	....	...x......	....	....	....	........x.	......x...	......x...	x.x.......	...xxx....	x	
97. Dome Glacier	52°12.1'	117°18.1'	5.92	(1846).	....	....	....	....	....	...x......	....	.......m..	.x..xx..zz	zxzzzzzzz.	
98. *Hilda Glacier*	52°11.0'	117°10.0'	1.35	....	....	....	....	....	....	....	....	.......z.	....	.......z.	
99. *Cline Glacier*	52°05.0'	116°41.0'	?	....	....	....	....	....	....	....	....	....	.......zzz	zz.......	
100. Southeast Lyell Glacier	51°54.5'	117°01.6'	16.	(1858)...	....	x	......x...	x........	....	...x......	....	.......m..	.x..xx..zz	zxzzzzzzz.	
101. Ram River Glacier	51°51.0'	116°11.5'	1.8	....	....	....	....	....	....	....	.....ooooo	oooooo....	....	....	
102. Freshfield Glacier	51°45.8'	116°54.2'	40.	....	..x.......	....	..x...x...	x...x..x..	xxx	x.x.x.....	....	....	....	....	
103. Peyto Glacier	51°40.6'	116°32.8'	13.	.......x..	....	....	....	...x..x..x	..x..xxxxx	x.x.x.x.x.	x.x.o*oooo	ooooooooos	oosossoooo	..ooooooo.	
104. Bow Glacier	51°38.9'	116°30.4'	5.1	.......x..	....	....	..x.......	...x......	.....x....	..xx......	......x...	....	....	.......zzz	
105. Yoho Glacier	51°36.0'	116°32.5'	23.	.......x..	.x.xxxxxxx	x.xxx.xxxx	....	.x.x......	....	....	....	....	....	....	
106. Hector Glacier	51°35.7'	116°15.5'	2.5	....	....x.....	....	....	........x.	....	..x.......	.....x....	....	....	....	
107. Drummond Glacier	51°35.5'	116°02.0'	1.3	....	......x...	....	x........	x........x	....	..x.......	..****xx..	....	....	....	
108. Emerald Glacier	51°30.0'	116°32.0'	1.9	....	....	....	....	....	....	....	....	xx	xxx.......	....	
109. *Cathedral Glacier*	51°24.3'	116°23.4'	0.9	....	....	....	....	....	....	....	....	........zx	..z.z.....	....	
110. Victoria Glacier	51°22.8'	116°17.2'	3.5	.......xx.	...x...x.x	x.x.......	....	.x........	xxxxx	x.x.......	......x...	......x...	....	....	
111. Wenkchemna Glacier	51°18.7'	116°14.2'	4.3	....	xxx.x.....	....	....	....	....	...x......	.....z.z.z	.......z.z	....	....	
112. *Robertson Glacier*	50°44.0'	115°20.0'	0.8	....	....	....	....	....	....	....	....	....	....	.....zz...	
113. *Rae Glacier*	50°37.4'	114°59.1'	?	....	....	....	....	....	....	....	....	....	....	...z......	

TABLE 2.—*Summary of historical information on glaciers of arctic and eastern Canada (see also fig. 2)*

[x, variations; o, mass balance; *, variations and mass balance; z, other studies; s, other, some mass balance; m, other, some variations; ?, missing glacier area data; italicized place-names are variant names and names not listed in the CPCGN/CGNDB[3]]

HIGH ARCTIC	Latitude North	Longitude West	km²	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
120. Ward Hunt Ice Shelf (Elles)	83°07.2'	73°30.3'	660.	....	....	....	....	....	....	...zz....z	ozzzzooooo	ooooooo...	oooooo....	....	
121. *Ward Hunt Ice Rise* (Elles)	83°07.0'	74°10.0'	32.	....	....	....	....	....	....	........oo	oooooooooo	ooooooo...	oooooo....	....	
122. Milne Glacier (Elles)	82°24.0'	80°00.0'	900.	....	....	....	....	....	....	x	......x...	....	...x......	....	
123. Gilman Glacier (Elles)	82°05.8'	70°36.9'	480.	....	....	....	....	....	....	.......ooo	oooooooooo	....	..o.......	....	
124. *Muskox Glacier* (Elles)	82°05.0'	86°10.0'	?	....	....	....	....	....	....	....	....	....	......z...	....	
125. *Unnamed Ice Cap* (Elles)	81°57.3'	64°12.0'	7.5	....	....	....	....	....	....	....	......oo..	ooooooo...	....	....	
126. Per Ardua Glacier (Elles)	81°31.0'	76°27.0'	4.3	....	....	....	....	....	....	....	....oooooo	oo........	....	....	
127. Otto Glacier (Elles)	81°20.0'	84°15.0'	1018.	....	....	....	....	....	....	....	...x..z...	....	....	....	
128. Hare Fiord Glacier (Elles)	81°08.5'	82°20.0'	?	....	....	....	....	....	....	........x.	....	........x.	....	....	
129. Webber Glacier (Elles)	80°55.0'	82°10.0'	123.	....	....	....	....	....	....	....	....	........z.	....	....	
130. Gnome Glacier (Elles)	80°54.5'	82°23.5'	3.1	....	....	....	....	....	....	....	....	........x.	....	....	
131. Dwarf Glacier (Elles)	80°54.0'	82°30.3'	4.3	....	....	....	....	....	....	....	....	........x.	....	....	
132. Midget Glacier (Elles)	80°53.7'	82°37.3'	3.0	....	....	....	....	....	....	....	....	........x.	....	....	
133. Arklio Glacier (Elles)	80°53.6'	82°44.0'	7.2	....	....	....	....	....	....	....	....	........x.	....	....	
134. Okpuddyshao Glacier (Elles)	80°53.1'	82°50.9'	5.6	....	....	....	....	....	....	....	....	........x.	....	....	
135. Nukapingwa Glacier (Elles)	80°52.9'	82°58.1'	4.8	....	....	....	....	....	....	....	....	........x.	....	....	
136. Van Royen Glacier (Elles)	80°53.2'	83°10.5'	111.	....	....	....	....	....	....	....	....	........x.	....	....z.....	
137. *Shirley Glacier* (Elles)	80°50.0'	83°25.0'	?	....	....	....	....	....	....	....	....	....	....	....z.....	
138. *Blackwelder Ice Cap* (Elles)	80°38.0'	85°00.0'	117.	....	....	....	....	....	....	....	....	....	....	....z.....	
139. Agassiz Ice Cap (Elles)	80°25.0'	75°00.0'	17326.	....	....	....	....	....	....	....	....	......ssss	ssssssssss	sssssssss.	

TABLE 2.—*Summary of historical information on glaciers of arctic and eastern Canada (see also fig. 2)*—Continued

[x, variations; o, mass balance; *, variations and mass balance; z, other studies; s, other, some mass balance; m, other, some variations; ?, missing glacier area data; italicized place-names are variant names and names not listed in the CPCGN/CGNDB[3]]

HIGH ARCTIC	Latitude North	Longitude West	km²	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
140. d'Iberville Glacier (Elles)	80°25.6'	77°33.0'	1609.	....	....	....	....	....	....	....	....	...ZZ.....	....	....	
141. John Evans Glacier (Elles)	79°38.5'	74°30.0'	220.	....	....	....	....	....	....	....	....	....	....	....OSSSS.	
142. *Quviagivaa Glacier* (Elles)	79°34.0'	83°15.0'	?	....	....	....	....	....	....	....	....	....	....	.000......	
143. Leffert Glacier (Elles)	78°41.3'	75°01.4'	593.	....	....	....	....	....	....	....	....	0	0.........	....	
144. *Unnamed Glacier* (Elles)	78°39.1'	74°55.0'	50.	....	....	....	....	....	....	....	....	0	0.........	....	
145. Prince of Wales Icefield (Elles)	78°15.0'	80°00.0'	?	....	....	....	....	....	....	....	....	..ZZZ......	....	....	
146. *Laika Glacier* (Coburg)	75°53.5'	79°05.2'	4.3	....	....	....	....	....	....	....	....	...00....0	0.........	....	
147. *Laika Ice Cap* (Coburg)	75°53.0'	79°09.1'	10.	....	....	....	....	....	....	....	....	....000..0	0.........	....	
148. *Wolf Glacier* (Coburg)	75°54.2'	79°12.2'	2.0	....	....	....	....	....	....	....	....	0	0.........	....	
149. Baby Glacier (Axel)	79°26.4'	90°58.0'	0.6	....	....	....	....	....	....	0	0000000000	0000000000	000......0	00........	
150. Crusoe Glacier (Axel)	79°25.7'	91°10.0'	44.	....	....	....	....	....	....	X	XXXXXXXXXXX	XXXXXXXXXX	XXX.......	....	
151. Müller Ice Cap (Axel)	79°54.0'	90°59.0'	6300.	....	....	....	....	....	....	.........Z	ZZZZ......	......0...	....	....	
152. Thompson Glacier (Axel)	79°28.0'	90°30.0'	230.	....	....	....	....	....	....	X	XXXXXXXXXX	XXXXXXXXXX	XXX.......	Z.........	
153. White Glacier (Axel)	79°26.7'	90°40.0'	39.	....	....	....	....	....	....	0	0000000000	0000000000	0000000000	000000000.	
154. *Good Friday Bay Glacier* (Axel)	78°37.0'	91°10.0	641.	....	....	....	....	....	....	..X......X	....	....	....	....	
155. Meighen Ice Cap (Meighen)	79°57.2'	99°08.0'	90.	....	....	....	....	....	....	0	00000SSS00	00.0000000	.000000000	0....0....	
156. *South Ice Cap* (Melville)	75°25.4'	115°01.1	66	....	....	....	....	....	....	....	...0000.00	00.00.....	.00.......	.00000....	
157. *West Ice Cap* (Melville)	75°37.8'	114°45.0'	36.4	....	....	....	....	....	....	....	...0000.00	00.0......	....	.00000....	
158. *East Ice Cap* (Melville)	75°39.3'	114°28.6'	16.0	....	....	....	....	....	....	....	...0000.00	00.0......	....	.00000....	
159. Leopold Glacier (Melville)	75°49.0'	114°45.0'	27.7	....	....	....	....	....	....	....	...0000.00	00.0......	....	.00000....	
160. Devon Ice Cap (Devon)	75°20.0'	82°30.0'	12825.	....	....	....	....	....	....	....	.000000000	SSSSSOS000	0000000000	000000....	
161. Sverdrup Glacier (Devon)	75°40.6'	83°15.5'	672.	....	....	....	....	....	....	....	.000......	....	....	....	
LOW ARCTIC	Latitude North	Longitude West	km²	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
162. Aktineq Glacier (Bylot)	72°54.9'	78°51.8'		....	....	....	....	....	....	....	....	....	....	....	
163. Lewis Glacier (Baffin)	70°25.9'	74°46.0'	182.	....	....	....	....	....	....	....	..Z000....	....	....	....	
164. Barnes Ice Cap (Baffin)	70°10.0'	73°30.0'	6200.	....	....	....	....	....	....	S.........	..Z0000000	SSSSSSSSSS	SSSSS....Z	ZZZZZZ.Z..	
165. Decade Glacier (Baffin)	69°38.2'	69°49.5'	8.7	....	....	....	....	....	....	....	00000	00.0......	....	....	
166. *Akudnirmuit Glacier* (Baffin)	67°34.6'	65°14.5'	0.6	....	....	....	....	....	....	....	....	.00.......	....	....	
167. *Boas Glacier* (Baffin)	67°34.1'	65°15.6'	1.4	....	....	....	....	....	....	....	0	000000....	....	....	
168. Penny Ice Cap (Baffin)	67°10.0'	66°13.0'	6000.	....	....	....	....	....	....	...Z......	..Z.ZZ...Z	....	.........Z	ZZZZZZ....	
169. Turner Glacier (Baffin)	66°41.2'	65°14.1'	26.2	....	....	....	....	....	....	...Z......	....	....	....	....	
170. Virginia Glacier (Baffin)	66°36.5'	62°18.5'		....	....	....	....	....	....	....	....	....	....	....	
171. Grinnell Glacier (Baffin)	62°32.4	66°51.4'	126.	....	....	....	....	....	....	..X.......	.....X....	....	.Z........	....	
LABRADOR	Latitude North	Longitude West	km²	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
172. *Bryant's Glacier*	59°19.0	63°55.7	1.3	....	........X.	....	....	.X........	....	....	....	....	....	....	
173. Superguksoak Glacier	58°57.0	63°47.0	1.8	....	....	....	....	....	....	....	....	....	.0000.....	....	
174. Abraham Glacier	58°56.2	63°31.9	0.8	....	....	....	....	....	....	....	....	....	.****.....	....	
175. Hidden Glacier	58°55.7	63°32.7	0.7	....	....	....	....	....	....	....	....	....	.0000.....	....	
176. Minaret Glacier	58°53.1	63°41.2	0.9	....	....	....	....	....	....	....	....	....	.0000.....	....	

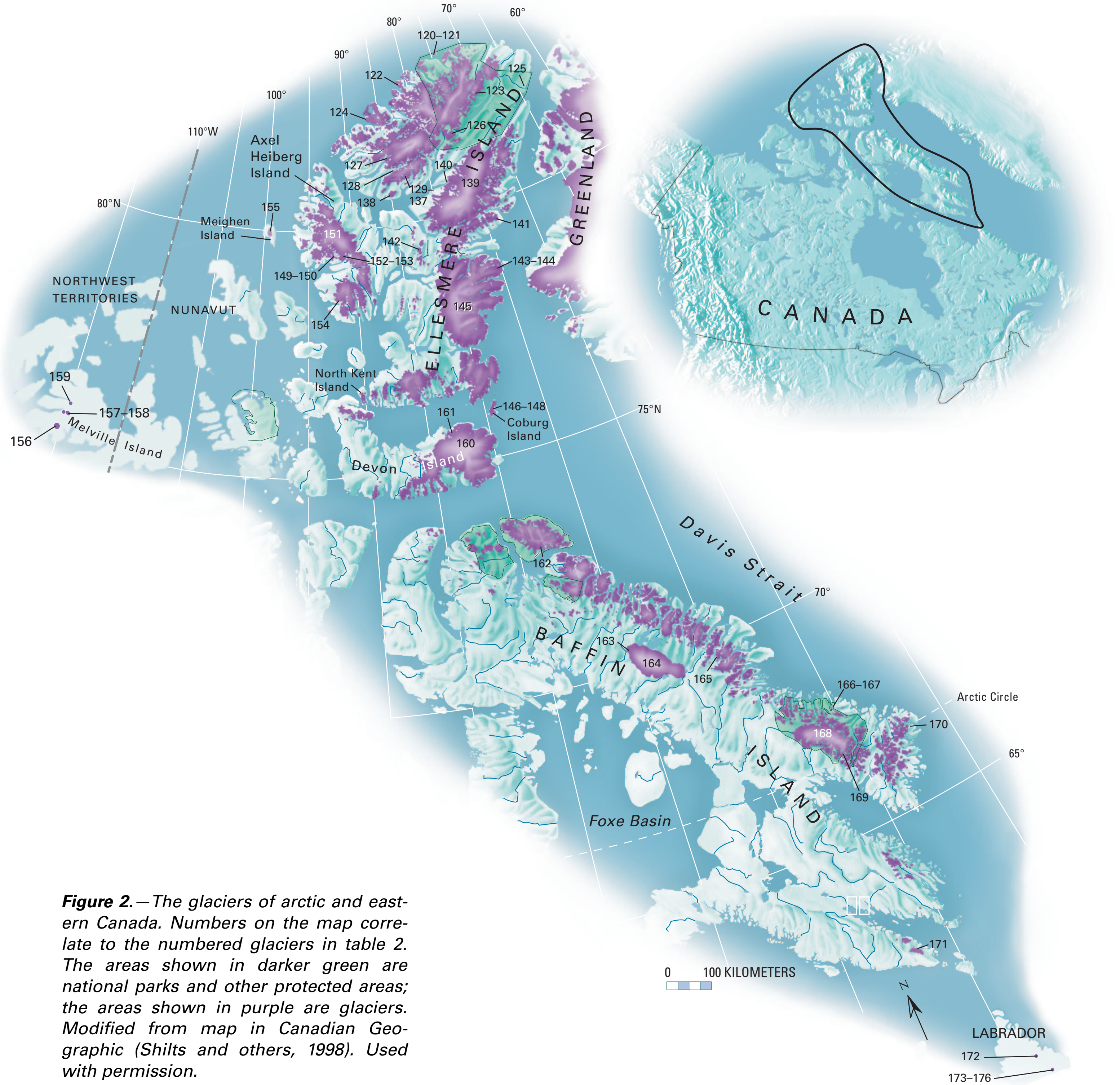

Figure 2.—The glaciers of arctic and eastern Canada. Numbers on the map correlate to the numbered glaciers in table 2. The areas shown in darker green are national parks and other protected areas; the areas shown in purple are glaciers. Modified from map in Canadian Geographic (Shilts and others, 1998). Used with permission.

TABLE 3.—*The Glacierized Areas of Canada (km²) (Ommanney, 1971a)*

ARCTIC ISLANDS	
Ellesmere Island	80,000
ice shelves	500
Axel Heiberg Island	11,735
Devon Island	16,200
Coburg Island	225
Meighen Island	85
Melville Island	160
North Kent Island	152
Baffin Island	37,000
Bylot Island	5,000
Subtotal	151,057
MAINLAND	
Pacific drainage	37,659
Nelson River drainage	328
Great Slave Lake drainage	626
Yukon River drainage	10,564
Arctic Ocean drainage	840
Labrador	24
Subtotal	50,041
Total Glacierized Area	201,098

Observation of Glaciers

Historic (Prior to World War II)

Penetration of the western mountains by the Canadian voyageurs, by European traders, and by settlers took place only comparatively recently. Although some aboriginal legends refer to glaciers (Morey, 1971), the earliest recorded description of a Canadian glacier was probably that made by James Hector (1861), a geologist on the Palliser Expedition who visited Southeast Lyell Glacier [100] in 1858. Another early observation of note was that of the Great Glacier [27] by W.P. Blake (1867), a member of a scientific party on a Russian naval squadron ship, in 1863. Developments since then have largely been linked to technological innovations or to the stimulation provided by international initiatives.

One major influence on the settlement of southern Canada, and an element that is deeply etched in the Canadian psyche, has been the railroad. The crossing of the cordillera by the Canadian Pacific Railroad (CPR) was the first technological development that impacted the study of glaciers. The opening up of the west by the CPR and the linking of British Columbia with the rest of Canada gave everyone access to the Rocky Mountains and *Interior Ranges* (fig. 3), creating an opportunity for the first systematic glacier observations. New facilities such as Chateau Lake Louise and Glacier House provided bases from which the early amateur and professional scientists could work. Guides, imported from Switzerland, were made available to those wishing to climb or do glacier research. It was the CPR, responding to pressure from A.O. Wheeler, a prominent Canadian surveyor, and his

***Figure 3.**—Oblique aerial photograph of the Columbia Mountains,* Interior Ranges*, British Columbia, Canada, in late summer of 1970, showing the rugged topography and several mountain glaciers. Photograph by C. Simon L. Ommanney, National Hydrology Research Institute. [NTS Map: 082L16]*

influential friends, that provided the free passes that enabled the founders of the Alpine Club of Canada (ACC) to meet and establish that organization.

Glacier House was built by the CPR at Rogers Pass, in what is now Glacier National Park, because the grade was too steep to permit the inclusion of a restaurant car on the train. Passengers were required to disembark, and many took the opportunity of this enforced stop to take the trail to the Illecillewaet Glacier (or "Great Glacier") [80]. It is hardly surprising then that this, and the neighbouring Asulkan Glacier [81], became the object of the first investigations. Although the earliest observations in Glacier National Park were made by the Rev. Spotswood Green (1890), the subsequent systematic studies were made mainly by members of the Vaux family of Philadelphia (Vaux, G., Jr., and Vaux, W.S., Jr., 1900a, b, 1901, 1908; Vaux, W.S., Jr., 1907, 1909; Vaux, G., 1910; Vaux, M.M., 1911, 1913) (fig. 4). Their activities and contributions were reviewed by Edward Cavell (1983). Other studies of note in this area were those by A.O. Wheeler (1905, 1920; Wheeler and Parker, 1912) and Howard Palmer (1914). In the 1970's, the Canadian Exploration Group visited Palmer's field area and resurveyed the Silvertip, Haworth, and Sir Sandford Glaciers [77–79] (Marsh, 1976, 1978).

The Victoria Glacier [110], visible and easily accessible from Chateau Lake Louise, also received early attention. Studies here and on the Wenkchemna [111] and Yoho [105] Glaciers were conducted by W.H. Sherzer of the Smithsonian Institution (Sherzer, 1907, 1908; Gardner, 1977, 1978). The Yoho Glacier was also included in the set of observations undertaken by the Vaux family (Vaux, G., Jr., and Vaux, W.S., Jr., 1907a, b, 1908; Vaux, G., 1910; Vaux, M.M., 1911, 1913; Vaux, M.M., and Vaux, G., Jr., 1911). These studies were extended by A.O. Wheeler and members of the ACC who held a number of field camps near this glacier (Wheeler, 1911, 1913, 1932, 1934).

Table 1 summarizes the available information on glacier observations during this period. The early records for the Illecillewaet [80], Asulkan [81], and Yoho [105] Glaciers are evident, as is the comparative lack of similar studies in the Coast Mountains. Some of the apparent observations there [36–40, 43, 48–52, 57, 59, 61, 63, 68] reflect modern reconstructions of glacier snout positions using air-photo interpretation and dendrochronological techniques rather than field observations at the dates indicated.

The First World War caused a hiatus in the recording of glacier variations that continued until after the Second World War. However, a few observations were made in the interwar years by members of the ACC (Palmer, 1924; Munday, 1931; McCoubrey, 1938; Thorington, 1938), and snout positions for many other glaciers have been reconstructed.

An interesting development at this time was the 1931 aerial survey of glaciers in Labrador, completed under the auspices of the American Geographical Society (AGS) by Forbes and others (1938). Some ground observations of *Bryant's Glacier* [172][3] were made by Odell (1933), who compared the snout position with that recorded by Bryant and Forbes in 1908.

Compared to many more highly populated mountain areas, such as the Alps, the early record of Canadian glacier variations is fairly sparse. However, at least for the three glaciers discussed above (the Illecillewaet, Asulkan, and Yoho Glaciers), we do have fairly complete records of their retreat during an extended period of glacier recession.

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[3] The names in this section conform to the usage authorized by the Secretariat of the Canadian Permanent Committee on Geographic Names (CPCGN); URL address: [http://GeoNames.NRCan.gc.ca/]. The website is maintained by the Secretariat through Geomatics Canada, Natural Resources Canada, and combines the CPCGN server with the Canadian Geographical Names Data Base (CGNDB). Variant names and names not listed in the CPCGN/CGNDB are shown in italics.

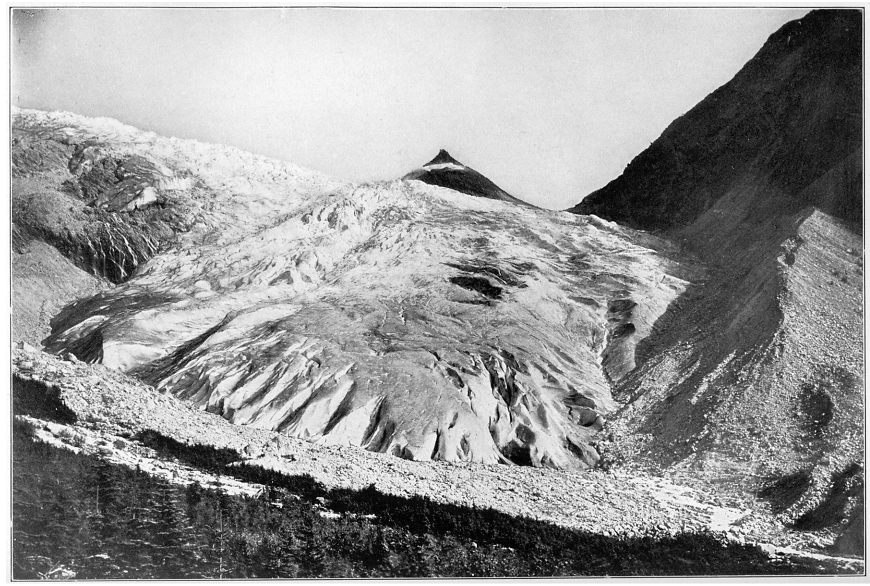


***Figure 4.**—Photograph of the Illecillewaet Glacier ("Great Glacier"),* Interior Ranges, *British Columbia, taken 19 August 1898. The successful crossing of the western mountains by the Canadian Pacific Railroad in the late 1880's gave access to the Rocky Mountains and* Interior Ranges *and made systematic glacier observations possible. The Vaux family was among the earliest to take an interest in the glaciers. According to George, Jr., and W.S. Vaux, Jr., the Illecillewaet Glacier was the most accessible and one of the most remarkable in the area. It was notable for the lack of debris at its foot and the rapidity of the ice fall. They concluded that photography offered the most satisfactory means of permanently recording the position of the ice from year to year. Photograph is a reproduction of Plate 5 from Vaux and Vaux (1900b). (Glacier 80 in table 1; see also section in this volume by Wheate and others on Mapping Glaciers in the* Interior Ranges *and Rocky Mountains with Landsat Data.)*

1945 to the Middle 1950's

The immediate postwar period saw a significant increase in the number of glacier studies. This was largely due to the commencement of an annual survey of specific glaciers in the cordillera. The survey was initiated by the Dominion Water and Power Bureau (DWPB), forerunner of the Water Survey of Canada (WSC), as part of its studies of the water resources of mountain rivers. In 1945, seven glaciers in Alberta—Angel [89], Athabasca [93], Freshfield [102], Peyto [103], Saskatchewan [92], Southeast Lyell [100], and Victoria [110] Glaciers—were investigated by the DWPB Calgary office. Eight glaciers in British Columbia were observed by the DWPB Vancouver office—Bugaboo [83], Franklin [46], Helm [69], Illecillewaet [80], Kokanee [86] (fig. 5), Nadahini [15] (fig. 6), Sentinel [71], and Sphinx [70] (fig. 7) Glaciers. The position of the glacier termini and changes in their areal extent were measured, and a set of plaques were placed on the ice surface to determine velocity. Some surveys were abandoned after a few years, but table 1 shows that many continued every year until 1950, when they became biennial. Detailed reports were prepared by the DWPB as internal documents, but some results were published (Lang, 1943; McFarlane, 1946; Meek, 1948a, b; Webb, 1948; McFarlane and others, 1950; Collier, 1958; Strilaeff, 1961). Summaries of the reports for Peyto Glacier and the Victoria Glacier have been published by Ommanney (1971b, 1972b).

During this period, photographs of many cordilleran glaciers appeared in mountaineering journals, and some specific photographic recording of glaciers was carried out (Field, 1949). Following on the WSC initiatives, the next significant development was by the American Geographical Society (AGS), which established the Juneau Icefield Research Project in 1948 in conjunction with the U.S. Office of Naval Research (ONR). This project concentrated on glaciers in Alaska but laid the groundwork for the subsequent Summer Institute of Glaciological and Arctic Sciences that, from its subsidiary base in Atlin, B.C., has contributed to our knowledge of Canadian glaciers in the area, particularly the Cathedral Glacier [18] (Field and Miller, 1950; Eagan, 1963; Miller, 1963; Marcus, 1964; Miller and Anderson, 1974). Another AGS expedition visited a number of glaciers in the Rockies in 1953. Glacier surface areas and variations for the Robson [87], Columbia [95], Southeast Lyell [100], Peyto [103], Freshfield [102], Athabasca [93], and Saskatchewan [92] Glaciers were documented using photographic and botanical techniques (Field and Heusser, 1954; Heusser, 1954, 1956, 1960). In the Yukon Territory, the Arctic Institute of North America (AINA)

Figure 5.—Photograph of the terminus of the Kokanee Glacier, Interior Ranges, *British Columbia, Canada, showing the transient snowline in September 1972. Photograph by I.A. Reid, Water Survey of Canada. (Glacier 86 in table 1) [NTS Map: 082F11]*

Figure 6.—Photograph of Nadahini Glacier in August 1974 at Photo Station No. 5, Coast Mountains, British Columbia. Studies of the glacier terminus and changes in its areal extent were begun in 1945 by the Dominion Water and Power Bureau, forerunner of the Water Survey of Canada. Studies continued in the 1960's and 1970's. Photograph by I.A. Reid, Water Survey of Canada. (Glacier 15 in table 1)

Figure 7.—Photograph of the terminus of Sphinx Glacier, Coast Mountains, British Columbia, Canada, in September 1968. Photograph by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 70 in table 1) [NTS Map: 092G15]

sponsored Project Snow Cornice. This airborne expedition established a semipermanent research station on Seward Glacier [11] (Wood, 1948, 1949; Baird and Salt, 1949; Sharp, 1950).

Advances in transportation technology made a significant impact on postwar field research in Canada. Previously inaccessible areas were opened up to scientists. Thus Baird, through the Arctic Institute of North America, was able to mount major expeditions on Baffin Island to study the Barnes Ice Cap [164] in 1950 (Baird and others, 1950; Baird, 1952a) and the Penny Ice Cap [168] in 1953 (Baird and others, 1953). These expeditions provided the first substantial information on glaciers in this region (Orvig, 1951, 1953, 1954; Baird, 1952b; Baird and others, 1953; Ward and Orvig, 1953; Ward, 1954, 1955; Ward and Baird, 1954). Other scientists also found it easier to work independently in such areas—for example, Mercer's (1956) study of Grinnell Glacier [171].

Meanwhile, in the High Arctic, a group sponsored by the United States government was attempting to understand the nature and origin of ice islands, such as Fletcher's Ice Island or T–3, by studies on Ward Hunt Ice Shelf [120] in 1953 and 1954 (Crary, 1956).

Mention was made earlier of the influence of international programs on Canadian glaciological studies. Although the International Geophysical Year (IGY) (1957–59) did not focus any particular emphasis on such studies, it did prompt some organizations to undertake new programs or to extend existing ones. Canadian participation in the IGY led to a University of Toronto Expedition (1956–57) to study Salmon Glacier [33] (Adkins, 1958, 1959; Jacobs, 1958; Haumann, 1960; Russell and others, 1960; Doell, 1963). On Ellesmere Island, the Defence Research Board (DRB) started a program on Gilman Glacier [123] and continued studies on the Ward Hunt Ice Shelf (Hattersley-Smith, 1954, 1959, 1961; Hattersley-Smith and others, 1961; Weber, 1961; Weber and others, 1961; Lister, 1962; Lyons and Ragle, 1962; Ragle and others, 1964; Lyons and others, 1972).

Middle 1950's to the Middle 1960's

In the period immediately following the IGY, concern in Canadian government circles about security and sovereignty in the Arctic, and a lack of knowledge about that region, translated into funding for major projects. The Geological Survey of Canada (GSC) mounted Operation Franklin to map the geology of the Queen Elizabeth Islands. A consortium of McGill University professors, in conjunction with George Jacobsen, an entrepreneur, obtained a major expedition grant from the National Research Council of Canada (NRCC) to launch the Jacobsen-McGill Arctic Research Expedition to Axel Heiberg Island under the direction of the Swiss glaciologist Fritz Müller. The Department of Mines and Technical Surveys organized Arctic logistics through the Polar Continental Shelf Project (PCSP), which was also charged with a multidisciplinary investigation of the continental shelf region, and appointed geologist Fred Roots as its first coordinator. The Arctic Institute of North America mounted an expedition to Devon Island, and the Department of National Defence continued and expanded its studies on Ellesmere Island. This Defence Research Board (DRB) expedition, led by Geoffrey Hattersley-Smith, and named Operation Hazen after the lake on which its base camp was located, later became Operation Tanquary when the camp was moved to the head of Tanquary Fiord (Hattersley-Smith, 1974). All these activities combined to raise glaciological research in Canada to a new level and helped establish Canada's reputation in the international scientific community during that period.

The McGill University expedition started with a small reconnaissance party in 1959; this was followed in 1960 and 1961 by large multidisciplinary parties working on Crusoe [150], Baby [149], White [153], and Thompson [152] Glaciers and on the Müller Ice Cap (renamed; previously Akaioa Ice Cap or informally *McGill Ice Cap*) [151] (Müller, 1961; Müller 1962a, b, 1963; Müller and others, 1963; Andrews, R.H.G., 1964; Havens, 1964; Havens and others, 1965; Redpath, 1965; Adams, 1966; Müller and Keeler, 1969) (fig. 8). A comprehensive list of publications arising out of this early work was included in a glacier inventory of Axel Heiberg Island (Ommanney, 1969).

Within the terms of reference establishing the PCSP, provision was made for the hiring of staff scientists to cover disciplines not contributed by the participating government departments. Stan Paterson joined the PCSP and started working on Meighen Ice Cap [155]. By the middle 1960's, his program on that ice cap had been expanded to include the Melville Island ice caps [156–159] and Devon Ice Cap [160], taking over in the latter case from the AINA, whose studies there were winding down.

The AINA program involved mass balance and meteorological studies on Devon Ice Cap and some detailed investigations of Sverdrup Glacier [161] (Apollonio, 1962; Keeler, 1964; Hyndman, 1965; Koerner, 1966; Vögtli, 1967; Holmgren, 1971).

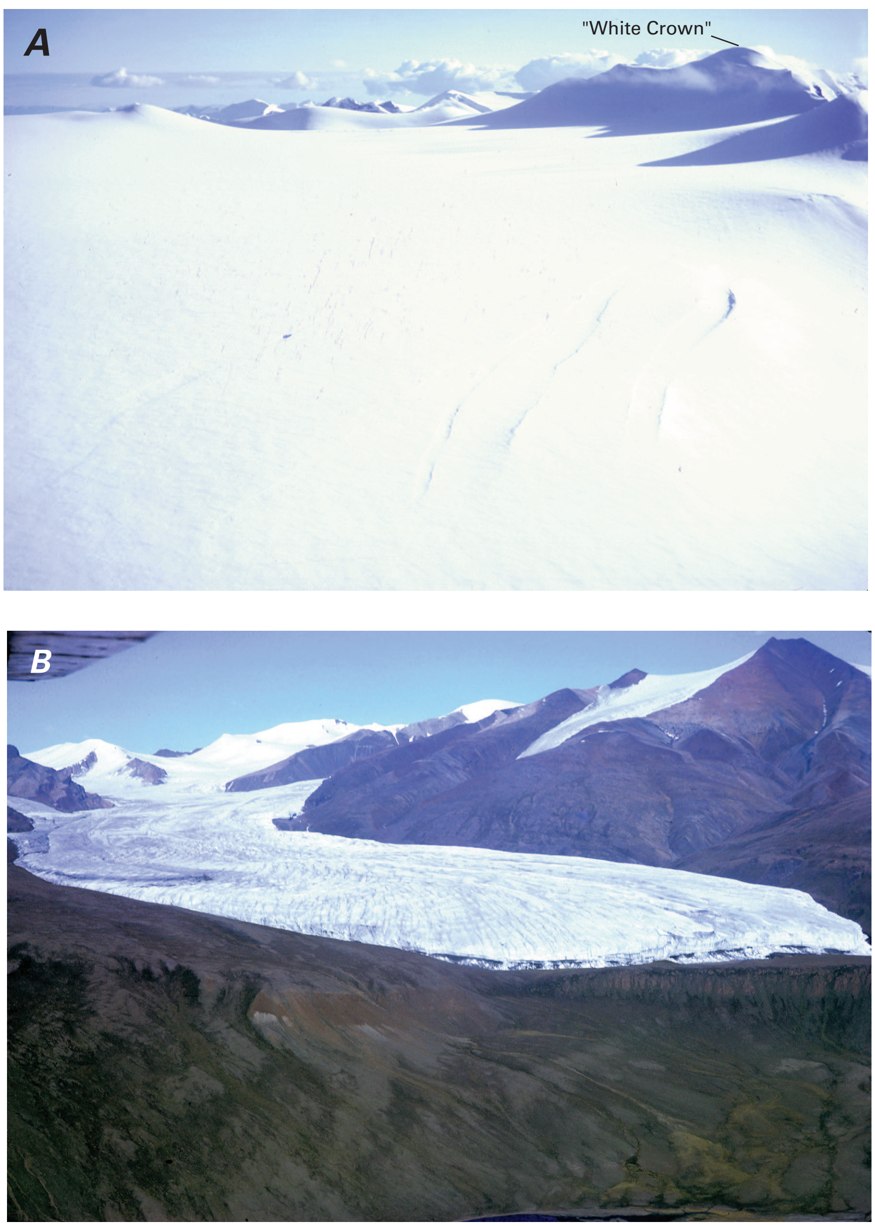


***Figure 8.**—Photographs of the Müller Ice Cap* **A**, *and Crusoe Glacier* **B**, *on Axel Heiberg Island, Nunavut, High Arctic. In 1960 and 1961, large multidisciplinary parties of the Jacobsen-McGill Arctic Research Expedition carried out a number of glaciological studies, including measurements of mass balance and glacier variation under the direction of the Swiss glaciologist Fritz Müller on Müller Ice Cap, and Crusoe, White, Baby, and Thompson Glaciers on Axel Heiberg Island. Some studies continued in following years.* **A**, *Photograph of Müller Ice Cap (Glacier 151 in table 2) and "White Crown" in 1962 by C. Simon L. Ommanney, McGill University.* **B**, *Photograph of Crusoe Glacier in August 1962, looking to the northeast. Note that the termini abuts the terminal moraine, implying a mass balance in relative equilibrium. Photograph by C. Simon L. Ommanney, McGill University. (Glacier 150 in table 2)*

Operation Hazen, on Ellesmere Island, was a large multidisciplinary investigation, similar to the one underway on neighbouring Axel Heiberg Island. The glaciological part of the program was concentrated on Gilman Glacier [123], the Ward Hunt Ice Shelf [120] and *Ward Hunt Ice Rise* [121]. It resulted in reports on glacier surveying (Faig, 1966; Konecny and Faig, 1966; Dorrer, 1971), mass balance (Hattersley-Smith, 1960a, 1961; Hattersley-Smith and others, 1961; Sagar, 1964; Hattersley-Smith and Serson, 1970; Serson, 1979), temperatures (Hattersley-Smith, 1960b; Lyons and Ragle, 1962), radio-echo sounding (Evans and Robin, 1966; Hattersley-Smith, 1969b), and a popular account of the work done (Hattersley-Smith, 1974). A comprehensive bibliography covering this and other work on Ellesmere Island was published by Ommanney (1982).

Farther south, the Geographical Branch, Department of Mines and Technical Surveys, was continuing the work begun by the Baird (AINA) expedition on Barnes Ice Cap [164]. Geomorphologists were intrigued by this remnant of the last "Ice Age" and started a major investigation to map and study evidence of Wisconsinan glaciation in the area. Included were studies of the Barnes Ice Cap itself and the small Lewis Glacier [163] at its northern margin (Ives, 1966, 1967a, b; Løken, 1966; Løken and Andrews, 1966; Sagar, 1966; Anonymous, 1967) and regional variations of glaciers in northern Baffin Island and Bylot Island (Falconer, 1962). Some additional observations were also made on Penny Ice Cap [168] (Andrieux, 1970; Weber and Andrieux, 1970).

Many of the pilots who returned or emigrated to Canada after the war brought with them skills that were invaluable in the north. Most of the expeditions described above owed much to the use of small fixed-wing aircraft equipped with low-pressure balloon tires that were able to land on unprepared ground. The successful deployment of innumerable field camps was made possible by pilots who were willing to accede to the scientists' often unreasonable demands.

There was also much activity on the mainland at this time. In 1961, the AGS, in conjunction with the AINA, established the Icefield Ranges Research Project (IRRP) (Wood, 1963; Ragle, 1964, 1973). This was similar in scope and intent to the McGill and DRB expeditions. It was centered on what is now Kluane National Park and included detailed glaciological and climatological studies (Taylor-Barge, 1969), particularly on the Kaskawulsh Glacier [9] and around Mount Logan (Holdsworth, 1965, 1969; Shimizu and Wakahama, 1965; Brecher, 1966; Clarke, 1967; MacPherson and Krouse, 1967; Dewart, 1968; Keeler, 1969; Collins, 1970; Loomis and others, 1970; Anderton, 1973; Cameron, 1976). It was an incarnation of the earlier Project Snow Cornice. Many glaciologists received their early training in the Icefield Ranges, and some, such as Garry Clarke and Gerald Holdsworth, have continued to work in the area. The results of the scientific investigations were published in four volumes by the AGS (Bushnell and Ragle, 1969, 1970, 1972; Bushnell and Marcus, 1974).

Elsewhere, in the Coast Mountains, a study in connection with a mining development was initiated on the Leduc, Frank Mackie, Berendon, and Salmon Glaciers [30–33] by Bill Mathews of the University of British Columbia (Mathews, 1964c). Of particular concern was the activity of the Berendon Glacier [32] (fig. 9) (Untersteiner and Nye, 1968; Fisher and Jones, 1971). A more detailed report on this work is included in two separate sections of this volume, Glaciers of the Coast Mountains and Glaciers of the St. Elias Mountains. Other work here has focused on the provenance of material within and on the glacier (Eyles and Rogerson, 1977a, b, c, 1978a, b; Rogerson and Eyles, 1979; Eyles and others, 1982). Research was also being carried out on a number of other glaciers in the Rocky Mountains (West and Maki, 1961), but most of this will be reviewed in the following section.

Figure 9.—*Photograph of the Berendon Glacier showing its prominent medial moraines, Coast Mountains, British Columbia, Canada, on 27 August 1974. Photograph by A.D. Stanley, National Hydrology Research Institute. (Glacier 32 in table 1) [NTS Map: 104B01]*

Middle 1960's to the 1990's

The most important next stimulus was provided by the International Hydrological Decade (IHD) program (1965–74), which led to a major expansion of glaciological investigations in Canada. The nature of some of these developments has been reviewed by various authors (Meier and Post, 1962; Løken, 1971; Ommanney, 1975; Roots, 1984; Ommanney and Young, 1988). In the Cordillera, five glaciers—Place [62], Sentinel [71], Woolsey [82], Peyto [103] and Ram River [101] Glaciers—were selected for an east-west transect, and Berendon Glacier [32] was added to provide a link in the north-south chain. The program was run by the Glacier Section of the Geographical Branch, Department of Mines and Technical Surveys, the forerunner of the Snow and Ice Division, later known as the Hydrology Division (Glaciology Subdivision) of the National Hydrology Research Institute (NHRI), Department of the Environment (Østrem, 1966b, 1973a, b; Mokievsky-Zubok, 1973a, b, 1974; Stanley, 1975; Zubok, 1975; Mokievsky-Zubok and Stanley, 1976a, b; Young and Stanley, 1976a, b; Fogarasi and Mokievsky-Zubok, 1978; Young, 1981; Mokievsky-Zubok and others, 1985). It followed a set of standardized measurements for mass balance and hydrological observations outlined in the manual by Østrem and Stanley (1966), which was subsequently revised (Østrem and Brugman, 1991) (fig. 10). Data were deposited with the World Glacier Monitoring Service (WGMS) in Zürich.

Decade Glacier on Baffin Island [165] was selected as a contribution to the north-south chain in the eastern Arctic (Østrem and others, 1967; Løken, 1972), which included the DRB studies on Per Ardua Glacier [126] and the McGill University studies on White [153] and Baby [149] Glaciers (Young, 1972). However, the effective network was much larger than the official "representative glacier basins" because existing research investigations continued or were expanded to include a larger hydrological component. Thus, in the Arctic, data continued to be collected and analyzed for the Ward Hunt Ice Shelf and *Ward Hunt Ice Rise* [120, 121] (Hattersley-Smith and Serson, 1970; Holdsworth, 1971; Williams and Hutter, 1983; Hattersley-Smith, 1985; Holdsworth, 1986b, 1987; MacAyeal and Holdsworth, 1986; Narod and others, 1988), Gilman Glacier [123], Meighen Ice Cap [155] (Arnold, 1965; Paterson, 1969; Alt, 1979), the Melville Island ice caps [156–159] (Spector, 1966; Paterson and Koerner, 1974), the Devon Ice Cap [160] (Koerner, 1970a, b, 1973, 1979, 1985, 1986; Koerner and others, 1973; Alt, 1978, 1985, 1987; Koerner and Russell, 1979) and

Figure 10.—*Photographs of the Place Glacier, Coast Mountains, British Columbia.* **A**, *Dr. Gunnar Østrem and members of the 1980 Field Glaciology Course making mass-balance measurements on Place Glacier. In 1965, as part of a major expansion of glaciological studies during the International Hydrological Decade, Place Glacier was selected to be part of an east-west transect of glaciers to be monitored in western Canada. The mass-balance measurements begun here in 1965 have continued to the present day.* **B**, *Terminus of the Place Glacier and its proglacial lake in October 1975. Photograph by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 62 in table 1) [NTS Map: 092J07]*

the Barnes Ice Cap [164] (Løken and Sagar, 1968; Parker, 1975). New studies included those on an unnamed ice cap near St. Patrick Bay [125] (Hattersley-Smith and Serson, 1973), which was continued by Bradley (Bradley and England, 1977, 1978a, b; Bradley and Serreze, 1987a, b; Serreze and Bradley, 1987) and ones on *Boas* [167] and *Akudnirmuit* [166] *Glaciers* by the University of Colorado (Andrews and Webber, 1969; Andrews and others, 1970; Andrews and Barry, 1972; Jacobs and others, 1973; Williams, 1974, 1975; Weaver, 1975).

Similarly, on the mainland, new studies began on Rusty (*Fox*) [6] (Crossley and Clarke, 1970; Clarke, 1971; Collins, S.G., 1972; Faber, 1973), Cathedral [18] (Jones, 1974; Guigné, 1975; Miller, 1975; Cialek, 1977) and Drummond [107] (Nelson and others, 1966; Brunger and others, 1967) Glaciers. Many of these did not continue throughout the IHD, and, of the representative basins, the investigations on Woolsey, Ram River, Berendon, Decade, and Per Ardua Glaciers were terminated during or at the end of the IHD, but various studies did continue on the other glaciers.

The availability of semipermanent facilities at most of these glaciers, and core staff to maintain a measurement program throughout the summer melt season, led to the development of many other complementary glaciological investigations. The case of Peyto Glacier [103] exemplifies this situation. Studies here, during and after the IHD, included the following: **mapping** (Sedgwick and Henoch, 1975; Henoch and Croizet, 1976; Young and Arnold, 1978; Glenday, 1991; Wallace, 1995), **dendrochronology** (Parker and Henoch, 1971; Reynolds, 1992), **depth sounding** (Goodman, 1970; Goodman and Terroux, 1973; Hobson and Jobin, 1975; (Holdsworth and others, in press), **instrumentation** (Young, 1976), **hydrochemistry** (Collins and Young, 1979, 1981; Binda, 1984; Collins and Power, 1985; Binda and others, 1985; Bradley, 1990), **hydrological modeling** (Derikx and Loijens, 1971; Henoch, 1971; Derikx, 1973, 1975; Loijens, 1974; Munro, 1976; Power and Young, 1979; Gottlieb, 1980; Young, 1982, 1990; Johnson and Power, 1985; Power, 1985; Johnson and David, 1987), **mass balance and techniques, including remote sensing** (Young, 1971, 1974, 1975, 1976, 1981; Pietroniro and Demuth, 1999) and **meteorology** (Goodison, 1971, 1972a, b; Föhn, 1973; Munro, 1976, 1989, 1990, 1991a, b; Munro and Davies, 1976, 1977, 1978; Young, 1978; Munro and Young, 1980, 1982; Stenning and others, 1981; Nakawo and Young, 1982; Cutler and Munro, 1996) (fig. 11). The need to place these single-site observations within the larger regional context was recognized, so a study was made on Yoho Glacier [105] (David, 1989) and the

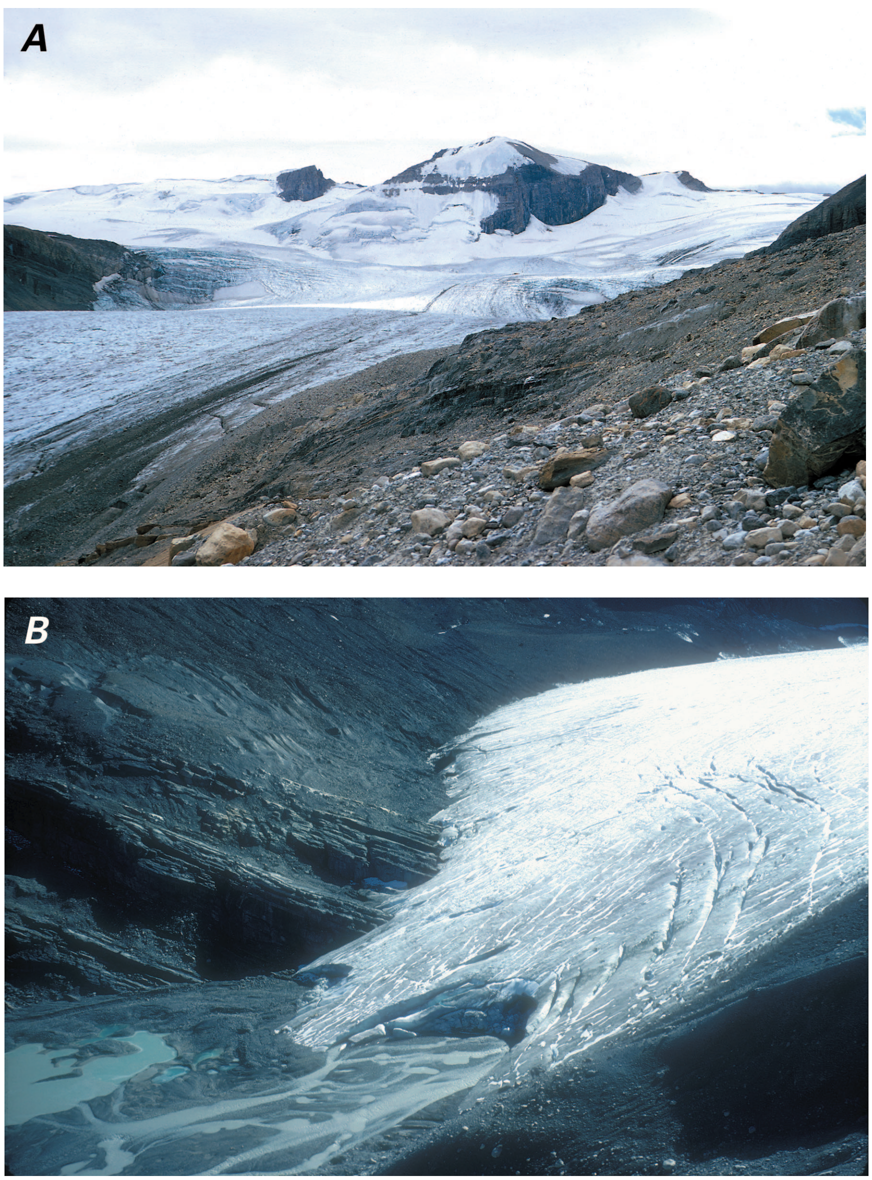


Figure 11.—**A**, *Photograph of Peyto Glacier, Rocky Mountains, Alberta, in late summer 1967. Peyto Glacier has been the site of numerous glacier studies since the early 1900's, including glacier variation, dendrochronology, hydrochemistry, meteorology, and mass-balance measurements and techniques. During the International Hydrological Decade, Peyto Glacier was one of the glaciers monitored in the east-west transect of western Canada. Mass-balance measurements begun here in 1964 are continuing. Photograph by C. Simon L. Ommanney, National Hydrology Research Institute. (Glacier 103 in table 1)* **B**, *Photograph of the terminal lobe of Peyto Glacier, Rocky Mountains, Alberta, on 25 September 1991. Photograph by Gerald Holdsworth, Arctic Institute of North America.*

Figure 12.**—Photographs of Bugaboo Glacier,* Interior Ranges*, British Columbia, Canada, in* **A, August 1970, and* **B***, July 1970. Photographs by I.A. Reid, Water Survey of Canada. (Glacier 83 in table 1) [NTS Map: 082K10]*

Yoho Valley on the other side of the Continental Divide, as well as the intervening Waputik Icefield from which both glaciers flow.

Although the IHD studies within the Columbia River basin had been terminated, some studies were initiated in Glacier National Park for the Canadian Parks Service (Champoux and Ommanney, 1986a, b), on Bugaboo Glacier [83] (fig. 12) (Osborn, 1986; Osborn and Karlstrom, 1988), and elsewhere (Power, 1985; Rogerson, 1985; Luckman and others, 1987; Duchemin and Seguin, 1998).

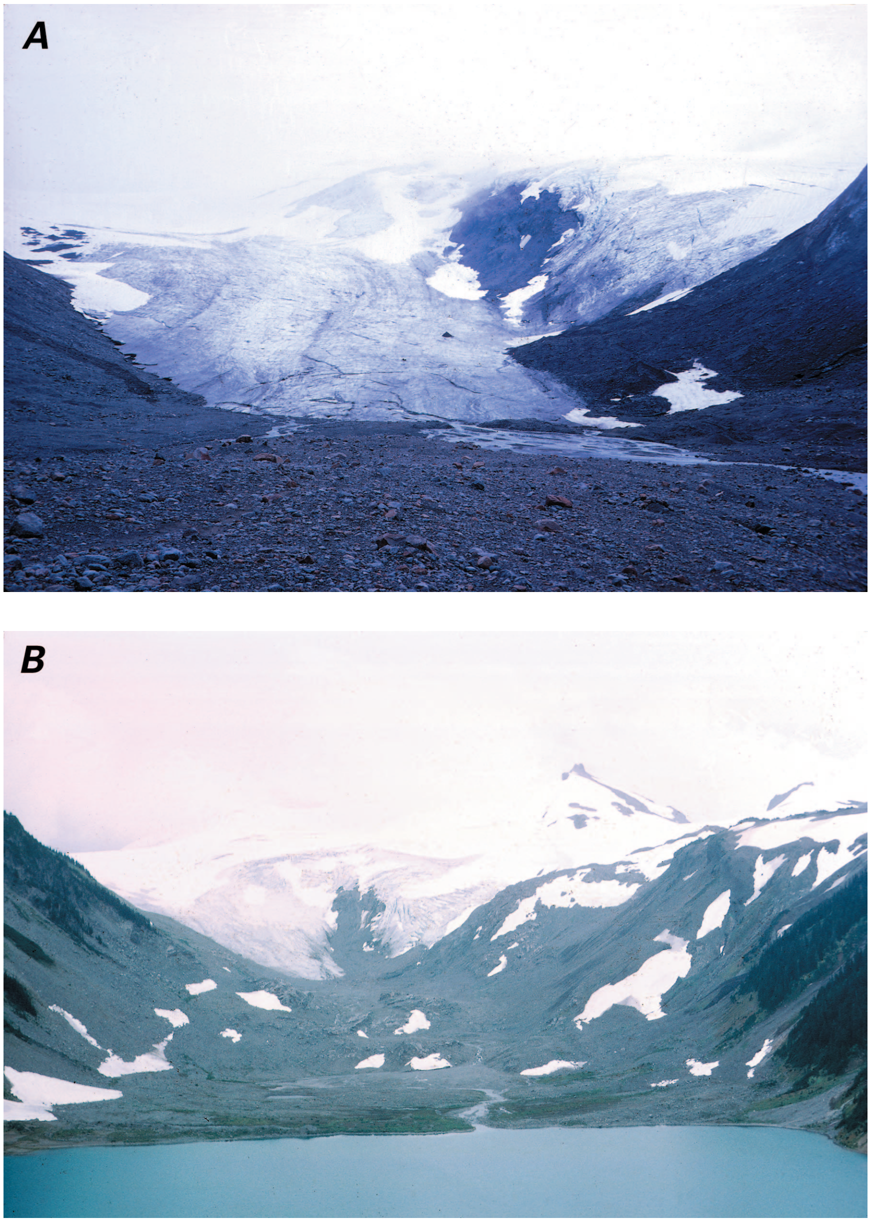


Figure 13.**—Photographs of Sentinel Glacier, Coast Mountains, British Columbia, Canada, showing the transient snowline in* **A, September 1968 and* **B***, 25 September 1973. Photographs by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 71 in table 1) [NTS Map: 092G15]*

In the Coast Mountains, continuous records were maintained on Sentinel [71] (fig. 13) and Place [62] Glaciers (Mokievsky-Zubok, 1987; Schmok, 1990), which served as bases for local studies (Yarnal, 1984b; Fogarasi and Mokievsky-Zubok, 1987; Brugman, 1991) and as benchmarks for comparison with shorter term mass-balance investigations elsewhere. The studies were closely related to the operational needs of the various governmental water-management agencies. Thus the program on the Bridge River glaciers, *Sykora Glacier* [53] (fig. 14), Bridge Glacier [54] (fig. 15), and *Zavisha Glacier* [55], aided in the management of the Downton Reservoir (Mokievsky-Zubok, 1980a; Mokievsky-Zubok, 1985). On the basis of data from Andrei [25], Alexander [22], *Forrest Kerr* [26], Natavas [23], and Yuri [24] Glaciers, the feasibility of a hydroelectric development in the Stikine and Iskut River basins was being assessed (Fogarasi, 1981; Mokievsky-Zubok, 1983b; Mokievsky-Zubok, 1992b). A similar study was started in the Homathko basin, on the Bench [42] and Tiedemann [45] (fig. 16) Glaciers (Mokievsky-Zubok, 1983a; Mokievsky-Zubok, 1992a). Data from all these studies were compiled in annual reports by NHRI and deposited with the WGMS. In the early 1990's, following a review of future hydroelectric needs for British Columbia, support for operational programs was withdrawn by BC Hydro.

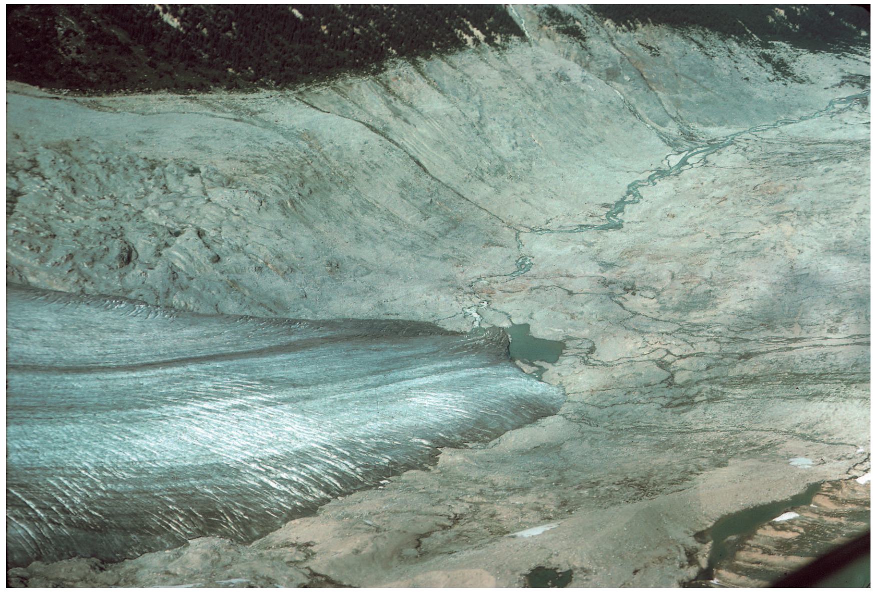


***Figure 14.**—Photograph of the terminus of the* Sykora Glacier, *Coast Mountains, British Columbia, Canada, on 19 August 1975. Photograph by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 53 in table 1)*

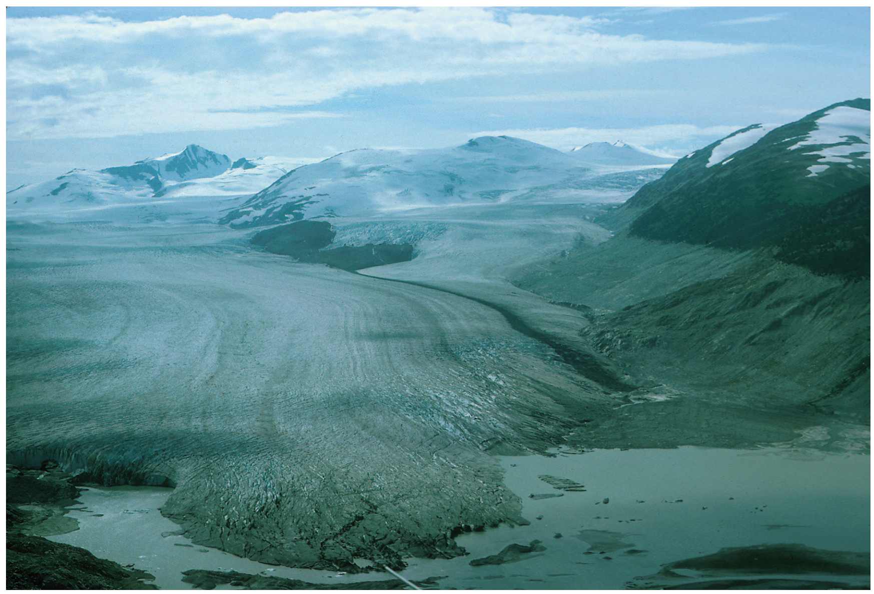


***Figure 15.**—Photograph of the terminus of the Bridge Glacier, Coast Mountains, British Columbia, Canada, on 19 August 1975, showing icebergs which have calved into the proglacial lake. Photograph by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 54 in table 1) [NTS Map: 092J13]*

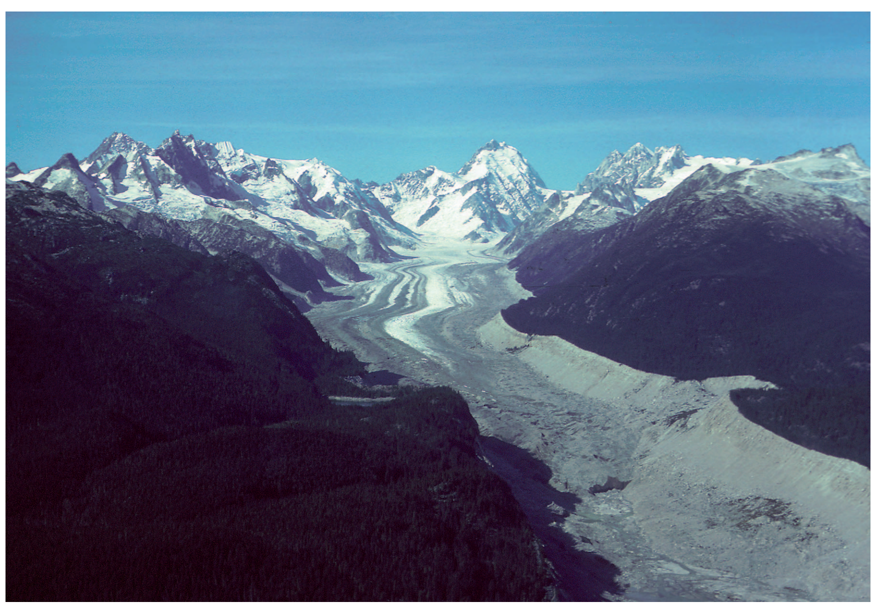


***Figure 16.**—Photograph of the terminus of the Tiedemann Glacier, Coast Mountains, British Columbia, Canada, in August 1982, showing prominent trim lines on the valley wall, prominent medial moraines, and the morainic-debris-covered lower part of the glacier. The difference in elevation of the trimline and the present surface of the glacier in its lower part indicates significant reduction in glacier volume and a prolonged period of negative mass balance. Photograph by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 45 in table 1) [NTS Map: 092N06]*

Data from these transects and supplementary studies have been used in a number of regional analyses of the spatial distribution of glaciers, their variations, and the relationship between glacier mass balance and climate (Henoch, 1972; Yarnal, 1984a; Osborn and Luckman, 1988; Letréguilly, 1988; Letréguilly and Reynaud, 1989, 1990; Luckman and others, 1993; Demuth, in press).

The Juneau Icefield Research Project, partly working from a base in Atlin, British Columbia, continued to introduce students to glaciology and mountain environments. Some results from work on the Juneau Icefield and Cathedral Glacier [18] are available (Johnson, R.F., 1983; Marston, 1983; Hasenauer, 1984; Mauelshagen, 1984; Mauelshagen and Slupetzky, 1985; Yao Tandong, 1987; Rentsch and others, 1990; Marcus and others, 1992).

On Barnes Ice Cap [164] the mass-balance program soon changed to one emphasizing glacier physics (Jones, 1972; Hooke, 1973a, b, 1976a, b, 1981; Holdsworth, 1973a, b, 1975, 1977c; Barnett and Holdsworth, 1974; Hudleston, 1976, 1980; Classen, 1977; Hooke and others, 1979, 1980, 1983, 1987; Hooke and Hudleston, 1980, 1981; Hudleston and Hooke, 1980; Hooke and Clausen, 1982; Hudleston, 1983; Hooke and Hanson, 1986; Stolle, 1986, 1988; Hanson, 1987, 1990). The mass-balance program maintained by R. Hooke (Hooke and others, 1987) lapsed. New studies subsequently began here, using remote sensing to assess changes in the ice cap (Lodwick and Paine, 1985; Moisan and Dubois, 1993; Jacobs and others, 1997). Work was also done on the subglacial characteristics of Aktineq Glacier [162] on Bylot Island (Souchez and De Groote, 1985; Souchez and others, 1988; Tison and others, 1989; Zdanowicz and others, 1996). In the south, Grinnell Glacier [171] was revisited in connection with a sediment study (Dowdeswell, 1986) and became the subject of an educational project that included mapping, directed by Gunnar Østrem (Norwegian Water Resources and Energy Administration, 1991). Nearby, a climbing expedition measured the fluctuations of Virginia Glacier [170] (Cochran, 1978).

Interest in reconstructing past climates in the High Arctic led to deep ice-coring projects on Meighen Ice Cap [155], Devon Ice Cap [160] and Agassiz Ice Cap [139] (fig. 17). Although mass-balance investigations were an integral part of the initial surface observations, the focus subsequently changed to analysis of the core constituents and their interpretation. Reports have covered the following: **climate at different time scales** (Koerner and Paterson, 1974; Koerner, 1977a, 1989, 1992; Fisher and Koerner, 1981; Koerner and Fisher, 1981, 1985, 1990; Alt and others, 1985, 1992; Harvey, 1988; Reeh, 1991; Fisher, 1992); **snow and ice properties** (Koerner, 1968, 1973; Fisher and Koerner, 1986; Goto-Azuma and others, 1997); **englacial temperatures, precipitation and isotope analysis** (Paterson, 1968, 1976a; Krouse and others, 1977; Paterson and others, 1977; Paterson and Clarke, 1978; Fisher, 1979, 1991; Paterson and Waddington, 1984; Fisher and Koerner, 1988, 1994; Fisher and others, 1996); **core particles and gases** (Lichti-Federovich, 1975; Koerner and Taniguchi, 1976; Koerner, 1977b; Koerner and Fisher, 1982; McAndrews, 1984; Barrie and others, 1985; Raisbeck and Yiou, 1985; Bourgeois, 1986, 1990; Cresswell and Herd, 1991; Koerner and others, 1991, 1998; Gregor, 1992; Nriagu and others, 1994; Sturges and others, 1998); **glacier flow** (Doake and others, 1976; Paterson, 1976b, 1977, 1985; Koerner and Fisher, 1979; Waddington and others, 1986; Reeh and others, 1987; Reeh and Paterson, 1988); **thickness and topographic measurements** (Oswald, 1975; Koerner, 1977c; Walford and others, 1977; Koerner and others, 1987; Haythornthwaite, 1988); **basal conditions** (Koerner, 1983; Gemmell and others, 1986; Fisher, 1987); and the **interpretation of records** (Fisher and others, 1983, 1985; Koerner and others, 1988; Illangasekare and others, 1990; Pfeffer and others, 1990; Clarke and Waddington, 1991). Attention was later directed to the Penny Ice Cap [168] on Baffin Island, where cores were taken and analyses made (Holdsworth, 1984; Short and Holdsworth, 1985; Fisher and others, 1998; Grumet and others, 1998).

Figure 17.—*Photograph of the electro-mechanical ice-core drill being lowered into the borehole on top of the Devon Ice Cap in April 1998. The drill was used in a partially fluid-filled borehole to minimize core fracturing. Lamp oil was used as a fluid and is filtered and re-used during drilling operations. On ice caps where the ice at the top of the flow line is often about 300-m thick, core fracturing usually begins at a depth of about 150 m and consists of microfractures that obscure the stratigraphy. Geological Survey of Canada personnel working in the shelter tent are as follows: D.A. Fisher is at the control box on the right; C. Zdanovicz has his hand on the torque springs on the left; and R. M. Koerner is in the left foreground. The torque springs prevent the outer sonde casing and the cable from turning in the borehole. Geological Survey of Canada photograph.*

McGill University continued the Axel Heiberg Island investigations after the end of the Jacobsen-McGill phase in 1962. Following the move of Fritz Müller to the Geographisches Institut, Eidgenössische Technische Hochschule in Zürich, the work was largely directed from Switzerland. Many excellent research reports and papers were written by expedition members (Maag, 1969; Iken, 1972, 1974; Müller and Iken, 1973; Müller, 1976; Alean and Müller, 1977; Hambrey and Müller, 1978; Arnold, 1981; Braithwaite, 1981; Weiss, 1984; Blatter, 1987a, b; Blatter and Hutter, 1991). Recently the work has been continued by Trent University on Baby [149] (Adams and Ecclestone, 1991; Tolland and others, 1991; Dicks and others, 1992; Adams and others, 1998) and White [153] (Jung-Rothenhäusler and others, 1992; Adams and others, 1995; Cogley and others, 1996b; Robertson, 1997) Glaciers, with some continuing involvement by McGill University on Thompson Glacier [152] (Parent, 1991; Lehmann, 1992; Moisan and Pollard, 1992). Earlier results have been compiled and carefully analysed (Glenday, 1989; Cogley and others, 1995, 1996a)

Changing priorities and reduced resources eventually led to the abandonment of the Arctic glacier program of the Snow and Ice Division. Study of Per Ardua Glacier [126], which had been handed over to this group on the termination of the DRB Operation Tanquary, was given up, as was a new project on Leffert Glacier [143] (Holdsworth, 1978), and a shorter term study of d'Iberville Glacier [140] (Holdsworth, 1975, 1977b). However, support subsequently became available for continuation of studies on the Ward Hunt Ice Shelf and new studies along the northern Ellesmere Island coast (Jeffries, 1982, 1984, 1986a, b, 1991, 1992; Jeffries and Serson, 1983, 1986;

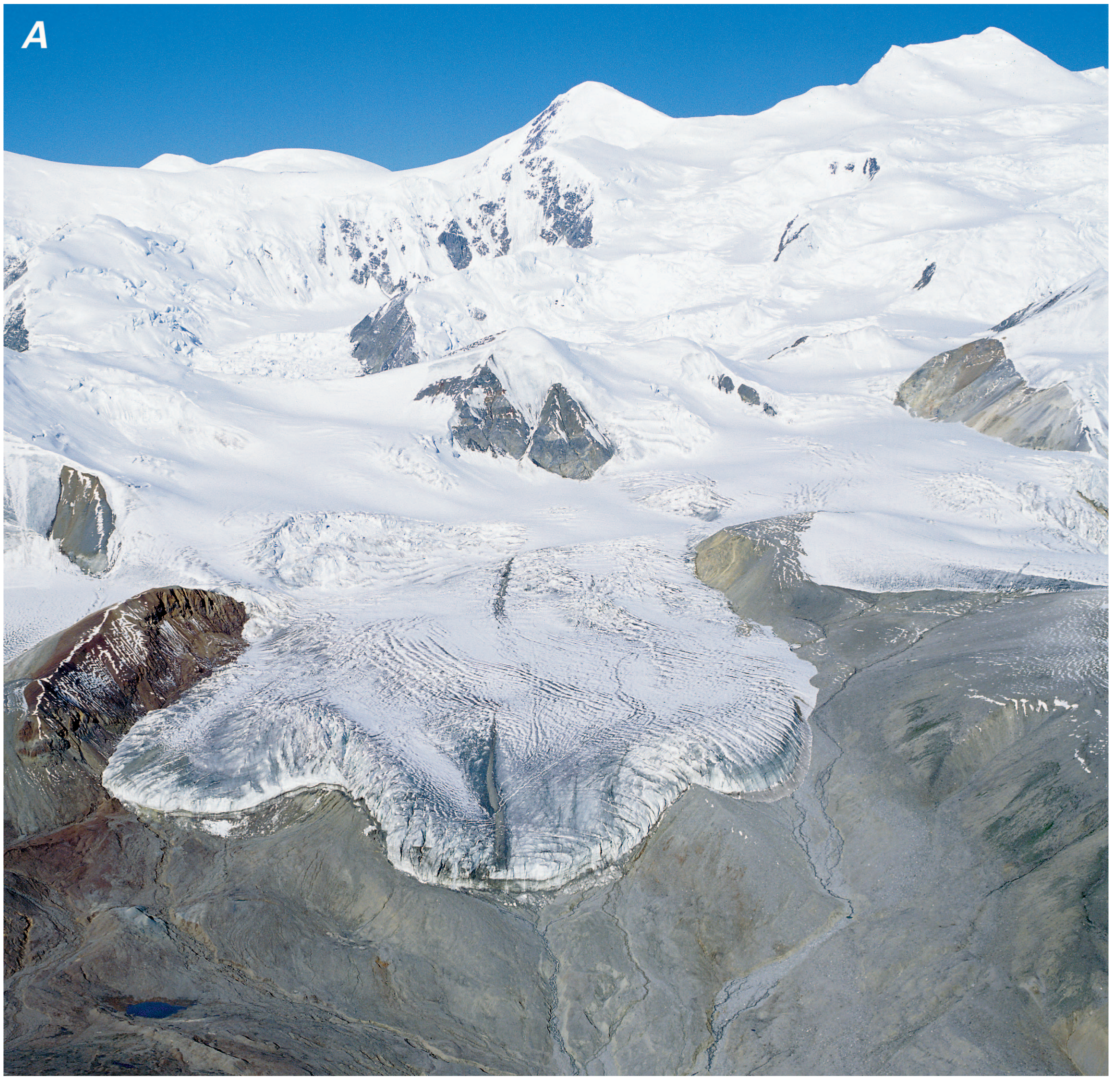
Jeffries and Krouse, 1985; Jeffries and Sackinger, 1990; Jeffries and others, 1988, 1991; Lemmen, 1988; Sackinger and others, 1985; Stewart, 1991). [See section in this volume on Ellesmere Island Ice Shelves and Ice Islands.] The University of Heidelberg later mounted a small multidisciplinary expedition to investigate the Webber, Gnome, Dwarf, Midget, Arklio, Van Royen, Okpuddyshao, and Nukapingwa Glaciers at the head of Oobloyah Bay [129–136] (Barsch and King, 1981; King, 1983) and a glacier tongue in the neighboring Hare Fiord [128] (Römmer and Hell, 1986; Hell and King, 1988). Meanwhile, studies of some other glaciers on Ellesmere Island (fig. 18) had been initiated: on *Quviagivaa Glacier* [142] (Wolfe, 1995; Wolfe and English, 1996); around *Blackwelder Ice Cap* [138], on *Shirley Glacier* [137] and a revisit to Van Royen Glacier [136] (Smith, 1997); at the head of Phillips Inlet on *Muskox Glacier* [124] (Evans and Fisher, 1987; Evans, 1989, 1993; Evans and England, 1992); and the University of Alberta commenced regular visits to John Evans Glacier [141] (Woodward, 1996; Arendt, 1997; Woodward and others, 1997).

In the middle 1960's, following the Glacier Mapping Symposium held in Ottawa and from recommendations made by the NRCC's Subcommittee on Glaciers, the WSC switched to a program of terrestrial photogrammetry that involved mapping the ablation areas of their glaciers every 2 years (Campbell and others, 1969a, b; Reid and Shastal, 1970; Reid and Charbonneau, 1972, 1975, 1979a, b; Reid, 1973; Reid and others, 1978). Terminus and plaque surveys of the Saskatchewan and Athabasca Glaciers [92–93] were continued in the intermediate years by the Calgary office of the WSC (Warner and others, 1972; Canada, 1976, 1982).

The accessibility of the Columbia Icefield [94] (Harmon and Robinson, 1981), particularly the Athabasca (Kucera, 1972) and Saskatchewan Glaciers, and the availability of a fairly good historical sequence of observations, probably favored its selection as the site for a wide variety of glaciological studies. These included investigations of **glacier chemistry** (Sharp and Epstein, 1958; Epstein and Sharp, 1959; Hallet, 1976; Mayewski and others, 1979), **glacier flow** (Meier and others, 1954; Meier, 1958a, b, 1960; Rigsby, 1958, 1960; Paterson, 1960, 1961, 1962, 1964, 1970; Paterson and Savage, 1963a, b; Savage and Paterson, 1963, 1965; Clee and others, 1969; Raymond, 1971a, b, 1973), **depth measurement** (Kanasewich, 1963; Neave and Savage, 1970; Goodman, 1973, 1975; Rossiter and others, 1973; Trombley, 1986), **glacial history** (Luckman, 1986, 1988, 1993), **photogrammetry** (Reid, 1961; Konecny, 1966; Paterson, 1966; Reid and Paterson, 1973; Kite and Reid, 1977; Reynolds, and Young, 1997), **remote sensing** (Østrem, 1973b; Gratton and others, 1990, 1993; Vachon and others, 1996); **resistivity** (Keller and Frischknecht, 1960, 1961), **sediment transport and erosion** (Mathews, 1964a, b; Iverson, 1991) and **temperature** (Paterson, 1971, 1972). Nearby studies have included the **hydrology** of the *Small River Glacier* [88] (Smart, 1992, 1998) and **glacierized alpine karst** (Smart, 1984, 1986, 1988; Smart and Ford, 1983, 1986; Worthington, 1991), **erosion and hydrological characteristics** of Decade Glacier [165] (Østrem and others, 1967), *Hilda Glacier* [98] (Hammer and Smith, 1983; Gardner and Bajewsky, 1987; Bajewsky and Gardner, 1989), *Boundary Glacier* [96] (Gardner and Jones, 1985; Jones, 1987; Sloan, 1987; Mattson, 1990; Mattson and Gardner, 1991) and Dome Glacier [97] (Gardner, 1992). A welcome development was the construction of a new Icefields Interpretative Centre in the middle 1990's (Waskasoo Design Group Limited, 1991)

The fortunate conjunction of a climbing camp in the St. Elias Range and the surge of the Steele Glacier [3] (Roots, 1967) led to studies of its cause (Bayrock, 1967; Nielsen, 1969; Stanley, 1969), spawned an influential symposium which outlined directions for future research (Ambrose, 1969), and helped generate grants for further work (Jarvis and Clarke, 1974; Clarke and Jarvis, 1976). Garry Clarke has focused much of his research effort on the elucidation of the problem of **surging glaciers**. Extremely detailed studies have been carried out on the Trapridge (*Hyena*), Backe (*Jackal*), Rusty (*Fox*), and Donjek Glaciers [4–7] (Classen and Clarke, 1971; Johnson, 1971, 1972; Hoffmann and Clarke, 1973; Clarke and Goodman, 1975; Jarvis and Clarke, 1975; Clarke, 1976, 1991, 1996; Collins and Clarke, 1977; Collins, 1980; Narod and Clarke, 1980; Clarke and Collins, 1984; Clarke and others, 1984, 1986b; Maxwell, 1986; Clarke and Blake, 1991; Blake and Clarke, 1992; Stone and Clarke, 1993, 1998; Fischer and Clarke, 1994, 1997; Murray and Clarke, 1995; Waddington and Clarke, 1988;

***Figure 18.**—Ice field adjoining ice cap, Victoria, and Albert Mountains, east coast Ellesmere Island, Queen Elizabeth Islands, Nunavut (80°18'N., 74°21'W.); view to the east; John Richardson Bay is at top right and Kane Basin and Greenland in the background. NAPL T400L–201. From figure 2 in Prest, 1983, p. 13.*

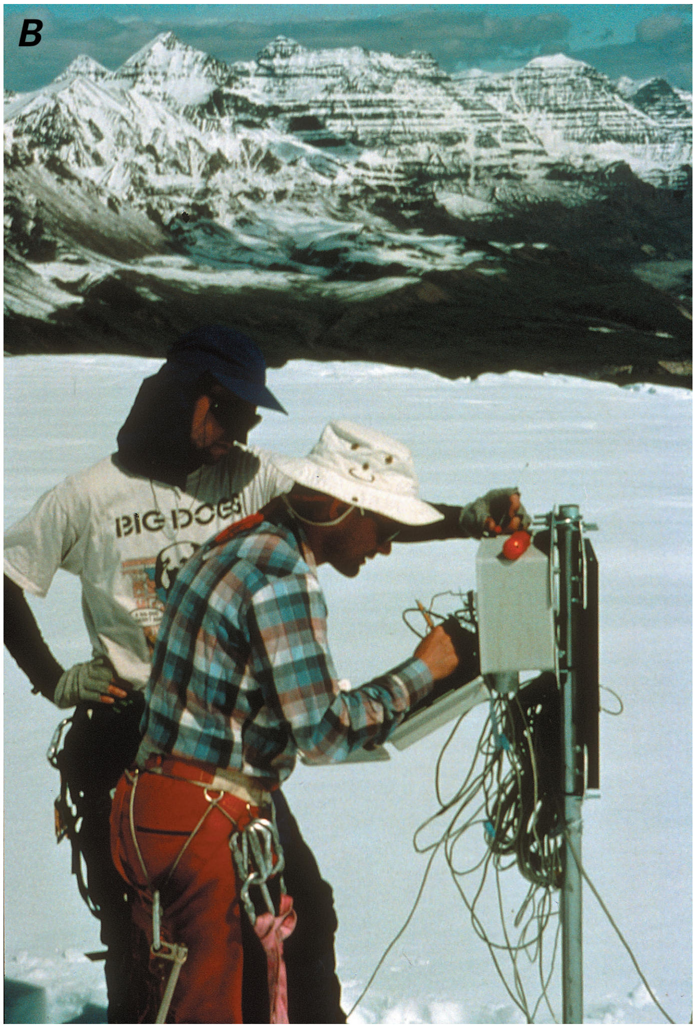


Flowers and Clarke, 1999) (fig. 19). Other surging-glacier studies of have been made of the Tweedsmuir [14], Lowell [13] and Walsh Glaciers [8] (Post, 1966; Krimmel and Meier, 1975; Post and others, 1976), of Otto Glacier [127] (Hattersley-Smith, 1964, 1969a), Milne Glacier [122] (Jeffries, 1984), *Good Friday Bay Glacier* [154] (Müller, 1969), of the Barnes Ice Cap [164] (Holdsworth, 1973a, 1977c; Løken, 1969), and of the distribution of such features (Post, 1969). The most recent surge to attract substantial public attention was that of Hubbard Glacier [12] (Begley and White, 1986; Mayo, 1989; Trabant and others, 1991; Krimmel and Trabant, 1992).

Curiosity about the environmental effects of the large polynya known as the North Water, located at the head of Baffin Bay between Greenland and Ellesmere Island, prompted Fritz Müller to launch a major scientific program there. Although the focus was primarily on energy exchanges, sea ice, and atmospheric effects, mass-balance studies on Coburg Island, on *Wolf Glacier*, *Laika Glacier;* and *Laika Ice Cap* [146–148] (Berger and Müller, 1977; Blatter and Kappenberger, 1988), on Leffert Glacier, and on a neighboring unnamed glacier [143, 144] were started (Müller and others, 1974–80, 1977). A popular account of this work, and that on Axel Heiberg Island, was also published (Müller, 1981). Unfortunately, the unexpected death of Fritz Müller led to the premature termination of this project before all the analyses had been completed.

A later initiative by Karl Ricker, a private consultant, in conjunction with Bill Tupper of the British Columbia Institute of Technology, added

Figure 19.—**A**, *Oblique aerial photograph of Trapridge Glacier, Yukon, Canada, in August 1999. The peak in the background (top right) is Mount Wood. Photograph by Garry K.C. Clarke.* **B**, *(opposite page) Graduate students from the University of British Columbia connecting sensors to one of more than 20 data loggers operating year-round at Trapridge Glacier. Photograph by Garry K.C. Clarke, University of British Columbia. (Glacier 4 in table 1)*



significantly to our knowledge of recent glacier variations in the Coast Mountains. Studies of glaciers (glacier numbers in table 1 shown in brackets for each mountain range) ranged from the St. Elias Mountains [16], through the Hazelton Mountains [34, 35], the Pacific Ranges [36–41], the Chilcotin Ranges [43, 44, 48–52], the Elaho Range [56–58], the Clendenning Range [59–61], and the Lillooet Ranges [64] to Garibaldi Provincial Park [63, 72–75] and Overlord Glacier [68] (Ricker, 1976, 1977, 1979, 1980, 1990; Tupper and Ricker, 1982; Ricker and others, 1983; Ricker and Jozsa, 1984; Ricker and Parke, 1984; Tupper and others, 1984, 1985, 1986; Ricker and Tupper, 1988, 1992, 1996). The extensive ice cover of parts of British Columbia means that geophysical surveys for mineral exploration are often conducted on and through glaciers; these have included *Ridge Icefield Glacier* [28] at McLymont Creek and Horstman Glacier [67] (J.P. Schmok, oral commun., 1991–93).

A valuable study was that begun by Robert Rogerson of Memorial University in 1981 on four glaciers in Labrador—Superguksoak, Abraham, Hidden, and Minaret Glaciers [173–176]. As small glaciers are expected to respond quite rapidly to changes in climate, and climatologists are predicting global warming as a result of the "greenhouse effect," the results, at the southeastern limits of glacier cover in Canada, would have been most interesting. Unfortunately, the program was concluded after only a few years (McCoy, 1983; Branson, 1984; Rogerson, 1986; Rogerson and others, 1986). However, Dan Smith of the University of Victoria started investigating the behavior of Moving Glacier [76] on Vancouver Island (Smith, 1994), which would be representative of the southwestern limits. While at the University of Saskatchewan, he had initiated a study of *Rae Glacier* [113] (Lawby and others, 1994), the most southerly of any glacier investigated in the Canadian Rocky Mountains.

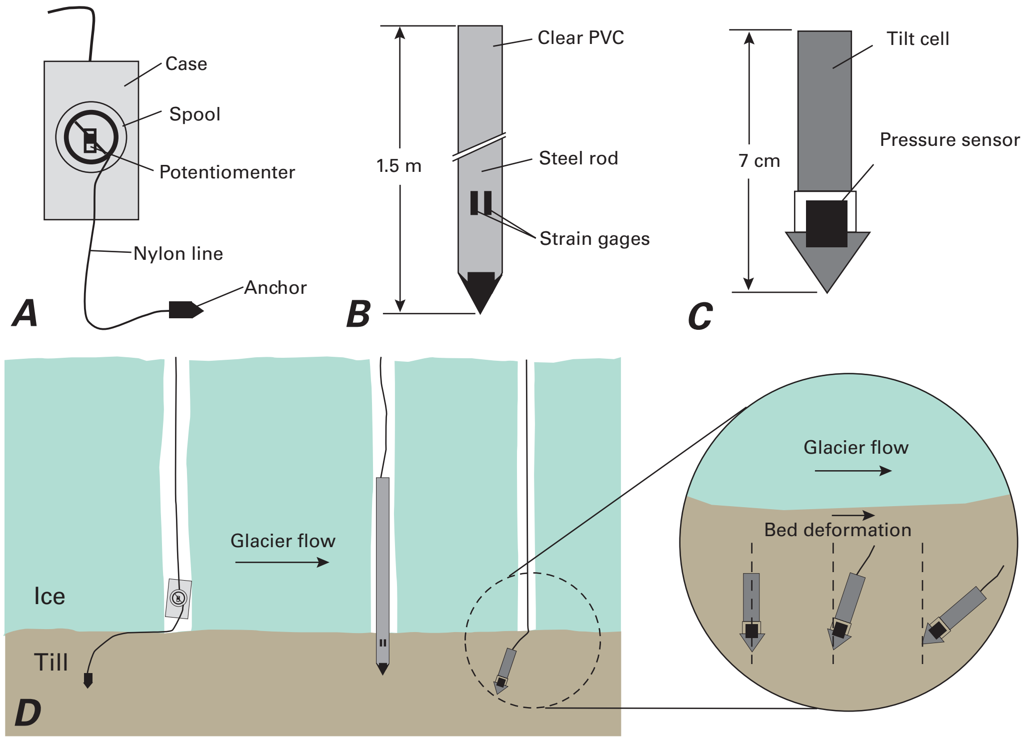
In the Yukon Territory, Gerald Holdsworth, in conjunction with the AINA and their considerably reduced program in the Icefield Ranges, has been establishing the recent climate history of the southwest Yukon through the analysis of an ice core obtained from the 5,340-m-high plateau of Mount Logan [10] (fig. 20), (De la Barre, 1977; Holdsworth, 1977a, 1983, 1986a, 1990; Holdsworth and Jones, 1979; Holdsworth and others, 1984, 1989, 1991, 1992; Holdsworth and Peake, 1985; Pourchet and others, 1988; Monaghan and Holdsworth, 1990; Dibb and others, 1993; Holdsworth and Sawyer, 1993; Mayewski and others, 1993; Yang and others, 1995). Peter Johnson, together with staff and students from the University of Ottawa, has studied the glacier hydrology of the Grizzly Creek region and debris- and moraine-covered ice masses (Johnson, 1976, 1980a, b, 1981, 1983, 1984, 1985, 1991a, b, 1992, 1998; Lacasse, 1985; Johnson and David, 1987; Johnson and Lacasse, 1988; Kruszynski and Johnson, 1993).

Observations that cannot readily be subjected to either a systematic regional or chronological review are those on ice-dammed lakes and associated hazards. Their regional distribution on the mainland has been discussed by Post and Mayo (1971) and other general aspects reviewed by several authors (VanDine, 1985; Young, 1985; Evans, 1986; Shoemaker, 1991; Clague and Evans, 1994). The catastrophic drainage (jökulhlaup) of Summit Lake, dammed by Salmon Glacier [33], caused severe flooding downstream and washed out the access road to the Granduc Mine at Berendon Glacier [32] (Mathews, 1965, 1973; Gilbert, 1971; Fisher, 1973; Mathews and Clague, 1993). That of Ape Lake removed trees from a substantial area of forest downstream of Fyles Glacier [39] (Jones and others, 1985; Desloges and others, 1989; Desloges and Church, 1992). Other catastrophic events noted in British Columbia include those on Klattasine Creek associated with Cumberland Glacier [47] (Blown and Church, 1985; Clague and others, 1985) and on *Tim Williams Glacier* [29] (Evans and Clague, 1990). Detailed studies have been made on lakes associated with the surge-type Steele [3], Donjek [7] and Kaskawulsh [9] Glaciers (Collins and Clarke, 1977; Clarke and Mathews, 1981; Clarke, 1982; Liverman, 1987; Kasper and Johnson, 1991; Johnson and Kasper, 1992). To the south, the Tulsequah Glacier [20] flood was investigated by Marcus (1960). Hydropower feasibility investigations in the Stikine and Iskut River basins have included similar studies (Perchanok, 1980), particularly of the Flood Glacier [21] jökulhlaup (Mokievsky-Zubok, 1980b; Clarke and Waldron, 1984) (fig. 21). An interesting case study was that of the

Figure 20.*—Photograph of Mount Logan (5,959 m), St. Elias Mountains, Yukon Territory, Canada, from the ice-core drill site at Eclipse (3,017m) in June 1990. Photograph by Gerald Holdsworth, Arctic Institute of North America.*

Figure 21.*—Photograph of Flood Glacier, Coast Mountains, British Columbia, on 13 July 1979 showing the iceberg-filled lake dammed by the glacier. In August 1979, the lake drained catastrophically, causing severe flooding downstream. Photograph by Oleg Mokievsky-Zubok, National Hydrology Research Institute. (Glacier 21 in table 1)*

Figure 22.—Bed instruments developed for studying the subglacial mechanical processes of Trapridge Glacier. **A**, Slidometer used to measure basal sliding rate. **B**, Ploughmeter used to measure the ploughing interaction between a glacier and a soft sedimentary bed. **C**, Tilt cell to measure the deformation of subglacial sediment. **D**, Schematic diagram (not to scale) showing the foregoing instruments installed near the ice-bed contact. Detail: Progressive tilting of a tilt cell in response to shear deformation of subglacial sediment. Diagram from Garry K.C. Clarke, University of British Columbia.



Cathedral Glacier [109] jökulhlaup, whose debris flows periodically block the CPR railway and Trans-Canada Highway in Kicking Horse Pass (Jackson, 1979, 1980; Jackson and others, 1989). Such studies have not been limited to the mainland. Maag (1969) completed a comprehensive report on ice-dammed lakes and associated jökulhlaups in the expedition area of Axel Heiberg Island. Ricker (1962) has also reported on this area, and a later study was made by a McMaster University group along the margin of the Prince of Wales Icefield [145] on Ellesmere Island (McCann and Cogley, 1977; Blachut and McCann, 1981). Some environmental-impact studies have had a glaciological component that, carried out in connection with the proposed Alcan pipeline route in the Yukon, included a general study of glacier-dammed lakes in the St. Elias Mountains (Canada, 1977; Young, 1980). Studies on Tats Glacier [17] (J.P. Schmok, oral commun.,1990) were in connection with an impact assessment of the Windy Craggy development (Canada, 1990). In Alberta, a small glacier on Mount Cline [99] was assessed in response to a license application to mine the glacier for "pure" water and ice cubes (The Ice Age Co., 1989; Rains, 1990).

To complete this review, it is worth mentioning briefly that some of the field programs described above have prompted the development of new glaciological instruments and techniques. The geophysical group at the University of British Columbia, driven by the desire to measure Trapridge Glacier in even more detail, has been a leader in this area. Radars and ancillary equipment have been constructed (Narod and Clarke, 1983; Prager, 1983; Jones and others, 1989; Cross and Clarke, 1990), as well as devices for recording activity at the glacier bed (Blake and Clarke, 1991; Blake, 1992; Blake and others, 1992; Stone and others, 1993; Waddington and Clarke, 1995; Kavanaugh and Clarke, 1996) (fig. 22) and on the surface (Clarke and others, 1986a). One member of the group has gone on to develop instrumentation for use elsewhere (Blake and others, 1998). The current techniques used for mass-balance measurement in mainland Canada have been documented (Østrem and Brugman, 1991) and a conductivity measurement system automated for use in the Columbia River basin (Kite, 1994). A major contribution to the glaciological community has been Paterson's outstanding book on glacier physics (Paterson, 1994), now in its third edition.

The 21st Century

In the decade or so leading up to the end of the 20th century, there was a significant decline in governmental support of glacier research in Canada. At the end of the 20th century, systematic long-term mass-balance observations were being continued at Peyto Glacier [103] in the Rocky Mountains, Place Glacier [62] and Helm Glacier [69] in the Coast Mountains, and White Glacier [153] on Axel Heiberg Island, Canadian High Arctic, Nunavut (Haeberli and others, 1999), by the GSC under its new National Glaciology Programme. Three of the sites, one in the Rockies and two in the Coast Mountains, are low latitude and are unlikely to be representative of the full extent of these ranges. Old glacier sites may be revisited from time to time and additional glaciers added to the record as opportunities present themselves (for example, Bow [104] and *Robertson* [112] Glaciers (M. Sharp, oral commun., 2000). Airborne and satellite remote sensing and geographic information system (GIS) technology will be used increasingly in glaciological studies, such as the use of synthetic aperture radar (SAR) imagery in glacier-hydrology investigations of Place Glacier [62], Coast Mountains (Adam and others, 1997); Landsat Thematic Mapper (TM) and SAR imagery of Wapta Icefield and Peyto Glacier [103] (Brugman and others, 1996); airborne laser altimetry and interferometric SAR (InSAR) mapping of the Wapta Icefield (Demuth and others, 2001); areal and volumetric changes of the Prince of Wales Icefield and Devon Ice Cap using historical aerial photographs and Landsat 7 imagery (Burgess and others, 2001); studies of fluctuations of glacier termini on Axel Heiberg Island, using historical aerial photographs and satellite imagery (Cogley, 2001); and the Illecillewaet Icefield and Illecillewaet Glacier [80], *Interior Ranges* (see section on Mapping Glaciers in the *Interior Ranges* and Rocky Mountains with Landsat Data, by Roger D. Wheate, Robert W. Sidjak, and Garnet T. Whyte, in this volume). Improvements in spatial [reduction in size of picture elements (pixels)] and spectral (increase in the number and/or smaller band width) resolution of satellite sensors [for example Landsat 7 Enhanced Thematic Mapper (ETM+) (15-m pixels), Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) (15-m pixels, stereoscopic capability; and 14 spectral bands on three sensors), and IKONOS (1-m pixels)] and the surface profile and elevation data to be acquired by ICESat (±1 m) after its planned launch in December 2002, will provide glaciologists with additional remote sensing datasets. The Global Land Ice Measurements from Space (GLIMS) is using ASTER and other satellite images to foster increased cooperation between regional centers.

The work in the Yukon Territory, by teams from the University of British Columbia and Ottawa University, will likely continue, but continued research may well be in doubt when the principal investigators retire. In the Arctic, the continuation of some of the smaller expeditions, on Axel Heiberg and Ellesmere Islands, is also in doubt. The Polar Continental Shelf Project provided the logistical support that has enabled scientists to work in remote areas of Nunavut for the last 40 years. Fortunately, the GSC's ice-coring project has been receiving sufficient support to continue acquiring data from existing core sites and even to obtain a new core from the Penny Ice Cap [168]. In 1998 and 1999, new ice cores to bedrock were obtained from Devon Island.

Looking to the future, it seems likely that water will return to the national agenda early in the 21st century. Recently there has been renewed public discussion in Canada about water exports. The gradual depletion of mountain reservoirs as the climate warms will alter not only the amount but also the timing of discharges. The switch from a glacial to a nival regime in some prairie rivers may adversely affect agriculture. The depletion of resources in central British Columbia potentially could lead to water-transfer disputes with the United States as flow in the Columbia River declines. If a warming climate creates more demand for energy, the hydroelectric-generating companies may be obliged to revisit some of their earlier proposals. All of these situations involve glaciers and may lead to the restoration of some previous studies and the initiation of new ones. However, as qualified and experienced scientists retire, a new generation of glaciologists will need to be trained.

Interest in past and present climates is expected to continue and even increase. Impact and adaptation studies funded by the Government of Canada's Climate Change Action Fund indicate renewed interest in water resources, including glacier hydrology. The Canadian CRYSYS (Cryospheric Systems Research Initiative), a Canadian contribution to the National Aeronautics and Space Administration Earth Observing System (EOS) Program, includes a glacier/ice cap theme as part of a government/university partnership. In the first decade of the 21st century, we will probably see a redrilling on the Agassiz Ice Cap [139]. Additional drilling programs are in the planning stage for Barnes Ice Cap, Baffin Island, and on Mt. Oxford, Ellesmere Island, Nunavat. After a long and patient wait we can also expect Trapridge Glacier [4] to surge and, thanks to all the preparatory work that has been done by Garry Clarke and his colleagues, to provide valuable new insights into the mechanism of surging glaciers, perhaps finally answering the question "why do some glaciers surge and what are the process(es) that cause some glaciers to surge?"

A promising recent development has been the establishment of a National Glaciology Programme (NGP) in the Terrain Sciences Division, Geological Survey of Canada (GSC), Natural Resources Canada. In 2001, a new ice core from a glacier on Mount Logan was obtained as part of this program. The NGP of the GSC also provides a national correspondent (Canada) to the World Glacier Monitoring Service, Zürich, Switzerland, who is responsible for the annual submission of glaciological data, including fluctuation of glaciers in Canada, and mass-balance data from the Place, Peyto, Helm, and White Glaciers. Glaciologists with the NGP (GSC) and the International Glaciological Society (Cambridge, England, U.K.) also provided information for the special issue of Canadian Geographic on Canada's glaciers (Anonymous, 1998), including a fold-out map on the Glaciers of Canada (Fick and others, 1998).

References Cited

Adam, S., Toutin, T., Pietroniro, Alain, and Brugman, Melinda, 1997, Using ortho-rectified SAR imagery acquired over rugged terrain for thematic applications in glacier hydrology: Canadian Journal of Remote Sensing, v. 23, no. 1, p. 76–80.

Adams, W.P., 1966, Ablation and run-off on the White Glacier, Axel Heiberg Island, Canadian Arctic Archipelago: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Glaciology No. 1, 77 p.

Adams, W.P., and Ecclestone, M.A., 1991, Mass balance measurements on Baby Glacier, Axel Heiberg Island, NWT, Canada, 1959–present, for the record: Eastern Snow Conference, 48th Annual Meeting, Guelph, Ontario, 5–7 June 1991, Proceedings, p. 317–324.

Adams, W.P., Cogley, J.G., and Ecclestone, M.A., 1995, The equilibrium zone on polar glaciers: Eastern Snow Conference, 52nd Annual Meeting, Toronto, Ontario, 6–8 June 1995, Proceedings, p. 211–219.

Adams, W.P., Cogley, J.G., Ecclestone, M.A., and Demuth, M.N., 1998, A small glacier as an index of regional mass balance—Baby Glacier, Axel Heiberg Island, 1959–1992: Geografiska Annaler, v. 80A, no. 1, p. 37–50.

Adkins, C.J., 1958, The summer climate in the accumulation area of the Salmon Glacier: Journal of Glaciology, v. 3, no. 23, p. 195–206.

———1959, Measurement of the atmospheric potential gradient on a Canadian glacier: Quarterly Journal of the Royal Meteorological Society, v. 85, no. 363, p. 60–67.

Alean, Jürg, and Müller, Fritz, 1977, Zum Massenhaushalt des Baby Glacier, Axel Heiberg Island, kanadische Hocharktis: Geographica Helvetica, v. 32, no. 4, p. 203–208.

Alt, B.T., 1978, Synoptic climate controls of mass-balance variations on Devon Island Ice Cap: Arctic and Alpine Research, v. 10, no. 1, p. 61–80.

———1979, Investigation of summer synoptic climate controls on the mass balance of Meighen Ice Cap: Atmosphere-Ocean, v. 17, no. 3, p. 181–199.

———1985, 1550–1620: A period of summer accumulation in the Queen Elizabeth Islands: Ottawa, Ont., National Museums of Canada, National Museum of Natural Sciences, Syllogeus No. 55, p. 461–479.

———1987, Developing synoptic analogs for extreme mass balance conditions on Queen Elizabeth Island ice caps: Journal of Climate and Applied Meteorology, v. 26, no. 12, p. 1605–1623.

Alt, B.T., Fisher, D.A. and Koerner, R.M., 1992, Climatic conditions for the period surrounding the Tambora signal in ice cores from the Canadian High Arctic islands, *in* Harington, C.R., ed., The year without a Summer? World climate in 1816: Ottawa, Ont., Canadian Museum of Nature, p. 309–327.

Alt, B.T., Koerner, R.M., Fisher, D.A., and Bourgeois, J.C., 1985, Arctic climate during the Franklin era, as deduced from ice cores, *in* Sutherland, P.D., ed., The Franklin Era in Canadian Arctic history, 1845–1859: Ottawa, Ont., National Museum of Man, Archaeological Survey of Canada, Mercury Series Paper No. 131, p. 69–92.

Ambrose, J.W., ed., 1969, Papers presented at the Seminar on the Causes and Mechanics of Glacier Surges, St. Hilaire, Québec, Canada, September 10–11, 1968, and the Symposium on Surging Glaciers, Banff, Alberta, Canada, June 6–8, 1968: Canadian Journal of Earth Sciences, v. 6, no. 4, pt. 2, p. 807–1018.

Anderton, P.W., 1973, Structural glaciology of a glacier confluence, Kaskawulsh Glacier, Yukon Territory, Canada: Columbus, Ohio, Ohio State University, Institute of Polar Studies Report No. 26, 109 p.

Andrews, J.T., and Barry, R.G., 1972, Present and paleo-climatic influences on the glacierization and deglacierization of Cumberland Peninsula, Baffin Island, N.W.T., Canada: Durham, NC, U.S. Army Research Office, Final Report, Grant No. DA–AR0–D–31–124–70–G80, 220 p.

Andrews, J.T., and Miller, G.H., 1972, Quaternary history of northern Cumberland Peninsula, Baffin Island, N.W.T., Canada—Part IV. Maps of the present glaciation limits and lowest equilibrium line altitude for north and south Baffin Island: Arctic and Alpine Research, v. 4, no. 1, p. 45–59.

Andrews, J.T., and Webber, P.J., 1969, Lichenometry to evaluate changes in glacial mass budgets, as illustrated from north-central Baffin Island, N.W.T: Arctic and Alpine Research, v. 1, no. 3, p. 181–194.

Andrews, J.T., Barry, R.G., and Drapier, Lyn, 1970, An inventory of the present and past glacierization of Home Bay and Okoa Bay, east Baffin Island, N.W.T., Canada, and some climatic and paleoclimatic considerations: Journal of Glaciology, v. 9, no. 57, p. 337–362.

Andrews, R.H.G., 1964, Meteorology and heat balance of the ablation area, White Glacier, Canadian Arctic Archipelago—summer 1960 (Lower Ice Station: 79°26' N., 90°39' W., 208 m): Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Meteorology No. 1, 107 p.

Andrieux, Pierre, 1970, Les méthodes électriques de prospection, appliquées à l'étude de la glace et des glaciers—résultats obtenus de 1962 à 1965: Paris, Comité National Français des Recherches Antarctiques, Institut Géographique National, Rapport No. 24, 62 p.

Anonymous, 1967, Hydrology of the Lewis Glacier, north-central Baffin Island, N.W.T., and discussion of reliability of the measurements: Geographical Bulletin, v. 9, no. 3, p. 232–261.

Anonymous, 1998, Rivers of ice: Canadian Geographic, v. 118, no. 7, p. 34–39.

Apollonio, Spencer, 1962, The Devon Island Expedition, 1960–64: Arctic, v. 15, no. 4, p. 317–321.

Arendt, Anthony, 1997, Mass balance modelling of an Arctic glacier: M.Sc. thesis, Edmonton, Alberta, University of Alberta., 222 p.

Arnold, K.C., 1965, Aspects of the glaciology of Meighen Island, Northwest Territories, Canada: Journal of Glaciology, v. 5, no. 40, p. 399–410.

———1981, Ice ablation measured by stakes and terrestrial photogrammetry—A comparison on the lower part of the White Glacier, Axel Heiberg Island, Canadian Arctic Archipelago: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Glaciology No. 2, 98 p. and maps.

Baird, P.D., 1952a, The Baffin Island Expedition, 1950: Geographical Journal, v. 118, pt. 3, p. 267–279.

———1952b, The glaciological studies of the Baffin Island Expedition, 1950. Part I, Method of nourishment of the Barnes Ice Cap: Journal of Glaciology, v. 2, no. 11, p. 2–9, 17–19.

Baird, P.D., and Salt, D.J., 1949, Report on Expedition Snow Cornice: Ottawa, Ont., National Research Council of Canada (NRCC 2034), Associate Committee on Soil and Snow Mechanics, Technical Memorandum No. 14, p. 1–13.

Baird, P.D., and others, 1950, Baffin Island Expedition, 1950—A preliminary report: Arctic, v. 3, no. 3, p. 131–149.

———1953, Baffin Island expedition 1953—A preliminary field report: Arctic, v. 6, no. 4, p. 226–251.

Bajewsky, Ingrid, and Gardner, J.S., 1989, Discharge and sediment-load characteristics of the Hilda Rock-Glacier stream, Canadian Rocky Mountains, Alberta: Physical Geography, v. 10, no. 4, p. 295–306.

Barnett, D.M., and Holdsworth, Gerald, 1974, Origin, morphology, and chronology of sublacustrine moraines, Generator Lake, Baffin Island, Northwest Territories, Canada: Canadian Journal of Earth Sciences, v. 11, no. 3, p. 380–408.

Barrie, L.A., Fisher, D.[A.], and Koerner, R.M., 1985, Twentieth century trends in Arctic air pollution revealed by conductivity and acidity observations in snow and ice in the Canadian High Arctic: Atmospheric Environment, v. 19, no. 12, p. 2055–2063.

Barsch, Dietrich, and King, Lorenz, 1981, Ergebnisse der Heidelberg-Ellesmere Island Expedition (Results of the Heidelberg Ellesmere Island Expedition): Heidelberger Geographische Arbeiten, v. 69, 573 p. and map.

Bayrock, L.A., 1967, Catastrophic advance of the Steele Glacier, Yukon, Canada: Edmonton, Alberta, University of Alberta, Boreal Inst., Occasional Paper No. 3, 35 p.

Begley, S., and White, B., 1986, Alaska's runaway glacier: Newsweek, v. 108, no. 8, p. 52–53.

Berger, Peter, and Müller, Fritz, 1977, Massenhaushalt des Laika Glacier, Coburg Island, kanadischer arktischer Archipel: Geographica Helvetica, v. 32, no. 4, p. 209–212.

Binda, G.G., 1984, Fluvioglacial sediment and hydrochemical dynamics, Peyto Glacier, Alberta: M.A. thesis, Ottawa, Ont., University of Ottawa, Department of Geography, 139 p.

Binda, G.G., Johnson, P.G., and Power, J.M., 1985, Glacier control of suspended-sediment and solute loads in a Rocky Mountain basin, *in* Water quality evolution within the hydrological cycle of watersheds, Québec, Québec, 10–12 June 1984, Proceedings of the Canadian Hydrology Symposium No. 15, v. 1: Ottawa, Ont., National Research Council of Canada (NRCC 24633), Associate Committee on Hydrology, p. 309–327.

Blachut, S.P., and McCann, S.B., 1981, The behaviour of a polar ice-dammed lake, Ellesmere Island, N.W.T., Canada: Arctic and Alpine Research, v. 13, no. 1, p. 63–74.

Blake, E.W., 1992, The deforming bed beneath a surge-type glacier—Measurement of mechanical and electrical properties: Ph.D. thesis, Vancouver, B.C., University of British Columbia, 179 p.

Blake, E.W., and Clarke, G.K.C., 1991, Correspondence. Subglacial water and sediment samplers: Journal of Glaciology, v. 37, no. 125, p. 188–190.

———1992, Interpretation of borehole-inclinometer data—A general theory applied to a new instrument: Journal of Glaciology, v. 38, no. 128, p. 113–124.

Blake, E.[W.], Clarke, G.K.C., and Gérin, M.C., 1992, Tools for examining subglacial bed deformation: Journal of Glaciology, v. 38, no. 130, p. 388–396.

Blake, E.W., Wake, C.P., and Gerasimoff, M.D., 1998, The ECLIPSE drill—A field-portable intermediate-depth ice-coring drill: Journal of Glaciology, v. 44, no. 146, p. 175–178.

Blake, W.P., 1867, The glaciers of Alaska, Russian America: American Journal of Science, 2nd Series, no. 44, p. 96–101.

Blatter, Heinz, 1987a, On the thermal regime of an Arctic valley glacier—A study of White Glacier, Axel Heiberg Island, N.W.T., Canada: Journal of Glaciology, v. 33, no. 114, p. 200–211.

———1987b, Stagnant ice at the bed of White Glacier, Axel Heiberg Island, N.W.T., Canada: Annals of Glaciology, v. 9, p. 35–38.

Blatter, Heinz, and Hutter, Kolumban, 1991, Polythermal conditions in Arctic glaciers: Journal of Glaciology, v. 37, no. 126, p. 261–269.

Blatter, Heinz, and Kappenberger, Giovanni, 1988, Mass balance and thermal regime of Laika ice cap, Coburg Island, N.W.T., Canada: Journal of Glaciology, v. 34, no. 116, p. 102–110.

Blown, Iain, and Church, Michael, 1985, Catastrophic lake drainage within the Homathko River basin, British Columbia: Canadian Geotechnical Journal, v. 22, no. 4, p. 551–563.

Bourgeois, J.C., 1986, A pollen record from the Agassiz Ice Cap, northern Ellesmere Island, Canada: Boreas, v. 15, no. 4, p. 345–354.

———1990, Seasonal and annual variation of pollen content in the snow of a Canadian High Arctic ice cap: Boreas, v. 19, no. 4, p. 313–322.

Bradley, C., 1990, Water quality dynamics in meltwaters draining Peyto Glacier, Alberta: M.A. thesis, Waterloo, Ont., Wilfrid Laurier University, Department of Geography, 133 p.

Bradley, R.S., 1975, Equilibrium-line altitudes, mass balance, and July freezing-level heights in the Canadian High Arctic: Journal of Glaciology, v. 14, no. 71, p. 267–274.

Bradley, R.S., and England, John, 1977, Past glacial activity in the High Arctic: Amherst, MA, University of Massachusetts, Department of Geology and Geography, Contribution No. 31, 184 p.

Bradley, R.S., and England, John, 1978a, Recent climatic fluctuations of the Canadian High Arctic and their significance for glaciology: Arctic and Alpine Research, v. 10, no. 4, p. 715–731.

———1978b, Volcanic dust influence on glacier mass balance at high latitudes: Nature, v. 271, no. 5647, p. 736–738.

Bradley, R.S., and Serreze, M.C., 1987a, Mass balance of two High Arctic plateau ice caps: Journal of Glaciology, v. 33, no. 113, p. 123–128.

———1987b, Topoclimatic studies of a High Arctic plateau ice cap: Journal of Glaciology, v. 33, no. 114, p. 149–158.

Braithwaite, R.J., 1981, On glacier energy balance, ablation, and air temperature: Journal of Glaciology, v. 27, no. 97, p. 381–391.

Branson, D., 1984., Magnitude and characteristics of ablation on four Torngat glaciers: B.A. honours thesis, St. John's, Newfoundland, Memorial University of Newfoundland, Department of Geography.

Brecher, H.H., 1966, Surface velocity measurements on the Kaskawulsh Glacier, Yukon Territory, Canada: Columbus, Ohio, Ohio State University, Institute of Polar Studies Report No. 21, 73 p.

Brugman, M.M., 1991, Scale dependent albedo variations and runoff from a glacierized Alpine basin, *in* Snow, hydrology and forests in high alpine areas, Proceedings of the Vienna Symposium, 11–24 August 1991: IAHS Publication No. 205, p. 61–71.

Brugman, M.M., Pietroniro, Alain, and Shi, Jiancheng, 1996, Mapping alpine snow and ice using Landsat TM and SAR imagery at Wapta Icefield: Canadian Journal of Remote Sensing, v. 22, no. 1, p. 127–129.

Brunger, A.G., Nelson, J.G., and Ashwell, I.Y., 1967, Recession of the Hector and Peyto Glaciers—Further studies in the Drummond Glacier, Red Deer River valley area, Alberta: Canadian Geographer, v. 11, no. 1, p. 35–48.

Burgess, D., Sharp, M., and Mair, D., 2001, Dynamics and volumetric changes of ice caps: Ice, no. 125, p. 15.

Bushnell, V.C., and Marcus, M.G., 1974, Icefield Ranges Research Project scientific results, v. 4: Montréal, Québec, Arctic Institute of North America and American Geographical Society, New York, 385 p.

Bushnell, V.C., and Ragle, R.H., 1969, Icefield Ranges Research Project scientific results, v. 1: Montréal, Québec, Arctic Institute of North America and American Geographical Society, New York, 224 p.

———1970, Icefield Ranges Research Project scientific results, v. 2: Montréal, Québec, Arctic Institute of North America and American Geographical Society, New York, 138 p.

———1972, Icefield Ranges Research Project scientific results, v. 3: Montréal, Québec, Arctic Institute of North America and American Geographical Society, New York, 259 p.

Cameron, R.L., 1976, Glaciological studies in the St. Elias Mountains, Alaska—Yukon Territory, 1968: Washington, D.C., National Geographic Society Research Reports 1968, v. 9, p. 57–59.

Campbell, P.I., Reid, I.A., and Shastal, John, 1969a, Glacier surveys in Alberta: Ottawa, Ont., Department of Energy, Mines and Resources, Water Survey of Canada, Inland Waters Branch Report Series No. 4, 16 p.

———1969b, Glacier surveys in British Columbia: Ottawa, Ont., Department of Energy, Mines and Resources, Water Survey of Canada, Inland Waters Branch Report Series No. 5, 18 p.

Canada, 1976, 1974–1976 survey of the Athabasca and Saskatchewan glaciers: Calgary, Alberta, Environment Canada, Western Region, Inland Waters Directorate, Calgary District Office, Water Survey of Canada, Internal report, 36 p.

———1977, Report on the influence of glaciers on the hydrology of streams affecting the proposed Alcan pipeline route: Vancouver, B.C., Fisheries and Environment Canada, Pacific Region, Inland Waters Directorate submitted by Glaciology Division, Unpublished report, pt. 1, 38 p., appendices, map and bibliography, 54 p.

———1982, 1978–1980 Survey of the Athabasca and Saskatchewan glaciers: Calgary, Alberta, Environment Canada, Western and Northern Region, Inland Waters Directorate, Calgary District Office, Water Survey of Canada, Internal report, 36 p.

———1990, Detailed review comments on the Windy Craggy Stage I environmental and socioeconomic impact assessment (January 1990): Vancouver, B.C., Environment Canada, Environmental Protection, Conservation and Protection, 114 p.

Cavell, Edward, 1983, Legacy in ice—The Vaux family and the Canadian Alps: Banff, Alberta, Altitude Publishing, Peter and Catharine Whyte Foundation, 98 p.

Champoux, André, and Ommanney, C.S.L., 1986a, Evolution of the Illecillewaet Glacier, Glacier National Park, B.C., using historical data, aerial photography and satellite image analysis: Annals of Glaciology, v. 8, p. 31–33.

———1986b, Photo-interpretation, digital mapping, and the evolution of glaciers in Glacier National Park, B.C: Annals of Glaciology, v. 8, p. 27–30.

Cialek, C.J., 1977, The Cathedral Massif, Atlin Provincial Park, British Columbia: Department of Geography, Michigan State University, sponsored by the Foundation for Glacier and Environmental Research, Pacific Science Center, Seattle, Washington, map, scale 1:20,000, contour interval 100 feet.

Clague, J.J., and Evans, S.G., 1994, Formation and failure of natural dams in the Canadian Cordillera: Geological Survey of Canada Bulletin No. 464, 35 p.

Clague, J.J., Evans, S.G., and Blown, I.G., 1985, A debris flow triggered by the breaching of a moraine-dammed lake, Klattasine Creek, British Columbia: Canadian Journal of Earth Sciences, v. 22, no. 10, p. 1492–1502.

Clarke, G.K.C., 1967, Geophysical measurements on the Kaskawulsh and Hubbard Glaciers, Yukon Territory: Montréal, Québec, Arctic Institute of North America, Technical Paper No. 20, 36 p.

———[1971], Temperature measurements in Fox Glacier, Yukon Territory, *in* Glaciers, Proceedings of IHD Workshop Seminar 1970, Vancouver, B.C., 24–25 September 1970: Ottawa, Ont., Canadian National Committee for the I.H.D., p. 47–48.

———1976, Thermal regulation of glacier surging: Journal of Glaciology, v. 16, no. 74, p. 231–250.

———1982, Glacier outburst floods from "Hazard Lake," Yukon Territory, and the problem of flood magnitude prediction: Journal of Glaciology, v. 28, no. 98, p. 3–21.

———1991, Length, width and slope influences on glacier surging: Journal of Glaciology, v. 37, no. 126, p. 236–246.

———1996, Lumped-element analysis of subglacial hydraulic circuits: Journal of Geophysical Research, v. 101, no. B8, p. 17,547–17,559.

Clarke, G.K.C., and Blake, E.W., 1991, Geometric and thermal evolution of a surge-type glacier in its quiescent state—Trapridge Glacier, Yukon Territory, Canada, 1969–89: Journal of Glaciology, v. 37, no. 125, p. 158–169.

Clarke, G.K.C., and Collins, S.G., 1984, The 1981–1982 surge of Hazard Glacier, Yukon Territory: Canadian Journal of Earth Sciences, v. 21, no. 3, p. 297–304.

Clarke, G.K.C., and Goodman, R.H., 1975, Radio echo soundings and ice-temperature measurements in a surge-type glacier: Journal of Glaciology, v. 14, no. 70, p. 71–78.

Clarke, G.K.C., and Jarvis, G.T., 1976, Post-surge temperatures in Steele Glacier, Yukon Territory, Canada: Journal of Glaciology, v. 16, no. 74, p. 261–268.

Clarke, G.K.C., and Mathews, W.H., 1981, Estimates of the magnitude of glacier outburst floods from Lake Donjek, Yukon Territory, Canada: Canadian Journal of Earth Sciences, v. 18, no. 9, p. 1452–1463.

Clarke, G.K.C., and Waddington, E.D., 1991, A three-dimensional theory of wind pumping: Journal of Glaciology, v. 37, no. 125, p. 89–96.

Clarke, G.K.C., and Waldron, D.A., 1984, Simulation of the August 1979 sudden discharge of glacier-dammed Flood Lake, British Columbia: Canadian Journal of Earth Sciences, v. 21, no. 4, p. 502–504.

Clarke, G.K.C., Collins, S.G., and Thompson, D.E., 1984, Flow, thermal structure, and subglacial conditions of a surge-type glacier: Canadian Journal of Earth Sciences, v. 21, no. 2, p. 232–240.

Clarke, G.K.C., Meldrum, R.D., and Collins, S.G., 1986a, Measuring glacier-motion fluctuations using a computer-controlled survey system: Canadian Journal of Earth Sciences, v. 23, no. 5, p. 727–733.

Clarke, G.K.C., Schmok, J.P., Ommanney, C.S.L., and Collins, S.G., 1986b, Characteristics of surge-type glaciers: Journal of Geophysical Research, v. 91, no. B7, p. 7165–7180.

Classen, D.F., 1977, Temperature profiles for the Barnes Ice Cap surge zone: Journal of Glaciology, v. 18, no. 80, p. 391–405.

Classen, D.F., and Clarke, G.K.C., 1971, Basal hot spot on a surge type glacier: Nature, v. 229, no. 5285, p. 481–483.

Clee, T.E., Savage, J.C., and Neave, K.G., 1969, Internal friction in ice near its melting point: Journal of Geophysical Research, v. 74, no. 4, p. 973–980.

Cochran, G. van B., 1978, Virginia Glacier Expedition 1977: Canadian Alpine Journal, v. 61, p. 36–38.

Cogley, J.G., 2001, Glaciers of the Canadian High Arctic: Ice, no. 125, p. 15.

Cogley, J.G., Adams, W.P., Ecclestone, M.A., Jung-Rothenhäusler, Friedrich, and Ommanney, C.S.L., 1995, Mass balance of Axel Heiberg Island glaciers, 1960–1991—A reassessment and discussion: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute, NHRI Science Report No. 6, 168 p.

———1996a, Mass balance of White Glacier, Axel Heiberg Island, N.W.T., Canada, 1960–1991: Journal of Glaciology, v. 42, no. 142, p. 548–563.

Cogley, J.G., Ecclestone, M.A., and Adams, W.P., 1996b, Fluctuations of the terminuses of White and Thompson Glaciers, Axel Heiberg Island, N.W.T., Canada: Eastern Snow Conference, 53rd Annual Meeting, Williamsburg, Virginia, 1–3 May 1996, Proceedings, p. 83–94.

Coleman, A.P., 1921, Glaciers of the Rockies and Selkirks (2d ed.): Ottawa, Ont., Department of the Interior, Dominion Parks Branch, 36 p.

Collier, E.P., 1958, Glacier variation and trends in run-off in the Canadian Cordillera, *in* General Assembly of Toronto, v. 4, September 3–14, 1957: Association Internationale d'Hydrologie Scientifique Publication No. 46, p. 344–357.

Collins, D.N., and Power, J.M., 1985, Meltwater provenance, hydrological pathways and hydrochemical processes in an alpine glacierised basin, *in* Water quality evolution within the hydrological cycle of watersheds, Québec, Québec, 10–12 June 1984, Proceedings of the Canadian Hydrology Symposium No. 15, v. 1: National Research Council of Canada (NRCC 24633), Associate Committee on Hydrology, p. 307–308.

Collins, D.N., and Young, G.J., 1979, Separation of runoff components in glacierized alpine watersheds by hydrochemical analysis, *in* Canadian Hydrology Symposium: 79—Cold Climate Hydrology, Vancouver, B.C., 10–11 May 1979, Proceedings: Ottawa, Ont., National Research Council of Canada (NRCC 17834), Associate Committee on Hydrology, p. 570–581.

———1981, Meltwater hydrology and hydrochemistry in snow- and ice-covered mountain catchments: Nordic Hydrology, v. 12, no. 4–5, p. 319–334.

Collins, I.F., 1970, A slip-line field analysis of the deformation at the confluence of two glacier streams: Journal of Glaciology, v. 9, no. 56, p. 169–193.

Collins, S.G., 1972, Survey of the Rusty Glacier area, Yukon Territory, Canada, 1967–70: Journal of Glaciology, v. 11, no. 62, p. 235–253.

———1980, Three surging glaciers, St. Elias Mountains, Canada: Washington, D.C., National Geographic Society Research Reports 1971, v. 12, p. 103–115.

Collins, S.G., and Clarke, G.K.C., 1977, History and bathymetry of a surge-dammed lake: Arctic, v. 30, no. 4, p. 217–224.

Crary, A.P., 1956, Geophysical studies along northern Ellesmere Island: Arctic, v. 9, no. 3, p. 155–165.

Cresswell, R.G., and Herd, R.K., 1991, Concentrations of cosmic spherules from the Devon Island ice cap, Devon Island, Northwest Territories [abs.], *in* Program with Abstracts, Geological Association of Canada and Mineralogical Association of Canada Joint Annual Meeting with Society of Economic Geologists, Toronto, Ontario, 27–29 May 1991, 16th: p. A27.

Cross, G.M., and Clarke, G.K.C., 1990, A waveform alignment approach to positioning airborne radar-sounding data: IEEE Transactions on Geoscience and Remote Sensing, v. 28, no. 1, p. 123–126.

Crossley, D.J., and Clarke, G.K.C., 1970, Gravity measurements on "Fox Glacier," Yukon Territory, Canada: Journal of Glaciology, v. 9, no. 57, p. 363–374.

Cutler, P.M., and Munro, D.S., 1996, Visible and near-infrared reflectivity during the ablation period on Peyto Glacier, Alberta, Canada: Journal of Glaciology, v. 42, no. 141, p. 333–340.

David, C.R., 1989, Hydrological regimes of nival and glacierized mountain basins, Yoho National Park, British Columbia: M.A. thesis, Ottawa, Ont., Ottawa University, Department of Geography, 127 p.

De la Barre, Kenneth, 1977, The Icefield Ranges Research Project, 1975 and 1976: Arctic, v. 30, no. 2, p. 130–132.

Demuth, M.N., ed., in press, Peyto Glacier—One century of science: Saskatoon, National Water Research Institute.

Demuth, M.N., Pietroniro, Alain, Hopkinson, C., and Sitar, M., 2001, Airborne LASER mapping of Wapta Icefield: Ice, no. 125, p. 14.

Denton, G.H., 1975a, Glaciers of the Canadian Rocky Mountains, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 1: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 603–653.

———1975b, Glaciers of the Coast Mountains (Pacific Ranges and Cascade Mountains) and Coast Ranges of British Columbia, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 1: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 671–687.

———1975c, Glaciers of the Interior Ranges of British Columbia, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 1: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 655–670.

Derikx, Leo, 1973, Glacier discharge simulation by ground-water analogue, *in* Symposium on the Hydrology of Glaciers, Cambridge, 7–13 September, 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 29–40.

———1975, The heat balance and associated runoff from an experimental site on a glacier tongue, *in* Snow and Ice Symposium, Moscow, August 1971, Proceedings: IAHS-AISH Publication No. 104, p. 59–69.

Derikx, Leo, and Loijens, H.[S.], 1971, Model of runoff from glaciers, *in* Runoff from snow and ice, Québec, 26–27 May 1971: National Research Council, Associate Committee on Geodesy and Geophysics, Subcommittee on Hydrology, Hydrology Symposium No. 8, v. 1, p. 153–199.

Desloges, J.R., and Church, Michael, 1992, Geomorphic implications of glacier outburst flooding—Noeick River valley, British Columbia: Canadian Journal of Earth Sciences, v. 29, no. 3, p. 551–564.

Desloges, J.R., Jones, D.P., and Ricker, K.E., 1989, Estimates of peak discharge from the drainage of ice-dammed Ape Lake, British Columbia, Canada: Journal of Glaciology, v. 35, no. 121, p. 349–354.

Dewart, Gilbert, 1968, Seismic investigation of ice properties and bedrock topography at the confluence of two glaciers, Kaskawulsh Glacier, Yukon Territory, Canada: Columbus, Ohio, Ohio State University, Institute of Polar Studies Report No. 27, 207 p.

Dibb, J.E., Rasmussen, R.A., Mayewski, P.A., and Holdsworth, Gerald, 1993, Northern Hemisphere concentrations of methane and nitrous oxide since 1800—Results from the Mt. Logan and 20D ice cores: Chemosphere, v. 27, no. 12, p. 2413–2423.

Dicks, W., Adams, W.P., and Ecclestone, M.[A.], 1992, Mass balance and ablation season processes, Baby Glacier, Axel Heiberg Island, N.W.T: Musk-ox, v. 39, p. 15–23.

Doake, C.S.M., Gorman, M.[R.], and Paterson, W.S.B., 1976, A further comparison of glacier velocities measured by radio-echo and survey methods: Journal of Glaciology, v. 17, no. 75, p. 35–38.

Doell, R.R., 1963, Seismic depth study of the Salmon Glacier, British Columbia: Journal of Glaciology, v. 4, no. 34, p. 425–437.

Dorrer, Egon, 1971, Movement of the Ward Hunt Ice Shelf, Ellesmere Island, N.W.T., Canada: Journal of Glaciology, v. 10, no. 59, p. 211–225.

Dowdeswell, J.A., 1986, The distribution and character of sediments in a tidewater glacier, southern Baffin Island, N.W.T., Canada: Arctic and Alpine Research, v. 18, no. 1, p. 45–56.

Duchemin, Marc, and Seguin, M.K., 1998, Modeling and simulation of Illecillewaet watershed, southeastern British Columbia, Canada [abs.]: EOS, Transactions, American Geophysical Union, v. 79, no. 45, Fall Meeting Supplement, p. F353.

Dunbar, Moira, and Greenaway, K.R., 1956, Arctic Canada from the air: Ottawa, Ont., Queen's Printer, Defence Research Board, 541 p.

Eagan, C.P., 1963, Résumé of the 1962 field season of the Michigan State University Glaciological Institute, Juneau Icefield, Alaska: Compass of Sigma Gamma Epsilon, v. 41, no. 1, p. 61–69.

Epstein, Samuel, and Sharp, R.P., 1959, Oxygen-isotope variations in the Malaspina and Saskatchewan Glaciers: Journal of Geology, v. 67, no. 1, p. 88–102.

Evans, D.J.A., 1989, The nature of glacitectonic structure and sediments at sub-polar glacier margins, northwest Ellesmere Island, Canada: Geografiska Annaler, v. 71A, no. 3–4, p. 113–123.

———1993, High-latitude rock glaciers—A case study of forms and processes in the Canadian Arctic: Permafrost and Periglacial Processes, v. 4, no. 1, p. 17–35.

Evans, D.J.A., and England, John, 1992, Geomorphological evidence of Holocene climatic change from northwest Ellesmere Island, Canadian High Arctic: Holocene, v. 2, no. 2, p. 148–158.

Evans, D.J.A., and Fisher, T.G., 1987, Evidence of a periodic ice-cliff avalanche on north-west Ellesmere Island, N.W.T., Canadian High Arctic: Journal of Glaciology, v. 33, no. 113, p. 68–71.

Evans, S.G., 1986, The maximum discharge of outburst floods caused by breaching of man-made and natural dams: Canadian Geotechnical Journal, v. 23, no. 3, p. 385–387.

Evans, S.G., and Clague, J.J., 1990, Reconnaissance observations on the Tim Williams Glacier rock avalanche, near Stewart, British Columbia: Geological Survey of Canada Paper No. 90–1E, p. 351–354.

Evans, Stanley, and Robin, G. de Q., 1966, Glacier depth-sounding from the air: Nature, v. 210, no. 5039, p. 883–885.

Eyles, Nicholas, and Rogerson, R.J., 1977a, Artificially induced thermokarst in active glacier ice—An example from northwest British Columbia, Canada: Journal of Glaciology, v. 18, no. 80, p. 437–444.

———1977b, Glacier movement, ice structures, and medial moraine form at a glacier confluence, Berendon Glacier, British Columbia: Canadian Journal of Earth Sciences, v. 14, no. 12, p. 2807–2816.

———1977c, How to save your mine from a glacier: Canadian Mining Journal, v. 98, no. 7, p. 32.

———1978a, A framework for the investigation of medial moraine formation—Austerdalsbreen, Norway, and Berendon Glacier, British Columbia, Canada: Journal of Glaciology, v. 20, no. 82, p. 99–113.

———1978b, Sedimentology of medial moraines on Berendon Glacier, British Columbia, Canada—Implications for debris transport in a glacierized basin: Geological Society of America Bulletin, v. 89, no. 11, p. 1688–1693.

Eyles, Nicholas, Sasseville, D.R., Slatt, R.M., and Rogerson, R.J., 1982, Geochemical denudation rates and solute transport mechanisms in a maritime temperate glacier basin: Canadian Journal of Earth Sciences, v. 19, no. 8, p. 1570–1581.

Faber, Th., 1973, Rusty Glacier basin, Yukon Territory, Canada—Results of the 1968 hydrological field work [abs.], *in* Symposium on the Hydrology of Glaciers, Cambridge, 7–13 September, 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 197.

Fahn, C., 1975, Glaciers of northern Labrador, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 2: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 673–682.

Faig, Wolfgang, 1966, Photogrammetry applied to Arctic glacier surveys: Ottawa, Ont., Department of National Defence, Defence Research Board, Operation Hazen Report D Phys R(G) Hazen 27, 56 p.

Falconer, G., 1962, Glaciers of northern Baffin and Bylot Islands, N.W.T.: Ottawa, Canada Department of Energy, Mines and Resources, Technical Surveys, Geographical Branch, Geographical Paper 33, 31 p.

Field, W.O., Jr., 1949, Glacier observations in the Canadian Rockies, 1948: Canadian Alpine Journal, v. 32, p. 99–114.

———1975a, Glaciers of the Coast Mountains—Boundary Ranges (Alaska, British Columbia, and Yukon Territory), *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 2: Hanover, N.H., U.S, Army Cold Regions Research and Engineering Lab., p. 11–141.

———1975b, Glaciers of the St. Elias Mountains, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 2: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 143–297.

———1975c, Mountain glaciers of the Northern Hemisphere: Hanover, N.H., American Geographical Society. U.S. Army Cold Regions Research and Engineering Lab., v. 1, 698 p., v. 2, 932 p., atlas, 49 plates.

———1990, Glaciers of Alaska and adjacent Yukon Territory and British Columbia: American Alpine Journal, v. 32, no. 64, p. 79–149.

Field, W.O., Jr., and Heusser, C.J., 1954, Glacier and botanical studies in the Canadian Rockies, 1953: Canadian Alpine Journal, v. 37, p. 128–140.

Field, W.O., Jr., and Miller, M.M., 1950, The Juneau Ice Field research project: Geographical Review, v. 40, no. 2, p. 179–190.

Fischer, U.H., and Clarke, G.K.C., 1994, Ploughing of subglacial sediment: Journal of Glaciology, v. 40, no. 134, p. 97–106.

———1997, Stick-slip sliding behaviour at the base of a glacier: Annals of Glaciology, v. 24, p. 390–396.

Fisher, D.[A.], 1973, Subglacial leakage of Summit Lake, British Columbia, by dye determinations, *in* Symposium on the Hydrology of Glaciers, Cambridge, 7–13 September, 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 111–116.

———1979, Comparison of 105 years of oxygen isotope and insoluble impurity profiles from the Devon Island and Camp Century ice cores: Quaternary Research, v. 11, no. 3, p. 299–305.

———1987, Enhanced flow of Wisconsin ice related to solid conductivity through strain history and recrystallization, *in* Symposium on the Physical Basis of Ice Sheet Modelling, Vancouver, British Columbia, Canada, 9–22 August, 1987, Proceedings: IASH Publication No. 170, p. 45–51.

Fisher, D.[A.], 1991, Remarks on the deuterium excess in precipitation in cold regions: Tellus, Series B., Chemical and Physical Meteorology, v. 43B, no. 5, p. 401–407.

———1992, Possible ice-core evidence for a fresh melt water cap over the Atlantic Ocean in the Early Holocene, *in* Bard, Edouard, and Broecker, W.S., eds., The last deglaciation—Absolute and radiocarbon chronologies: Berlin, Springer-Verlag, NATO ASI Series I: Global Environmental Change No. 2, p. 267–293.

Fisher, D.A., and Jones, S.J., 1971, The possible future behaviour of Berendon Glacier, Canada—A further study: Journal of Glaciology, v. 10, no. 58, p. 85–92.

Fisher, D.A., and Koerner, R.M., 1981, Some aspects of climatic change in the High Arctic during the Holocene as deduced from ice cores, *in* Mahaney, W.C., ed., Quaternary paleoclimate, Proceedings of Fourth Conference on Quaternary Research, Toronto, Ontario, 18–20 May 1979: Norwich, U.K., Geo Abstracts Ltd., p. 249–271.

———1986, On the special rheological properties of ancient microparticle-laden Northern Hemisphere ice as derived from bore-hole and core measurements: Journal of Glaciology, v. 32, no. 112, p. 501–510.

———1988, The effects of wind on $\delta(^{18}O)$ and accumulation give an inferred record of seasonal δ amplitude from the Agassiz Ice Cap, Ellesmere Island, Canada: Annals of Glaciology, v. 10, p. 34–37.

———1994, Signal and noise in four ice-core records from the Agassiz Ice Cap, Ellesmere Island, Canada—Details of the last millennium for stable isotopes, melt and solid conductivity: Holocene, v. 4, no. 2, p. 113–120.

Fisher, D.A., Koerner, R.M., Paterson, W.S.B., Dansgaard, Willi, Gundestrup, N.[S.], and Reeh, Niels, 1983, Effect of wind scouring on climatic records from ice-core oxygen-isotope profiles: Nature, v. 301, no. 5897, p. 205–209.

Fisher, D.A., Koerner, R.M., Kuivinen, K.C., Clausen, H.B., Johnsen, S.J., Steffensen, J.P., Gundestrup, N.S., and Hammer, C.U., 1996, Inter-comparison of $\delta^{18}O$ and precipitation records from sites in Canada and Greenland over the last 3500 years and over the last few centuries in detail using EOF techniques, *in* Jones, P.D., Bradley, R.S., and Jouzel, Jean, eds., Climatic variations and forcing mechanisms of the last 2000 years: Berlin, Springer-Verlag, NATO ASI Series I: Global Environmental Change No. 41, p. 297–328.

Fisher, D.A., Koerner, R.M., Bourgeois, J.C., Zielinski, G., Wake, C.[P.], Hammer, C.U., Clausen, H.B., Gundestrup, N.[S.], Johnsen, S.[J.], Goto-Azuma, Kumiko, Hondoh, Takeo, Blake, E.[W.], and Gerasimoff, M.[D.], 1998, Penny Ice Cap cores, Baffin island, Canada, and the Wisconsinan Foxe Dome connection—Two states of Hudson Bay ice cover: Science, v. 279, no. 5351, p. 692–695.

Fisher, D.A., Reeh, Niels, and Clausen, H.B., 1985, Stratigraphic noise in time series derived from ice cores: Annals of Glaciology, v. 7, p. 76–83.

Flowers, G.E., and Clarke, G.K.C., 1999, Surface and bed topography of Trapridge Glacier, Yukon Territory, Canada—Digital elevation models and derived hydraulic geometry: Journal of Glaciology, v. 45, no. 149, p. 165–174.

Fogarasi, Stephen, 1981, Albedo survey on Andrei Glacier, Iskut River basin, B.C., midsummer, 1980: Ottawa, Ont., Environment Canada, Inland Waters Directorate, National Hydrology Research Institute Paper No. 15, 13 p.

Fogarasi, Stephen, and Mokievsky-Zubok, Oleg, 1978, Principal components analysis on glacier-climatological data for Sentinel Glacier, British Columbia: Ottawa, Ont., Fisheries and Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 95, 9 p.

———1987, An analysis of flow data from Sentinel Creek, British Columbia—Part 1: Saskatoon, Sask., Environment Canada, Surface Water Division, National Hydrology Research Institute Contribution No. 87012, 43 p.

Föhn, P.M.B., 1973, Short-term snow melt and ablation derived from heat- and mass-balance measurements: Journal of Glaciology, v. 12, no. 65, p. 275–289.

Forbes, Alexander, Miller, O.M., Odell, N.E., and Abbe, E.C., 1938, Northernmost Labrador mapped from the air: New York, N.Y., American Geographical Society, Special Publication No. 22, 255 p. and maps.

Gardner, J.S., 1977, The Wenkchemna Glacier: Canadian Alpine Journal, v. 60, p. 58–59.

———1978, Wenkchemna Glacier—Ablation complex and rock glacier in the Canadian Rocky Mountains: Canadian Journal of Earth Sciences, v. 15, no. 7, p. 1200–1204.

———1992, The zonation of freeze-thaw temperatures at a glacier headwall, Dome Glacier, Canadian Rockies, *in* Dixon, J.C., and Abrahams, A.D., eds., Periglacial geomorphology: Chichester, John Wiley and Sons, p. 89–102.

Gardner, J.S., and Bajewsky, Ingrid, 1987, Hilda rock glacier stream discharge and sediment load characteristics, Sunwapta Pass area, Canadian Rocky Mountains, *in* Giardino, J.R., Shroder, J.F., Jr., and Vitek, J.D., eds., Rock glaciers: London, Allen and Unwin, p. 161–174.

Gardner, J.S., and Jones, N.K., 1985, Evidence for a Neoglacial advance of the Boundary Glacier, Banff National Park, Alberta: Canadian Journal of Earth Sciences, v. 22, no. 11, p. 1753–1755.

Gemmell, A.M.D., Sharp, M.J., and Sugden, D.E., 1986, Debris from the basal ice of the Agassiz Ice Cap, Ellesmere Island, Arctic Canada: Earth Surface Processes and Landforms, v. 11, no. 2, p. 123–130.

Gilbert, Robert, 1971, Observations on ice-dammed Summit Lake, British Columbia, Canada: Journal of Glaciology, v. 10, no. 60, p. 351–356.

Glenday, P.J., 1989, Mass balance parameterization, White Glacier, Axel Heiberg Island, N.W.T., 1970–80: B.A. thesis, Peterborough, Ont., Trent University, Department of Geography, 120 p.

———1991, Determination of morphologic and volumetric change, Peyto Glacier, Alberta, 1966–1989: M.A. thesis, Waterloo, Ont., Wilfrid Laurier University, Department of Geography, 130 p.

Goodison, B.E., [1971], The relation between ablation and global radiation over Peyto Glacier, Alberta, *in* Glaciers, Proceedings of IHD Workshop Seminar 1970, Vancouver, B.C., 24–25 September 1970: Ottawa, Ont., Canadian National Committee for the I.H.D., p. 39–42.

Goodison, B.E., [1971], 1972a, An analysis of climate and runoff events for Peyto Glacier, Alberta: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 21, 29 p.

———1972b, The distribution of global radiation over Peyto Glacier, Alberta: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 22, 22 p.

Goodman, R.H., 1970, Radio-echo sounding on temperate glaciers—A Canadian view, *in* Gudmandsen, P., ed., Proceedings of the International Meeting on Radio Glaciology, May 1970: Lyngby, Technical University of Denmark, Lab. of Electromagnetic Theory, p. 135–146.

———1973, Time-dependent intraglacier structures: Journal of Glaciology, v. 12, no. 66, p. 512–513.

———1975, Radio echo sounding on temperate glaciers: Journal of Glaciology, v. 14, no. 70, p. 57–69.

Goodman, R.H., and Terroux, A.C.D., 1973, Use of radio-echo sounder techniques in the study of glacial hydrology [abs.], *in* Symposium on the Hydrology of Glaciers, Cambridge, 7–13 September 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 149.

Goto-Azuma, Kumiko, Koerner, R.M., Nakawo, Masayoshi, and Kudo, Akira, 1997, Snow chemistry of Agassiz Ice Cap, Ellesmere Island, Northwest Territories, Canada: Journal of Glaciology, v. 43, no. 144, p. 199–206.

Gottlieb, Lars, 1980, Development and applications of a runoff model for snowcovered and glacierized basins: Nordic Hydrology, v. 11, no. 5, p. 255–272.

Gratton, D.J., Howarth, P.J., and Marceau, D.J., 1990, Combining DEM parameters with Landsat MSS and TM imagery in a GIS for mountain glacier characterization: IEEE Transactions on Geoscience and Remote Sensing, v. 28, no. 4, p. 766–769.

———1993, Using Landsat-5 Thematic Mapper and digital elevation data to determine the net radiation field of a mountain glacier: Remote Sensing of Environment, v. 43, no. 3, p. 315–331.

Green, W.S., 1890, Among the Selkirk glaciers—Being the account of a rough survey in the Rocky Mountain regions of British Columbia: London, Macmillan and Co., 251 p.

Gregor, D.J., 1992, Organic micropollutants in arctic snow and firn, *in* Woo, M.-k., and Gregor, D.J., eds., Arctic environment—Past, present and future, Proceedings of Symposium, Hamilton, Ontario, 14–15 November 1991: Hamilton, Ont., Department of Geography, McMaster University, p. 79–90.

Grumet, N.S., Wake, C.P., Zielinski, G.A., Fisher, D.[A.], Koerner, R.[M.], and Jacobs, J.D., 1998, Preservation of glaciochemical time series in snow and ice from the Penny Ice Cap, Baffin Island: Geophysical Research Letters, v. 25, no. 3, p. 357–360.

Guigné, J.-Y., 1975, Glacio-hydrological mass balance study of the Cathedral Massif Glacier system, 1975, Atlin, British Columbia, Canada: Seattle, WA, Foundation for Glacier and Environmental Research, Juneau Icefield Research Program, Internal Report, 69 p.

Haeberli, Wilfried, Hoelzle, Martin, and Frauenfelder, Regula, eds., 1999, Glacier mass balance bulletin: Zürich, World Glacier Monitoring Service, Bulletin No. 5 (1996–1997), p. 8.

Hallet, Bernard, 1976, The effect of subglacial chemical processes on glacier sliding: Journal of Glaciology, v. 17, no. 76, p. 209–221.

Hambrey, M.J., and Müller, Fritz, 1978, Structures and ice deformation in the White Glacier, Axel Heiberg Island, Northwest Territories, Canada: Journal of Glaciology, v. 20, no. 82, p. 41–66.

Hammer, K.M., and Smith, N.D., 1983, Sediment production and transport in a proglacial stream—Hilda Glacier, Alberta, Canada: Boreas, v. 12, no. 2, p. 91–106.

Hanson, Brian, 1987, Reconstructing mass-balance profiles from climate for an Arctic ice cap, *in* Symposium on The Physical Basis of Ice Sheet Modelling, Vancouver, British Columbia, Canada, 9–22 August 1987, Proceedings: IAHS Publication No. 170, p. 181–189.

———1990, Thermal response of a small ice cap to climatic forcing: Journal of Glaciology, v. 36, no. 122, p. 49–56.

Harmon, Don, and Robinson, Bart, 1981, Columbia Icefield—A solitude of ice: Banff, Alberta, Altitude Publishing Ltd., 103 p.

Harvey, L.D.D., 1988, Climatic impact of ice-age aerosols: Nature, v. 334, no. 6180, p. 333–335.

Hasenauer, R., 1984, Die Berechnung der Massenbilanz des Cathedral Glacier (Atlin region, B.C., Kanada) für die Jahre 1976/77 und 1977/78: Hausarbeit aus Geographie, Institut für Geographie, Universität Salzburg, Salzburg, Austria, 38 p.

Hattersley-Smith, Geoffrey, 1954, Glaciological reconnaissance in northern Ellesmere Island, *in* General Assembly of Rome, v. 4, 1954: Association Internationale d'Hydrologie Scientifique Publication No. 39, p. 229–235.

———1959, Research in the Lake Hazen region of northern Ellesmere Island in the International Geophysical Year: The Arctic Circular, v. 12, no. 1, p. 2–12.

———1960a, Glaciological studies—Snow cover, accumulation and ablation: Ottawa, Ont., Department of National Defence, Defence Research Board, Operation Hazen D Phys R(G) Hazen 10, 13 p.

———1960b, Studies of englacial profiles in the Lake Hazen area of northern Ellesmere Island: Journal of Glaciology, v. 3, no. 27, p. 610–625.

———1961, Glaciological studies on Gilman Glacier, progress report 1960: Ottawa, Ont., Department of National Defence, Defence Research Board, Operation Hazen D Phys R(G) Hazen 16, 13 p.

———1964, Rapid advance of glacier in northern Ellesmere Island: Nature, v. 201, no. 4915, p. 176.

———1969a, Recent observations on the surging Otto Glacier, Ellesmere Island: Canadian Journal of Earth Sciences, pt. 2, v. 6, no. 4, p. 883–889.

———1969b, Results of radio echo soundings in northern Ellesmere Island, 1966: The Geographical Journal, v. 135, no. 4, p. 553–557.

Hattersley-Smith, Geoffrey, 1974, North of Latitude Eighty—The Defence Research Board in Ellesmere Island: Ottawa, Ont., Information Canada Cat. No. DR3-1774, Defence Research Board, 121 p.

———1985, Spreading rate of an Arctic ice shelf: Nature, v. 315, no. 6019, p. 462.

Hattersley-Smith, Geoffrey, and Serson, H.[V.], 1970, Mass balance of the Ward Hunt Ice Rise and Ice Shelf—A 10 year record: Journal of Glaciology, v. 9, no. 56, p. 247–252.

———1973, Reconnaissance of a small ice cap near St. Patrick Bay, Robeson Channel, northern Ellesmere Island, Canada: Journal of Glaciology, v. 12, no. 66, p. 417–421.

Hattersley-Smith, Geoffrey, Lotz, J.R., and Sagar, R.B., 1961, The ablation season on Gilman Glacier, northern Ellesmere Island, *in* General Assembly of Helsinki, 25 July–6 August 1960: Association Internationale d'Hydrologie Scientifique Publication No. 54, p. 152–168.

Haumann, Dieter, 1960, Photogrammetric and glaciological studies of Salmon Glacier: Arctic, v. 13, no. 2, p. 75–110 and map.

Havens, J.M., 1964, Meteorology and heat balance of the accumulation area, McGill Ice Cap, Canadian Arctic Archipelago—Summer 1960 (Upper Ice Station I, 79°41' N., 90°27' W., 1530 m): Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Meteorology No. 2, 87 p.

Havens, J.M., Müller, Fritz, and Wilmot, G.C., 1965, Comparative meteorological survey and a short-term heat balance study of the White Glacier, Canadian Arctic Archipelago—summer 1962: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Meteorology No. 4, 68 p.

Haythornthwaite, T.W., 1988, Topographic change of the Meighen Ice Cap, Meighen Island, N.W.T., *in* Adams, W.P., and Johnson, P.G., eds., Student research in Canada's North: National Student Conference on Northern Studies, Proceedings, Ottawa, Ontario, 18–19 November 1986, p. 87–92.

Hector, James, 1861, On the geology of the country between Lake Superior and the Pacific Ocean between the 48th and 54th parallels: Quarterly Journal of the Geological Society of London, v. 17, no. 68, p. 388–445.

Hell, Günther, and King, Lorenz, 1988, Fluctuations of a glacier tongue 1958–1978 at Hare Fjord, N.W.T., Canada, 1:20,000, *in* Haeberli, W. and Müller, P., eds., Fluctuations of glaciers 1980–1985, v. V: Wallingford, Oxfordshire, U.K., IAHS Press; Nairobi, UNEP; Paris, UNESCO, p. 66–67 and map.

Henoch, W.E.S., 1971, Estimate of glaciers' secular (1948–1966) volumetric change and its contribution to the discharge in the upper North Saskatchewan River basin: Journal of Hydrology, v. 12, no. 2, p. 145–160.

———1972, Glacier variations, *in* Guidebook to the International Symposium on the Role of Snow and Ice in Hydrology, 1972, Banff, Alberta: Ottawa, Ont., Canadian National Committee for I.H.D., p. 91–96.

Henoch, W.E.S., and Croizet, J.L., 1976, The Peyto Glacier map/A three-dimensional depiction of mountain relief: Canadian Cartographer, v. 13, no. 1, p. 69–86.

Heusser, C.J., 1954, Glacier fluctuations in the Canadian Rockies, *in* General Assembly of Rome, v. 4, 1954: Association Internationale d'Hydrologie Scientifique Publication No. 39, p. 493–497.

———1956, Postglacial environments in the Canadian Rocky Mountains: Ecological Monographs, v. 26, no. 4, p. 263–302.

———1960, Late-Pleistocene environments of North Pacific North America—An elaboration of Late-Glacial and Postglacial climatic, physiographic and biotic changes: New York, American Geographical Society, Special Publication No. 35, 308 p.

Hobson, G.D., and Jobin, Claude, 1975, A seismic investigation—Peyto Glacier, Banff National Park and Woolsey Glacier, Mount Revelstoke National Park: Geoexploration, v. 13, no. 2, p. 117–127.

Hoffmann, J.W., and Clarke, G.K.C., 1973, Periodic temperature instabilities in sub-polar glaciers, *in* The role of snow and ice in hydrology, Proceedings of the Banff Symposium, September 1972: IAHS-AISH Publication No. 107, v. 1, p. 445–453.

Holdsworth, Gerald, 1965, An examination and analysis of the formation of transverse crevasses, Kaskawulsh Glacier, Yukon Territory, Canada: Columbus, Ohio, Ohio State University, Institute of Polar Studies Report No. 16, p. 91.

———1969, Primary transverse crevasses: Journal of Glaciology, v. 8, no. 52, p. 107–129.

———1971, Calving from Ward-Hunt Ice Shelf 1961–62: Canadian Journal of Earth Sciences, v. 8, no. 2, p. 299–305.

———1973a, Evidence of a surge on Barnes Ice Cap, Baffin Island: Canadian Journal of Earth Sciences, v. 10, no. 10, p. 1565–1574.

———1973b, Ice calving into the proglacial Generator Lake, Baffin Island, N.W.T., Canada: Journal of Glaciology, v. 12, no. 65, p. 235–250.

———1975, Deformation and flow of Barnes Ice Cap, Baffin Island: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 52, 19 p.

———1977a, Glaciological studies on Mt. Logan: Canadian Alpine Journal, v. 60, p. 57–58.

———1977b, Ice flow and related measurements of d'Iberville Glacier, Ellesmere Island, N.W.T., Canada: Ottawa, Ont., Environment Canada, Inland Waters Directorate, Glaciology Division, Internal report, 28 p.

———1977c, Surge activity on the Barnes Ice Cap: Nature, v. 269, no. 5629, p. 588–590.

———1978, Some mechanisms for the calving of icebergs; *in* Husseiny, A.A., ed., Iceberg utilization: New York, Pergamon Press, p. 160–165.

———1983, A 100 year ice core record of volcanic pollution, topospheric [sic] chemistry and climate change in the Yukon [abs.], *in* Neighbours in science, Alaska Science Conference, 34th Alaska/Canada North, Whitehorse, Yukon, 28 September–1 October 1983, Proceedings: American Association for the Advancement of Science, Arctic Division, p. 132.

———1984, Glaciological reconnaissance of an ice core drilling site, Penny Ice Cap, Baffin Island: Journal of Glaciology, v. 30, no. 104, p. 3–15.

———1986a, Evidence of a link between atmospheric thermonuclear detonations and nitric acid: Nature, v. 324, no. 6097, p. 551–553.

———1986b, Ice shelf creep rates and the flow law of ice: Nature, v. 319, no. 6056, p. 727.

———1987, The surface wave forms on the Ellesmere Island ice shelves and ice islands, *in* Pilkington, G.R., and Danielwicz, B.W., eds., Workshop on Extreme Ice Features, Banff, Alberta, 3–5 November 1986: Ottawa, Ont., National Research Council of Canada (NRCC 28003), Snow and Ice Subcommittee, Associate Committee on Geotechnical Research Technical Memorandum No. 141, p. 385–403.

———1990, Scientific correspondence—Sunspot cycles and climate: Nature, v. 346, no. 6286, p. 705–706.

Holdsworth, Gerald, and Jones, D.P., 1979, Glaciological studies on Mt. Logan, 1978: Canadian Alpine Journal, v. 62, p. 67.

Holdsworth, Gerald, and Peake, E., 1985, Acid content of snow from a mid-troposphere sampling site on Mount Logan, Yukon Territory, Canada: Annals of Glaciology, v. 7, p. 153–160.

Holdsworth, Gerald, and Sawyer, B., 1993, Mount Logan map, research and reference folio: Calgary, Alberta, Arctic Institute of North America, two map sheets.

Holdsworth, Gerald, Demuth, M.N., and Beck, T.M.H., in press, Radar measurements of ice thickness on Peyto Glacier, Alberta, *in* Demuth, M.N., ed., Peyto Glacier—One century of science: Saskatoon, National Water Research Institute.

Holdsworth, Gerald, Fogarasi, Stephen, and Krouse, H.R., 1991, Variation of the stable isotopes of water with altitude in the St. Elias Mountains of Canada: Journal of Geophysical Research, v. 96, no. D4, p. 7483–7494.

Holdsworth, Gerald, Krouse, H.R., and Nosal, M., 1992, Ice core climate signals from Mount Logan, Yukon A.D. 1700–1987, *in* Bradley, R.S., and Jones, P.D., eds., Climate since A.D. 1500: London, Routledge, p. 483–504.

Holdsworth, Gerald, Krouse, H.R., Nosal, M., Spencer, M.J., and Mayewski, P.A., 1989, Analysis of a 290-year net accumulation time series from Mt. Logan, Yukon, *in* Snow cover and glacier variations, Proceedings of the Baltimore Symposium, 10–19 May, 1989: IAHS-AISH Publication No. 183, p. 71–79.

Holdsworth, Gerald, Pourchet, Michel, Prantl, F.A., and Meyerhof, D.P., 1984, Radioactivity levels in a firn core from the Yukon Territory, Canada: Atmospheric Environment, v. 18, no. 2, p. 461–466.

Holmgren, Björn, 1971, Climate and energy exchange on a subpolar ice cap in summer; Arctic Institute of North America Devon Island Expedition 1961–1963, 5 Parts: Uppsala, Uppsala Universitet, Meteorologiska Institutionen, Meddelande Nr. 107–112, 83 p., 47 p., 43 p., 29 p., 111 p., and 53 p.

Hooke, R. LeB., 1973a, Flow near the margin of the Barnes Ice Cap, and the development of ice-cored moraines: Geological Society of America Bulletin, v. 84, no. 12, p. 3929–3948.

———1973b, Structure and flow in the margin of the Barnes Ice Cap, Baffin Island, N.W.T., Canada: Journal of Glaciology, v. 12, no. 66, p. 423–438.

———1976a, Near-surface temperatures in the superimposed ice zone and lower part of the soaked zone of polar ice sheets [abs.]: Journal of Glaciology, v. 16, no. 74, p. 302–304.

———1976b, Pleistocene ice at the base of the Barnes Ice Cap, Baffin Island, N.W.T., Canada: Journal of Glaciology, v. 17, no. 75, p. 49–59.

———1981, Flow law for polycrystalline ice in glaciers—Comparison of theoretical predictions, laboratory data, and field measurements: Reviews of Geophysics and Space Physics, v. 19, no. 4, p. 664–672.

Hooke, R. LeB., and Clausen, H.B., 1982, Wisconsin and Holocene $\delta^{18}O$ variations, Barnes Ice Cap, Canada: Geological Society of America Bulletin, v. 93, no. 8, p. 784–789.

Hooke, R. LeB., and Hanson, Brian, 1986, Borehole deformation experiments, Barnes Ice Cap, Canada: Cold Regions Science and Technology, v. 12, no. 3, p. 261–276.

Hooke, R. LeB., and Hudleston, P.J., 1980, Ice fabrics in a vertical flow plane, Barnes Ice Cap, Canada: Journal of Glaciology, v. 25, no. 92, p. 195–214.

———1981, Ice fabrics from a borehole at the top of the south dome, Barnes Ice Cap, Baffin Island: Geological Society of America Bulletin, pt. 1, v. 92, no. 5, p. 274–281.

Hooke, R. LeB., Alexander, E.C., Jr., and Gustafson, R.J., 1980, Temperature profiles in the Barnes Ice Cap, Baffin Island, Canada, and heat flux from the subglacial terrane: Canadian Journal of Earth Sciences, v. 17, no. 9, p. 1174–1188.

Hooke, R. LeB., Gould, J.E., and Brzozowski, Jerzy, 1983, Near-surface temperatures near and below the equilibrium line on polar and subpolar glaciers: Zeitschrift für Gletscherkunde und Glazialgeologie, v. 19, no. 1, p. 1–25.

Hooke, R. LeB., Johnson, G.W., Brugger, K.A., Hanson, Brian, and Holdsworth, Gerald, 1987, Changes in mass balance, velocity, and surface profile along a flow line on Barnes Ice Cap, 1970–1984: Canadian Journal of Earth Sciences, v. 24, no. 8, p. 1550–1561.

Hooke, R. LeB., Raymond, C.F., Hotchkiss, R.L., and Gustafson, R.J., 1979, Calculations of velocity and temperature in a polar glacier using the finite-element method: Journal of Glaciology, v. 24, no. 90, p. 131–146.

Horvath, Eva, 1975, Glaciers of the Yukon and Northwest Territories (excluding the Queen Elizabeth Islands and St. Elias Mountains), *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 1: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 689–698.

Hudleston, P.J., 1976, Recumbent folding in the base of the Barnes Ice Cap, Baffin Island, Northwest Territories, Canada: Geological Society of America Bulletin, v. 87, no. 12, p. 1684–1692.

Hudleston, P.J., 1980, The progressive development of inhomogeneous shear and crystallographic fabric in glacial ice: Journal of Structural Geology, v. 2, no. 1–2, p. 189–196.

———1983, Strain patterns in an ice cap and implications for strain variations in shear zones: Journal of Structural Geology, v. 5, no. 3–4, p. 455–463.

Hudleston, P.J., and Hooke, R. LeB., 1980, Cumulative deformation in the Barnes Ice Cap and implications for the development of foliation: Tectonophysics, v. 66, no. 1–3, p. 127–146.

Hyndman, R.D., 1965, Gravity measurements on the Devon Island ice cap and an adjoining glacier: Journal of Glaciology, v. 5, no. 40, p. 489–496.

Iken, Almut, 1972, Measurements of water pressure in moulins as part of a movement study of the White Glacier, Axel Heiberg Island, Northwest Territories, Canada: Journal of Glaciology, v. 11, no. 61, p. 53–58.

———1974, Velocity fluctuations of an Arctic valley glacier; a study of the White Glacier, Axel Heiberg Island, Canadian Arctic Archipelago: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Glaciology No. 5, 116 p.

Illangasekare, T.H., Walter, R.J., Jr., Meier, M.F., and Pfeffer, W.T., 1990, Modeling of meltwater infiltration in subfreezing snow: Water Resources Research, v. 26, no. 5, p. 1001–1012.

Iverson, N.R., 1991, Morphology of glacial striae: Implications for abrasion of glacier beds and fault surfaces: Geological Society of America Bulletin, v. 103, no. 10, p. 1308–1316.

Ives, J.D., 1966, Glaciology in the Geographical Branch, 1961–1965: Geographical Bulletin, v. 8, no. 1, p. 1–2.

———1967a, Glacier terminal and lateral features in northeast Baffin Island—Illustrations with descriptive notes: Geographical Bulletin, v. 9, no. 2, p. 106–114.

———1967b, Glacier terminal features in northeast Baffin Island—Illustrations with descriptive notes: Geographical Bulletin, v. 9, no. 1, p. 62–70.

———1967c, Glaciers: Canadian Geographical Journal, v. 74, no. 4, p. 110–117.

Jackson, L.E., Jr., 1979, A catastrophic glacial outburst flood (jökulhlaup) mechanism for debris flow generation at the Spiral Tunnels, Kicking Horse River basin, British Columbia: Canadian Geotechnical Journal, v. 16, no. 4, p. 806–813.

———1980, New evidence on the origin of the September 6, 1978 jökulhlaup from Cathedral Glacier, British Columbia: Geological Survey of Canada Paper No. 80–1B, p. 292–294.

Jackson, L.E., Jr., Hungr, O., Gardner, J.S., and Mackay, C., 1989, Cathedral Mountain debris flows: Bulletin of the International Association of Engineering Geology, v. 40, p. 35–54.

Jacobs, J.A., 1958, Geophysical investigations on the Salmon Glacier, British Columbia, *in* Symposium on Physics of the Movement of the Ice, Symposium of Chamonix, September 16–24, 1958: Association Internationale d'Hydrologie Scientifique Publication No. 47, p. 43–44.

Jacobs, J.D., Andrews, J.T., Barry, R.G., Bradley, R.S., Weaver, Ronald, and Williams, L.D., 1973, Glaciological and meteorological studies on the Boas Glacier, Baffin Island, for two contrasting seasons (1969–70 and 1970–71), *in* The role of snow and ice in hydrology, Proceedings of the Banff Symposium, September 1972: IAHS-AISH Publication No. 107, v. 1, p. 371–382.

Jacobs, J.D., Simms, É.L., and Simms, A.[E.], 1997, Recession of the southern part of Barnes Ice Cap, Baffin Island, Canada, between 1961 and 1993, determined from digital mapping of Landsat TM: Journal of Glaciology, v. 43, no. 143, p. 98–102.

Jarvis, G.T., and Clarke, G.K.C., 1974, Thermal effects of crevassing on Steele Glacier, Yukon Territory, Canada: Journal of Glaciology, v. 13, no. 68, p. 243–254.

———1975, The thermal regime of Trapridge Glacier and its relevance to glacier surging: Journal of Glaciology, v. 14, no. 71, p. 235–250.

Jeffries, M.[O.], 1982, The Ward Hunt Ice Shelf, Spring 1982: Arctic, v. 35, no. 4, p. 542–544.

———1984, Milne Glacier, northern Ellesmere Island, N.W.T., Canada—A surging glacier?: Journal of Glaciology, v. 30, no. 105, p. 251–253.

———1986a, Glaciers and the morphology and structure of Milne Ice Shelf, Ellesmere Island, N.W.T., Canada: Arctic and Alpine Research, v. 18, no. 4, p. 397–405.

———1986b, Ice island calvings and ice shelf changes, Milne Ice Shelf and Ayles Ice Shelf, Ellesmere Island, N.W.T.: Arctic, v. 39, no. 1, p. 15–19.

———1991, Perennial water stratification and the role of basal freshwater flow in the mass balance of the Ward Hunt Ice Shelf, Canadian High Arctic, *in* Weller, Gunter, Wilson, C.L., and Severin, B.A.B., eds., International Conference on the Role of the Polar Regions in Global Change, Proceedings of a conference held 11–15 June 1990 at the University of Alaska Fairbanks, v. 1: Fairbanks, AK, University of Alaska, Geophysical Institute/Center for Global Change and Arctic System Research, p. 332–337.

———1992, Arctic ice shelves and ice islands—Origin, growth and disintegration, physical characteristics, structural-stratigraphic variability, and dynamics: Reviews of Geophysics, v. 30, no. 3, p. 245–267.

Jeffries, M.O., and Krouse, H.R., 1985, Arctic ice shelf growth, fiord oceanography and climate: Zeitschrift für Gletscherkunde und Glazialgeologie, 1984, v. 20, p. 147–153.

Jeffries, M.O., and Sackinger, W.M., 1990, Ice island detection and characterization with airborne synthetic aperture radar: Journal of Geophysical Research, v. 95, no. C 4, p. 5371–5377.

Jeffries, M.O., and Serson, H.[V.], 1983, Recent changes at the front of Ward Hunt Ice Shelf, Ellesmere Island, N.W.T.: Arctic, v. 36, no. 3, p. 289–290.

Jeffries, M.O., and Serson, H.V., 1986, Survey and mapping of recent ice shelf changes and landfast sea ice growth along the north coast of Ellesmere Island, NWT, Canada: Annals of Glaciology, v. 8, p. 96–99.

Jeffries, M.O., Sackinger, W.M., Krouse, H.R., and Serson, H.V., 1988, Water circulation and ice accretion beneath Ward Hunt Ice Shelf (northern Ellesmere Island, Canada), deduced from salinity and isotope analysis of ice cores: Annals of Glaciology, v. 10, p. 68–72.

Jeffries, M.O., Serson, H.V., Krouse, H.R., and Sackinger, W.M., 1991, Ice physical properties, structural characteristics and stratigraphy in Hobson's Choice Ice Island and implications for the growth history of East Ward Hunt Ice Shelf, Canadian High Arctic: Journal of Glaciology, v. 37, no. 126, p. 247–260.

Johnson, P.G., 1971, Ice-cored moraine formation and degradation, Donjek Glacier, Yukon Territory, Canada: Geografiska Annaler, v. 53A, no. 3–4, p. 198–202.

———1972, The morphological effects of surges of the Donjek Glacier, St. Elias Mountains, Yukon Territory, Canada: Journal of Glaciology, v. 11, no. 62, p. 227–234.

———1976, Environmental controls on geomorphic processes, Grizzly Creek, south-west Yukon Territory: Ottawa, Ont., University of Ottawa, Department of Geography and Regional Planning Research Note No. 9, 108 p.

———1980a, Glacier-rock glacier transition in the southwest Yukon Territory, Canada: Arctic and Alpine Research, v. 12, no. 2, p. 195–204.

———1980b, Rock glaciers—Glacial and non-glacial origin, *in* World Glacier Inventory Workshop, Riederalp, Switzerland, 17–22 September, 1978: IAHS-AISH Publication No. 126, p. 285–293.

———1981, The structure of a talus-derived rock glacier deduced from its hydrology: Canadian Journal of Earth Sciences, v. 18, no. 9, p. 1422–1430.

———1983, Rock glaciers—a case for a change in nomenclature: Geografiska Annaler, v. 65A, no. 1–2, p. 27–34.

———1984, Rock glacier formation by high-magnitude low-frequency slope processes in the southwest Yukon: Annals of the Association of American Geographers, v. 74, no. 3, p. 408–419.

———1985, Implications of Holocene palaeoclimatic changes for the glacier hydrology of the southwest Yukon: Zeitschrift für Gletscherkunde und Glazialgeologie, v. 21, p. 165–174.

———1991a, Discharge regimes of a glacierized basin, Slims River, Yukon, *in* Prowse, T.D., and Ommanney, C.S.L., eds., Northern hydrology—Selected perspectives, Proceedings of the Northern Hydrology Symposium, Saskatoon, 10–12 July 1990: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute Symposium No. 6, p. 151–164.

———1991b, Pulses in glacier discharge:—Indicators of the internal drainage system of glaciers, *in* Prowse, T.D., and Ommanney, C.S.L., eds., Northern hydrology—Selected perspectives, Proceedings of the Northern Hydrology Symposium, Saskatoon, 10–12 July 1990: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute Symposium No. 6, p. 165–175.

———1992, Stagnant glacier ice, St. Elias Mountains, Yukon: Geografiska Annaler, v. 74A, no. 1, p. 13–19.

Johnson, P.G., 1998, Morphology and surface structures of Maxwell Creek rock glaciers, St. Elias Mountains, Yukon—Rheological implications: Permafrost and Periglacial Processes, v. 9, no. 1, p. 57–70.

Johnson, P.G., and David, C.R., 1987, Impacts on river discharge of changes in glacierized components of mountain basins: Water Pollution Research Journal of Canada, v. 22, no. 4, p. 518–529.

Johnson, P.G., and Kasper, J.N., 1992, The development of an ice-dammed lake—The contemporary and older sedimentary record: Arctic and Alpine Research, v. 24, no. 4, p. 304–313.

Johnson, P.G., and Lacasse, Diane, 1988, Rock glaciers of the Dalton Range, Kluane Ranges, south-west Yukon Territory, Canada: Journal of Glaciology, v. 34, no. 118, p. 327–332.

Johnson, P.G., and Power, J.M., 1985, Flood and landslide events, Peyto Glacier terminus, Alberta, Canada, 11–14 July 1983: Journal of Glaciology, v. 31, no. 108, p. 86–91.

Johnson, R.F., 1983, Ice movement and structural characteristics of the Cathedral Glacier system, Atlin Provincial Park, British Columbia: M.Sc. thesis, Bozeman, MT, Montana State University, 65 p.

Jones, D.P., Ricker, K.E., Desloges, J.R., and Maxwell, M.G., 1985, Glacier outburst flood on the Noeick River—The draining of Ape Lake, British Columbia, October 20, 1984: Geological Survey of Canada Open File Report No. 1139, p. 107 and maps.

Jones, F.H.M., Narod, B.B., and Clarke, G.K.C., 1989, Design and operation of a portable, digital impulse radar: Journal of Glaciology, v. 35, no. 119, p. 143–148.

Jones, N.K., 1987, Debris transport and deposition at Boundary Glacier, Banff National Park, Alberta: Ph.D. thesis, Waterloo, Ont., University of Waterloo, Department of Geography.

Jones, S.J., 1972, Radio depth-sounding on Meighen and Barnes Ice Caps, Arctic Canada: Ottawa, Ont., Environment Canada, Inland Waters Directorate Scientific Series No. 25, 13 p.

Jones, V.K., 1974, Late-Neoglacial regimes of an inland cirque glacier and their paleoclimatic implications, *in* Quaternary environments, York University Symposium on Quaternary Research, 1st: Toronto, Ont., York University, Atkinson College, Geographical Monographs No. 5, p. 293–294.

Jung-Rothenhäusler, Friedrich, Cogley, J.G., and Adams, [W.]P., 1992, Preparations for a glacier study using Landsat imagery and a digital elevation model: Musk-ox, v. 39, p. 31–38.

Kanasewich, E.R., 1963, Gravity measurements on the Athabaska Glacier, Alberta, Canada: Journal of Glaciology, v. 4, no. 35, p. 617–631.

Kasper, J.N., and Johnson, P.G., 1991, Drainage of an ice-dammed lake, Kaskawulsh Glacier basin, Yukon, *in* Prowse, T.D., and Ommanney, C.S.L., eds., Northern hydrology—Selected perspectives, Proceedings of the Northern Hydrology Symposium, Saskatoon, 10–12 July 1990: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute Symposium No. 6, p. 177–188.

Kavanaugh, J.L., and Clarke, G.K.C., 1996, An instrument for detecting seasonal changes in sliding rate [abs.]: EOS, Transactions, American Geophysical Union, v. 77, no. 46, Fall Meeting Supplement, p. F218.

Keeler, C.M., 1964, Relationship between climate, ablation, and run-off on the Sverdrup Glacier, 1963, Devon Island, N.W.T: Montréal, Québec, Arctic Institute of North America Research Paper No. 27, 125 p.

———1969, Snow accumulation on Mount Logan, Yukon Territory, Canada: Water Resources Research, v. 5, no. 3, p. 719–723.

Keller, G.V., and Frischknecht, F.C., 1960, Electrical resistivity studies on the Athabasca Glacier, Alberta, Canada: Journal of Research of the National Bureau of Standards, Washington, D.C., v. 64D, no. 5, p. 439–448.

———1961, Induction and galvanic resistivity studies on the Athabasca Glacier, Alberta, Canada, *in* Raasch, G.O., ed., Geology of the Arctic, v. 2: Toronto, Ont., University of Toronto Press, p. 809–832.

King, Lorenz, 1983, Contribution to the glacial history of the Borup Fiord area, northern Ellesmere Island, N.W.T., Canada, *in* Schroeder-Lanz, H., ed., Late-and postglacial oscillations of glaciers—Glacial and periglacial forms, Colloquium, Trier, Germany, 15–17 May 1980: Rotterdam, A.A. Balkema, p. 305–323.

Kite, G.[W.], 1994, Measuring glacier outflows using a computerized conductivity system: Journal of Glaciology, v. 40, no. 134, p. 93–96.

Kite, G.W., and Reid, I.A., 1977, Volumetric change of the Athabasca Glacier over the last 100 years: Journal of Hydrology, v. 32, no. 3–4, p. 279–294.

Koerner, R.M., 1966, Accumulation on the Devon Island ice cap, Northwest Territories, Canada: Journal of Glaciology, v. 6, no. 45, p. 383–392.

———1968, Fabric analysis of a core from the Meighen Ice Cap, Northwest Territories, Canada: Journal of Glaciology, v. 7, no. 51, p. 421–430.

———1970a, The mass balance of the Devon Island ice cap, Northwest Territories, Canada, 1961–66: Journal of Glaciology, v. 9, no. 57, p. 325–336.

———1970b, Some observations on superimposition of ice on the Devon Island ice cap, N.W.T. Canada: Geografiska Annaler, v. 52A, no. 1, p. 57–67.

———1973, Specific electrolytic conductivity of snow and deep core samples, Canadian Arctic Archipelago, *in* The role of snow and ice in hydrology, Proceedings of the Banff Symposium, September 1972: IAHS-AISH Publication No. 107, v. 1, p. 51–63.

———1977a, Devon Island ice cap—Core stratigraphy and paleoclimate: Science, v. 196, no. 4285, p. 15–18.

———1977b, Distribution of microparticles in a 299-m core through the Devon Island ice cap, Northwest Territories, Canada, *in* Isotopes and impurities in snow and ice, Proceedings of the Grenoble Symposium, August/September 1975: IAHS-AISH Publication No. 118, p. 371–376.

———1977c, Ice thickness measurements and their implications with respect to past and present ice volumes in the Canadian High Arctic ice caps: Canadian Journal of Earth Sciences, v. 14, no. 12, p. 2697–2705.

———1979, Accumulation, ablation, and oxygen isotope variations on the Queen Elizabeth Islands ice caps, Canada: Journal of Glaciology, v. 22, no. 86, p. 25–41.

Koerner, R.M., 1983, Conditions at the ice/rock interface of large ice sheets, *in* Heinrich, W., ed., Workshop on Transitional Processes, 4–5 November 1982, Ottawa, Ontario: Pinewa, Manitoba, Whiteshell Nuclear Research Establishment, Atomic Energy of Canada Ltd., p. 200–211.

———1985, The Canadian Arctic Islands—Glacier mass balance and global sea level, *in* Glaciers, ice sheets, and sea level: effect of a CO_2-induced climatic change, Report of a workshop held in Seattle, Washington, September 13–15, 1984: Washington, D.C., U.S. Department of Energy, Office of Energy Research, Attachment 7, Report DOE/ER/60235-1, p. 145–154.

———1986, Novyy metod ispol'zovaniya lednikov dlya monitoringa izmeneniy klimata / A new method for using glaciers as monitors of climate: Materialy Glyatsiologicheskikh Issledovaniy, Khronika, Obsuzhdeniya (Data of Glaciological Studies, Chronicle, Discussion), v. 57, p. 47–52 (Russian), 175–179 (English).

———1989, Ice core evidence for extensive melting of the Greenland ice sheet in the last interglacial: Science, v. 244, no. 4907, p. 964–968.

———1992, Past climate changes as deduced from Canadian ice cores, *in* Woo, Ming-k., and Gregor, D.J., eds., Arctic environment—Past, present and future, Proceedings of Symposium, Hamilton, 14–15 November 1991: Hamilton, Ont., McMaster University, Department of Geography, p. 61–70.

Koerner, R.M., and Fisher, D.A., 1979, Discontinuous flow, ice texture, and dirt content in the basal layers of the Devon Island ice cap: Journal of Glaciology, v. 23, no. 89, p. 209–222.

———1981, Studying climatic change from Canadian High Arctic ice cores: Syllogeus, National Museum of Natural Sciences, National Museums of Canada, Ottawa, Ont., v. 33, p. 195–218.

———1982, Acid snow in the Canadian High Arctic: Nature, v. 295, no. 5845, p. 137–140.

———1985, The Devon Island ice core and the glacial record, *in* Andrews, J.T., ed., Quaternary environments: Eastern Canadian Arctic, Baffin Bay and western Greenland: Boston, MA, Allen and Unwin, p. 309–327.

———1990, A record of Holocene summer climate from a Canadian high-Arctic ice core: Nature, v. 343, no. 6259, p. 630–631.

Koerner, R.M., and Paterson, W.S.B., 1974, Analysis of a core through the Meighen Ice Cap, Arctic Canada, and its paleoclimatic implications: Quaternary Research, v. 4, no. 3, p. 253–263.

Koerner, R.M., and Russell, R.D., 1979, $\delta^{18}O$ variations in snow on the Devon Island ice cap, Northwest Territories, Canada: Canadian Journal of Earth Sciences, v. 16, no. 7, p. 1419–1427.

Koerner, R.M., and Taniguchi, Hiroshi, 1976, Artificial radioactivity layers in the Devon Island Ice Cap, Northwest Territories: Canadian Journal of Earth Sciences, v. 13, no. 9, p. 1251–1255.

Koerner, R.M., Alt, B.T., Bourgeois, J.C., and Fisher, D.A., 1991, Canadian ice caps as sources of environmental data, *in* Weller, Gunter, Wilson, C.L., and Severin, B.A.B., eds., International Conference on the Role of the Polar Regions in Global Change, Proceedings of a conference held June 11–15, 1990 at the University of Alaska-Fairbanks, v. 2: Fairbanks, AK, University of Alaska, Geophysical Institute/Center for Global Change and Arctic System Research, p. 576–581.

Koerner, R.M., Bourgeois, J.C., and Fisher, D.A., 1988, Pollen analysis and discussion of time-scales in Canadian ice cores: Annals of Glaciology, v. 10, p. 85–91.

Koerner, R.M., Fisher, D.[A.], and Goto-Azuma, Kumiko, 1998, A 100 year record of ion chemistry from Agassiz Ice Cap, northern Ellesmere Island, N.W.T., Canada: Atmospheric Environment, v. 33, no. 3, p. 347–357.

Koerner, R.M., Fisher, D.A., and Paterson, W.S.B., 1987, Wisconsinan and pre-Wisconsinan ice thicknesses on Ellesmere Island, Canada—Inferences from ice cores: Canadian Journal of Earth Sciences, v. 24, no. 2, p. 296–301.

Koerner, R.M., Paterson, W.S.B., and Krouse, H.R., 1973, $\delta^{18}O$ profile in ice formed between the equilibrium and firn lines: Nature, Physical Science, v. 245, no. 148, p. 137–140.

Konecny, Gottfried, 1966, Applications of photogrammetry to surveys of glaciers in Canada and Alaska: Canadian Journal of Earth Sciences, v. 3, no. 6, p. 783–798.

Konecny, Gottfried, and Faig, W., 1966, Studies of ice movements on the Ward Hunt Ice Shelf by means of triangulation-trilateration: Arctic, v. 19, no. 4, p. 337–342.

Krimmel, R.M., and Meier, M.F., 1975, Glacier applications of ERTS images: Journal of Glaciology, v. 15, no. 73, p. 391–402.

Krimmel, R.M., and Trabant, D.C., 1992, The terminus of Hubbard Glacier, Alaska: Annals of Glaciology, v. 16, p. 151–157.

Krouse, H.R., Hislop, R.[W.P.], Brown, H.M., West, K.[E.], and Smith, J.L., 1977, Climatic and spatial dependence of the retention of D/H and O^{18}/O^{16} abundances in snow and ice of North America, *in* Isotopes and impurities in snow and ice, Proceedings of the Grenoble Symposium, August/September 1975: IAHS-AISH Publication No. 118, p. 242–247.

Kruszynski, G.A., and Johnson, P.G., 1993, Glacierized basin hydrological variability and climate change trends, *in* Prowse, T.D., Ommanney, C.S.L., and Ulmer, K.E., eds., Proceedings of the 9th International Northern Research Basins Symposium/Workshop, 14–22 August 1992, Whitehorse, Dawson City, Eagle Plains, Yukon; Inuvik, Northwest Territories, v. 1: Saskatoon, Saskatchewan, Environment Canada, National Hydrology Research Institute Symposium No. 10, p. 269–284.

Kucera, R.E., 1972, Probing the Athabasca Glacier: Vancouver, British Columbia, Evergreen Press, 32 p.

Lacasse, Diane, 1985, État des connaissances actuelles sur la chronologie des fluctuations glaciaire de l'Holocène, sud-ouest du Yukon: Geoscope, v. 15, no. 2, p. 80–93.

Lang, A.H., 1943, Glaciers of the Rockies and Selkirks: Canadian Geographical Journal, v. 26, no. 2, p. 56–67.

Lawby, C.P., Smith, D.J. Laroque, C.P., and Brugman, M.M., 1994, Glaciological studies at Rae Glacier, Canadian Rocky Mountains: Physical Geography, v. 15, no. 5, p. 425–441.

Lehmann, Rainer, 1992, Arctic push moraines, a case study of the Thompson Glacier moraine, Axel Heiberg Island, N.W.T., Canada: Zeitschrift für Geomorphologie, Supplementband 86, p. 161–171.

Lemmen, D.S., 1988, The glacial history of Marvin Peninsula, northern Ellesmere Island, and Ward Hunt Island, High Arctic Canada: Ph.D. thesis, Edmonton, Alberta, University of Alberta, Department of Geography, 176 p.

Letréguilly, Anne, 1988, Relation between the mass balance of western Canadian mountain glaciers and meteorological data: Journal of Glaciology, v. 34, no. 116, p. 11–18.

Letréguilly, Anne, and Reynaud, Louis, 1989, Spatial patterns of mass-balance fluctuations of North American glaciers: Journal of Glaciology, v. 35, no. 120, p. 163–168.

———1990, Space and time distribution of glacier mass-balance in the Northern Hemisphere: Arctic and Alpine Research, v. 22, no. 1, p. 43–50.

Lichti-Federovich, Sigrid, 1975, Pollen analysis of ice core samples from the Devon Island Ice Cap: Canada Geological Survey Paper No. 75-1A, p. 441–444.

Lister, Hal, 1962, Heat and mass balance at the surface of the Ward Hunt Ice Shelf, 1960: Montréal, Québec, Arctic Institute of North America Research Paper No. 19, 54 p.

Liverman, D.G.E., 1987, Sedimentation in ice-dammed Hazard Lake, Yukon: Canadian Journal of Earth Sciences, v. 24, no. 9, p. 1797–1806.

Lodwick, G.D., and Paine, S.H., 1985, A digital elevation model of the Barnes Ice Cap derived from Landsat MSS data: Photogrammetric Engineering and Remote Sensing, v. 51, no. 12, p. 1937–1944.

Løken, O.H., 1966, Science on Baffin Island—Field research in physical geography: Canadian Geographical Journal, v. 72, no. 2, p. 38–47.

———1969, Evidence of surges on the Barnes Ice Cap, Baffin Island: Canadian Journal of Earth Sciences, v. 6, no. 4, pt. 2, p. 899–901.

———1971, Glacier studies in the Canadian IHD program, *in* Glaciers, Proceedings of the IHD Workshop Seminar 1970, Vancouver, B.C., 24–25 September 1970: Ottawa, Ont., Canadian National Committee for the I.H.D., p. 1–4.

———1972, Growth and decay of glaciers as an indicator of long-term environmental changes, *in* Environmental conditions in the Northwest Atlantic, Proceedings of symposium in Dartmouth, Nova Scotia: International Commission for Northwest Atlantic Fisheries, Special Publication No. 8, p. 71–87.

Løken, O.H., and Andrews, J.T., 1966, Glaciology and chronology of fluctuations of the ice margin at the south end of the Barnes Ice Cap, Baffin Island, N.W.T.: Geographical Bulletin, v. 8, no. 4, p. 341–359.

Løken, O.H., and Sagar, R.B., 1968, Mass balance observations on the Barnes Ice Cap, Baffin Island, Canada, *in* General Assembly of Bern 1967—Snow and Ice: Association Internationale d'Hydrologie Scientifique Publication No. 79, p. 282–291.

Loijens, H.S., 1974, Streamflow formation in the Mistaya River basin, Rocky Mountains, Canada: Western Snow Conference, 42nd Annual Meeting, Anchorage, Alaska, 16–20 April 1974, Proceedings, p. 86–95.

Loomis, S.R., Dozier, J., and Ewing, K.J., 1970, Studies of morphology and stream action on ablating ice: Montréal, Québec, Arctic Institute of North America Research Paper No. 57, 167 p.

Luckman, B.H., 1986, Reconstruction of Little Ice Age events in the Canadian Rocky Mountains: Géographie Physique et Quaternaire, v. 40, no. 1, p. 17–28.

———1988, 8000 year old wood from the Athabasca Glacier, Alberta: Canadian Journal of Earth Sciences, v. 25, no. 1, p. 148–151.

———1993, Glacier fluctuation and tree-ring records for the last millenium in the Canadian Rockies: Quaternary Science Reviews, v. 12, no. 6, p. 441–450.

Luckman, B.H., Harding, K.A., and Hamilton, J.P., 1987, Recent glacier advances in the Premier Range, British Columbia: Canadian Journal of Earth Sciences, v. 24, no. 6, p. 1149–1161.

Luckman, B.H., Holdsworth, Gerald, and Osborn, G.D., 1993, Neoglacial glacier fluctuations in the Canadian Rockies: Quaternary Research, v. 39, no. 2, p. 144–153.

Lyons, J.B., and Ragle, R.H., 1962, Thermal history and growth of the Hard Hunt Ice Shelf, *in* Variations of the Regime of Existing Glaciers, Symposium at Obergurgl, 10–18 September, 1962: Association Internationale d'Hydrologie Scientifique Publication No. 58, p. 88–97.

Lyons, J.B., Ragle, R.H., and Tamburi, A.J., 1972, Growth and grounding of the Ellesmere Island ice rises: Journal of Glaciology, v. 11, no. 61, p. 43–52.

Maag, Hans, 1969, Ice-dammed lakes and marginal glacial drainage on Axel Heiberg Island, Canadian Arctic Archipelago: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, 147 p.

MacAyeal, D.R., and Holdsworth, Gerald, 1986, An investigation of low-stress ice rheology on the Ward-Hunt Ice Shelf: Journal of Geophysical Research, v. 91, no. B6, p. 6347–6358.

MacPherson, D.S., and Krouse, H.R., 1967, O^{18}/O^{16} ratios in snow and ice of the Hubbard and Kaskawulsh Glaciers, *in* Stout, G.E., ed., Isotope techniques in the hydrologic cycle: Washington, D.C., American Geophysical Union, Geophysical Monograph No. 11, p. 180–194.

Marcus, M.G., 1960, Periodic drainage of glacier-dammed Tulsequah Lake, British Columbia: Geographical Review, v. 50, no. 1, p. 89–106.

———1964, Climate-glacier studies in the Juneau Ice Field region, Alaska: Chicago, Ill., University of Chicago, Department of Geography Research Paper No. 88, 128 p.

Marcus, W.A., Roberts, Keith, Harvey, Leslie, and Tackman, Gary, 1992, An evaluation of methods for estimating Manning's n in small mountain streams: Mountain Research and Development, v. 12, no. 3, p. 227–239.

Marsh, J.S., 1976, The Mt. Sir Sandford area, Selkirk Mountains, British Columbia, a scientific report of the Canadian Exploration Group's 1975 Selkirk Mountain expedition: Peterborough, Ont., Canadian Exploration Group, 133 p.

Marsh, J.[S.], 1978, Glacier and microclimate research in Mount Sir Sandford area, British Columbia: Canadian Alpine Journal, v. 61, p. 70–73.

Marston, R.A., 1983, Supraglacial stream dynamics on the Juneau Icefield: Annals of the Association of American Geographers, v. 73, no. 4, p. 597–608.

Mathews, W.H., 1964a, Discharge of a glacial stream, *in* Symposium on Surface Water, General Assembly of Berkeley, 19–31 August 1963: Association Internationale d'Hydrologie Scientifique Publication No. 63, p. 290–300.

Mathews, W.H., 1964b, Sediment transport from Athabasca Glacier, Alberta, *in* Symposium on Land Erosion, Precipitations, Hydrometry, Soil Moisture, General Assembly of Berkeley, 19–31 August 1963: Association Internationale d'Hydrologie Scientifique Publication No. 65, p. 155–165.

———1964c, Water pressure under a glacier: Journal of Glaciology, v. 5, no. 38, p. 235–240.

———1965, Two self-dumping ice-dammed lakes in British Columbia: Geographical Review, v. 55, no. 1, p. 46–52.

———1973, Record of two jökullhlaups, *in* Symposium on the hydrology of glaciers, Cambridge, 7–13 September 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 99–110.

Mathews, W.H., and Clague, J.J., 1993, The record of jökulhlaups from Summit Lake, northwestern British Columbia: Canadian Journal of Earth Sciences, v. 30, no. 3, p. 499–508.

Mattson, L.E., 1990, A comparison of meltwater discharge from a debris-free and a debris-covered glacier, Canadian Rocky Mountains: Eastern Snow Conference, 47th Annual Meeting, Bangor, Maine, 7–8 June 1990, Proceedings, p. 237–242.

Mattson, L.E., and Gardner, J.S., 1991, Mass wasting on valley-side ice-cored moraines, Boundary Glacier, Alberta, Canada: Geografiska Annaler, v. 73A, no. 3–4, p. 123–128.

Mauelshagen, L., 1984, Zur Entstehungsgeschichte und Herstellung der Karte des Cathedral Gletscher Vorfeldes in British Kolumbien (Kanada), *in* Festschrift zum 60, Geburtstag von Prof. Dr. Ing. G. Kupfer: Bonn, Germany: p. 90–99.

Mauelshagen, L., and Slupetzky, H., 1985, Cathedral Massif Glacier and forefield (Atlin Provincial Wildernes Park, B.C., Canada): Salzburg, Austria, Universität Salzburg, Institut für Geographie, map, scale 1:5,000.

Maxwell, M.G., 1986, Isotopic identification of subglacial processes: Ph.D. thesis, Vancouver, B.C., University of British Columbia, Department of Geophysics and Astronomy, 130 p.

Mayewski, P.A., Holdsworth, Gerald, Spencer, M.J., Whitlow, S.[I.], Twickler, M.[S.], Morrison, M.C., Ferland, K.K., and Meeker, L.D., 1993, Ice core sulfate from three Northern Hemisphere sites—Source and temperature forcing implications: Atmospheric Environment, ser. A, v. 27, no. 17–18, p. 2915–2919.

Mayewski, P.A., Pregent, G., Armstrong, T., Brown, P., Butler, D., Hassinger, J.[M.], Jeschke, P.[A.], Palais, J.[M.], and Trombley, T.[J.], 1979, Results of the 1978 Athabasca Glacier Expedition: Durham, N.H., University of New Hampshire, Department of Earth Science, Glaciology Report Series, 56 p.

Mayo, L.R., 1989, Advance of Hubbard Glacier and 1986 outburst of Russell Fiord, Alaska, U.S.A.: Annals of Glaciology, v. 13, p. 189–194.

McAndrews, J.H., 1984, Pollen analysis of the 1973 ice core from Devon Island glacier, Canada: Quaternary Research, v. 22, no. 1, p. 68–76.

McCann, S.B., and Cogley, J.G., 1977, Floods associated with glacier margin drainage in Ellesmere Island, N.W.T., *in* Canadian Hydrology Symposium 77, Edmonton, Alberta, 29–31 August 1977, Proceedings: Ottawa, Ont., National Research Council of Canada (NRCC 16428), Associate Committee on Hydrology, p. 14–23.

McCoubrey, A.A., 1938, Glacier observations, 1936 and 1937: Canadian Alpine Journal, v. 25, p. 113–116.

McCoy, W.D., 1983, Holocene glacier fluctuations in the Torngat Mountains, northern Labrador: Géographie Physique et Quaternaire, v. 37, no. 2, p. 211–216.

McFarlane, W.T., 1946, Glacier investigations in Banff, Yoho and Jasper National Parks: Canadian Alpine Journal, v. 29, no. 2, p. 265–273.

McFarlane, W.T., Blair, R.V., and Ozga, W.J., 1950, Glacier survey in Banff and Jasper National Parks, 1949: Canadian Alpine Journal, v. 33, p. 120–126.

Meek, Victor, 1948a, Glacier obervations in the Canadian Cordillera: Canadian Geographical Journal, v. 37, no. 5, p. 190–209.

———1948b, Glacier observations in the Canadian Cordillera, *in* General Assembly of Oslo, 19–28 August 1948, v. 2: Association Internationale d'Hydrologie Scientifique Publication No. 30, p. 264–275.

Meier, M.F., 1958a, The mechanics of crevasse formation, *in* General Assembly of Toronto, v. 4, 3–14 September 1957: Association Internationale d'Hydrologie Scientifique Publication No. 46, p. 500–508.

———1958b, Vertical profiles of velocity and the flow law of glacier ice, *in* Symposium on Physics of the Movement of the Ice, Symposium of Chamonix, 16–24 September 1958: Association Internationale d'Hydrologie Scientifique Publication No. 47, p. 169–170.

———1960, Mode of flow of Saskatchewan Glacier, Alberta, Canada: U.S. Geological Survey Professional Paper 351, p. 70.

Meier, M.F., and Post, A.S., 1962, Recent variations in mass net budgets of glaciers in western North America, *in* Variations of the Regime of Existing Glaciers, Symposium at Obergurgl, 10–18 September 1962: Association Internationale d'Hydrologie Scientifique Publication No. 58, p. 63–77.

Meier, M.F., Rigsby, G.P., and Sharp, R.P., 1954, Preliminary data from Saskatchewan Glacier, Alberta, Canada: Arctic, v. 7, no. 1, p. 3–26.

Mercer, J.H., 1956, The Grinnell and Terra Nivea Ice Caps, Baffin Island: Journal of Glaciology, v. 2, no. 19, p. 652–656.

———1975a, Glaciers of Baffin and Bylot Islands, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 2: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 683–721.

———1975b, Glaciers of the Queen Elizabeth Islands, N.W.T., Canada, *in* Field, W.O., ed., Mountain glaciers of the Northern Hemisphere, v. 2: Hanover, N.H., U.S. Army Cold Regions Research and Engineering Lab., p. 723–752.

Miller, G.H., Bradley, R.S., and Andrews, J.T., 1975, The glaciation level and lowest equilibrium line altitude in the High Canadian Arctic—Maps and climatic interpretation: Arctic and Alpine Research, v. 7, no. 2, p. 155–168.

Miller, M.M., 1963, A field institute of glaciological and expeditionary sciences in Alaska: Appalachia, v. 34, no. 136, p. 499–508.

Miller, M.M., 1975, Mountain and glacier terrain study and related investigations in the Juneau Icefield region, Alaska-Canada—Final Report 1971–1973 by Maynard M. Miller and Research Associates of the Juneau Icefield Research Program: Seattle, WA, Pacific Science Center, Foundation for Glacier and Environmental Research, 326 p.

Miller, M.M., and Anderson, J.H., 1974, The Alaskan Glacier Commemorative Project, Phase IV—Pleistocene-Holocene sequences in the Alaska-Canada Boundary Ranges: National Geographic Society Research Reports 1967, p. 197–223.

Moisan, Yves, and Dubois, J.-M.M., 1993, Estimation des variations spatiales de l'aire occupée par la calotte glaciaire de Barnes (Terre de Baffin, Territoire du Nord-Ouest) entre 1979 et 1990 à l'aide de données MSS de Landsat: 16e Symposium canadien sur la télédétection et 8e Congrès de l'Association Québécoise de télédétection, Sherbrooke, Québec, 7–10 juin 1993, Compte rendu, p. 221–226.

Moisan, Yves, and Pollard, W.H., 1992, Changes at the snout and proglacial zone of the White-Thompson Glacier complex, Axel Heiberg Island, Northwest Territories: Musk-ox, v. 39, p. 1–8.

Mokievsky-Zubok, Oleg, 1973a, Determination of mass balance on Sentinel Glacier, British Columbia, Canada: Ottawa, Ont., Department of the Environment, Water Resources Branch, Inland Waters Directorate Scientific Series No. 30, 39 p.

———1973b, Study of Sentinel Glacier, British Columbia, Canada, within the International Hydrological Decade (IHD) program—Procedures and techniques: Ottawa, Ont., Department of the Environment, Water Resources Branch, Inland Waters Directorate Technical Bulletin No. 77, 31 p.

———1974, Analysis of mass balance values and their accuracy at Sentinel Glacier, B.C., Canada: Ottawa, Ont., Department of the Environment, Water Resources Branch, Inland Waters Directorate Scientific Series No. 31, 4 p.

———1980a, Selected information on some West Coast glaciers studied in 1979: Ottawa, Ont., Environment Canada, National Hydrology Research Institute, Snow and Ice Division, Unpublished report to B.C. Hydro, Hydroelectric Design Division, Hydrology Section, Burnaby Mountain SCS, Vancouver, B.C., 11 p.

———1980b, Sudden discharge of glacier-dammed Flood Lake, August 1979: Ottawa, Ont., Environment Canada, National Hydrology Research Institute, Snow and Ice Division, Summary report, 17 p.

———1983a, Glaciological studies in Homathko River basin in 1982: Ottawa, Ont., Environment Canada, National Hydrology Research Institute, Internal report, 18 p.

———1983b, Glaciological studies in Iskut River basin in 1982: Ottawa, Ont., Environment Canada, National Hydrology Research Institute, Internal report, 25 p.

———1985, Glaciological studies in Bridge River basin in 1984: Ottawa, Ont., National Hydrology Research Institute, Environment Canada, Internal report, 22 p.

———1987, Glacier mass balance for 1986 on Sentinel, Helm and Place Glaciers, British Columbia: Saskatoon, Sask., Environment Canada, Surface Water Division, National Hydrology Research Institute Contribution No. 87061, 16 p.

———1992a, Glaciological studies in the Homathko River basin in 1991: Ottawa, Ont., Glacier Consulting Services, Contract report to B.C. Hydro, Vancouver, B.C., 19 p.

———1992b, Glaciological studies in the Iskut River basin in 1991: Ottawa, Ont., Glacier Consulting Services, Contract report to B.C. Hydro, Vancouver, B.C., 27 p.

Mokievsky-Zubok, Oleg, and Stanley, A.D., 1976a, Canadian glaciers in the International Hydrological Decade program, 1965–1974. No. 1. Sentinel Glacier, British Columbia—Summary of measurements: Ottawa, Ont., Fisheries and Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 68, 75 p.

———1976b, Canadian glaciers in the International Hydrological Decade program, 1965–1974. No. 2. Place Glacier, British Columbia—Summary of measurements: Ottawa, Ont., Fisheries and Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 69, 77 p.

Mokievsky-Zubok, Oleg, Ommanney, C.S.L., and Power, J.[M.], 1985, NHRI glacier mass balance, 1964–1984 (Cordillera and Arctic): Ottawa, Ont., Environment Canada, Surface Water Division, National Hydrology Research Institute, Internal report, 59 p.

Mollard, J.D., and Janes, J.R., 1984, Airphoto interpretation and the Canadian landscape: Ottawa, Ont., Department of Energy, Mines and Resources, 415 p.

Monaghan, M.C., and Holdsworth, Gerald, 1990, The origin of non-sea-salt sulphate in the Mount Logan ice core: Nature, v. 343, no. 6255, p. 245–248.

Morey, Anton, 1971, The legend of the Great Glacier battle: North/Nord, v. 18, no. 5, p. 20–23.

Müller, B.S., 1961, Jacobsen-McGill Arctic Research Expedition to Axel Heiberg Island, Queen Elizabeth Islands—Preliminary report of 1959–1960: Montréal, Québec, McGill University, 219 p.

Müller, Fritz, 1962a, Glacier mass-budget studies on Axel Heiberg Island, Canadian Arctic Archipelago, *in* Variations of the Regime of Existing Glaciers, Symposium at Obergurgl, 10–18 September 1962: Association Internationale d'Hydrologie Scientifique Publication No. 58, p. 131–142.

———1962b, Zonation in the accumulation area of the glaciers of Axel Heiberg Island, N.W.T., Canada: Journal of Glaciology, v. 4, no. 33, p. 302–311.

———1963, Englacial temperature measurements on Axel Heiberg Island, Canadian Arctic Archipelago, *in* Symposium on Snow and Ice, General Assembly of Berkeley, 19–31 August 1963: Association Internationale d'Hydrologie Scientifique Publication No. 61, p. 168–180.

———1969, Was the Good Friday glacier on Axel Heiberg Island surging?: Canadian Journal of Earth Sciences, v. 6, no. 4, pt. 2, p. 891–894.

———1976, On the thermal regime of a high-Arctic valley glacier: Journal of Glaciology, v. 16, no. 74, p. 119–133.

———1981, The living Arctic: Agincourt, Ont., Methuen Publications, 233 p.

Müller, Fritz, and Iken, Almut, 1973, Velocity fluctuations and water regime of Arctic valley glaciers, *in* Symposium on the Hydrology of Glaciers, Cambridge, 7–13 September 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 165–182.

Müller, Fritz, and Keeler, C.M., 1969, Errors in short-term ablation measurements on melting ice surfaces: Journal of Glaciology, v. 8, no. 52, p. 91–105.

Müller, Fritz, and others, 1963, Jacobsen-McGill Arctic Research Expedition 1959–1962; preliminary report 1961–1962 and map supplement: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, p. 241 and 6 maps.

Müller, Fritz and others, 1974–80, North Water project—Progress reports I–CI—Glaciological and climatological investigations of the North Water polynya in northern Baffin Bay: Zürich, ETH, Geographisches Institut, and Montréal, Québec, McGill University, Unpublished progress reports.

Müller, Fritz, Stauffer, Bernhard, and Schriber, G., 1977, Isotope measurements and firn stratigraphy on ice caps surrounding the North Water polynya, *in* Isotopes and impurities in snow and ice, Proceedings of the Grenoble Symposium, August/September 1975: IAHS-AISH Publication No. 118, p. 188–196.

Munday, W.A.D., 1931, Retreat of Coast Range glaciers: Canadian Alpine Journal, v. 20, p. 140–142.

Munro, D.S., 1976, On estimating the roughness lengths of glacier ice, *in* Davies, J.A., ed., Papers in climatology—the CAM Allen memorial volume: Hamilton, Ont., McMaster University, Department of Geography Discussion Paper No. 7, p. 129–141.

———1989, Surface roughness and bulk heat transfer on a glacier—Comparison with eddy correlation: Journal of Glaciology, v. 35, no. 121, p. 343–348.

———1990, Comparison of melt energy computations and ablatometer measurements on melting ice and snow: Arctic and Alpine Research, v. 22, no. 2, p. 153–162.

———1991a, On modelling surface meltwater discharge from arctic and alpine glaciers, *in* Prowse, T.D., and Ommanney, C.S.L., eds., Northern hydrology—Selected perspectives, Proceedings of the Northern Hydrology Symposium, Saskatoon, 10–12 July 1990: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute Symposium No. 6, p. 253–262.

———1991b, A surface energy exchange model of glacier melt and net mass balance: International Journal of Climatology, v. 11, no. 6, p. 689–700.

Munro, D.S., and Davies, J.A., 1976, Diurnal energy flux variations and glacier surface hydrology, *in* Lvovitch, M.I., Kotlyakov, V.M., and Rauner, Yu.L., eds., International Geography '76, Section 2—Climatology, Hydrology, Glaciology: Moscow, International Geographical Congress, 23rd, Moscow, 22–26 July 1976, Proceedings, p. 75–77.

———1977, An experimental study of the glacier boundary layer over melting ice: Journal of Glaciology, v. 18, no. 80, p. 425–436.

———1978, On fitting the log-linear model to wind speed and temperature profiles over a melting glacier: Boundary-Layer Meteorology, v. 15, no. 4, p. 423–437.

Munro, D.S., and Young, G.J., 1980, A net shortwave radiation model for glacierized basins: 37th Annual Meeting, Eastern Snow Conference, Peterborough, Ontario, 5–6 June 1980, Proceedings, p. 159–169.

———1982, An operational net shortwave radiation model for glacier basins: Water Resources Research, v. 18, no. 2, p. 220–230.

Murray, Tavi, and Clarke, G.K.C., 1995, Black-box modeling of the subglacial water system: Journal of Geophysical Research, v. 100, no. B6, p. 10,231–10,245.

Nakawo, Masayoshi, and Young, G.J., 1982, Estimate of glacier ablation under a debris layer from surface temperature and meteorological variables: Journal of Glaciology, v. 28, no. 98, p. 29–34.

Narod, B.B., and Clarke, G.K.C., 1980, Airborne UHF radio echo-sounding of three Yukon glaciers: Journal of Glaciology, v. 25, no. 91, p. 23–31.

———1983, UHF radar system for airborne surveys of ice thickness: Canadian Journal of Earth Sciences, v. 20, no. 7, p. 1073–1086.

Narod, B.B., Clarke, G.K.C., and Prager, B.T., 1988, Airborne UHF radar sounding of glaciers and ice shelves, northern Ellesmere Island, Arctic Canada: Canadian Journal of Earth Sciences, v. 25, no. 1, p. 95–105.

Neave, K.G., and Savage, J.C., 1970, Icequakes on the Athabasca Glacier: Journal of Geophysical Research, v. 75, no. 8, p. 1351–1362.

Nelson, J.G., Ashwell, I.Y., and Brunger, A.G., 1966, Recession of the Drummond Glacier, Alberta: Canadian Geographer, v. 10, no. 2, p. 71–81.

Nielsen, L.E., 1969, The ice-dam, powder-flow theory of glacier surges: Canadian Journal of Earth Sciences, v. 6, no. 4, pt. 2, p. 955–961.

Norwegian Water Resources and Energy Administration, 1991, Part of Grinnell Glacier, Baffin Island, N.W.T.: Oslo, Norway, Norwegian Water Resources and Energy Administration map, scale 1:20,000, contour interval—10 m on glacier, 20 m elsewhere.

Nriagu, J.O., Lawson, G.S., and Gregor, D.J., 1994, Cadmium concentrations in recent snow and firn layers in the Canadian Arctic: Bulletin of Environmental Contamination and Toxicology, v. 52, no. 5, p. 756–759.

Odell, N.E., 1933, The mountains of northern Labrador: Geographical Journal, v. 82, no. 3, p. 193–210, v. 82, no. 4, p. 315–325.

Ommanney, C.S.L., 1969, Glacier inventory of Canada—Axel Heiberg Island, Northwest Territories: Ottawa, Ont., Department of Energy, Mines and Resources, Inland Waters Branch Technical Bulletin No. 37, 97 p. and maps.

———[1971]a, Canadian glacier inventory, *in* Glaciers, Proceedings of Workshop Seminar 1970, Vancouver, B.C., 24–25 September 1970: Ottawa, Ont., Canadian National Committee for the I.H.D., p. 23–30.

———1971b, Glacier surveys by District personnel of the Water Survey of Canada—1. The Victoria Glacier: Ottawa, Ont., Department of the Environment, Inland Waters Branch, Glacier Inventory Note No. 6, 18 p.

———1972a, Application of the Canadian glacier inventory to studies of the static water balance—1. The glaciers of Vancouver Island, *in* Adams, W.P., and Helleiner, F.M., eds., International geography 1972, v. 2: Toronto, Ont., University of Toronto Press, p. 1266–1268.

———1972b, Glacier surveys by District personnel of the Water Survey of Canada: 2. Peyto Glacier: Ottawa, Ont., Department of the Environment, Inland Waters Branch, Glacier Inventory Note No. 7, 20 p.

———1975, Canadian glacier studies 1960–1975, retrospect and prospect, *in* Canadian Hydrology Symposium—75, Winnipeg, Manitoba, 11–14 August 1975, Proceedings: Ottawa, Ont., National Research Council of Canada (NRCC 15195), Associate Committee on Hydrology, p. 262–281.

———1980, The inventory of Canadian glaciers: Procedures, techniques, progress and applications, *in* World Glacier Inventory Workshop, Riederalp, Switzerland, 17–22 September 1978: IAHS-AISH Publication No. 126, p. 35–44.

———1982, Bibliography of Canadian Glaciology, 1982—Bibliography No. 2, Ellesmere Island glaciers and ice shelves: Ottawa, Ont., Environment Canada, National Hydrology Research Institute, Glacier Inventory Note No. 9, NHRI Paper No. 20, IWD Report Series No. 58, 53 p.

———1989, Glacier Atlas of Canada: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute, Scientific Information Division, Limited edition, 2 p. and 52 maps.

———1993, Yukon Glaciers, *in* Prowse, T.D., Ommanney, C.S.L., and Ulmer, K.E., eds., Proceedings of the 9th International Northern Research Basins Symposium/Workshop, Whitehorse, Dawson City, Eagle Plains, Yukon; Inuvik, Northwest Territories, 14–22 August 1992: Saskatoon, Saskatchewan, Environment Canada, National Hydrology Research Institute Symposium No. 10, v. 1, p. 373–382.

———1996, 100 years of glacier observations in Canada (1890–1990): Geografía Física e Dinámica Quaternaria, 1995, v. 18, no. 2, p. 321–330.

Ommanney, C.S.L., and Young, G.J., 1988, Research on Canadian glaciers within the IHD/IHP, in CHS–88 Canadian research basins—Successes, failures and future, Banff, Alberta, 9–11 May 1988, Proceedings: National Research Council of Canada (NRCC 30416), Associate Committee on Hydrology, Canadian Hydrology Symposium No. 17, p. 21–28.

Orvig, Svenn, 1951, The climate of the ablation period on the Barnes Ice-Cap in 1950: Geografiska Annaler, v. 33, p. 166–209.

———1953, The glaciological studies of the Baffin Island Expedition, 1950. Part V—On the variation of the shear stress on the bed of an ice cap: Journal of Glaciology, v. 2, no. 14, p. 242–247.

———1954, Glacial-meteorological observations on icecaps in Baffin Island: Geografiska Annaler, v. 36, no. 3–4, p. 193–318.

Osborn, G.[D.], 1986, Lateral-moraine stratigraphy and neoglacial history of Bugaboo Glacier, British Columbia: Quaternary Research, v. 26, no. 2, p. 171–178.

Osborn, G.[D.], and Karlstrom, E.T., 1988, Holocene history of the Bugaboo Glacier, British Columbia: Geology (Boulder), v. 16, no. 11, p. 1015–1017.

Osborn, G.[D.], and Luckman, B.H., 1988, Holocene glacier fluctuations in the Canadian Cordillera (Alberta and British Columbia): Quaternary Science Reviews, v. 7, no. 2, p. 115–128.

Østrem, Gunnar, 1966a, The height of the glaciation limit in southern British Columbia and Alberta: Geografiska Annaler, v. 48A, no. 3, p. 126–138.

———1966b, Mass balance studies on glaciers in western Canada, 1965: Geographical Bulletin, v. 8, no. 1, p. 81–107.

———1972, Height of the glaciation level in northern British Columbia and southeastern Alaska: Geografiska Annaler, v. 54A, no. 2, p. 76–84 and map.

———1973a, Runoff forecasts for highly glacierized basins, *in* The role of snow and ice in hydrology, Proceedings of the Banff Symposium, September 1972: IAHS-AISH Publication No. 107, v. 2, p. 1111–1132.

———1973b, The transient snowline and glacier mass balance in southern British Columbia and Alberta, Canada: Geografiska Annaler, v. 55A, no. 2, p. 93–106.

Østrem, Gunnar, and Brugman, M.[M.], 1991, Glacier mass-balance measurements—A manual for field and office work: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute NHRI Science Report No. 4, 224 p.

Østrem, Gunnar, and Stanley, A.D., 1966, Glacier mass balance measurements—A manual for field work: Ottawa, Ont., Department of Energy, Mines and Resources, Glaciology Section, 81 p. and tables.

Østrem, Gunnar, Bridge, C.W., and Rannie, W.F., 1967, Glaciohydrology, discharge and sediment transport in the Decade Glacier, Baffin Island, N.W.T.: Geografiska Annaler, v. 49A, no. 2–4, p. 268–282.

Oswald, G.K.A., 1975, Investigation of sub-ice bedrock characteristics by radio-echo sounding: Journal of Glaciology, v. 15, no. 73, p. 75–87.

Palmer, Howard, 1914, Mountaineering and exploration in the Selkirks—A record of pioneer work among the Canadian Alps, 1908–1912: New York and London, Knickerbocker Press, G.P. Putnam's Sons, 439 p.

———1924, Observations on the Freshfield Glacier, Canadian Rockies: Journal of Geology, v. 32, no. 5, p. 432–441.

Parent, Michel, 1991, La zone frontale des glaciers Thompson et White dans l'île Axel Heiberg du Haut Arctique canadien—Quelques observations préliminaires: Geological Survey of Canada Paper No. 91-1E, p. 203–210.

Parker, G., 1975, Meandering of supraglacial melt streams: Water Resources Research, v. 11, no. 4, p. 551–552.

Parker, M.L., and Henoch, W.E.S., 1971, The use of Engelmann spruce latewood density for dendrochronological purposes: Canadian Journal of Forest Research, v. 1, no. 2, p. 90–98.

Paterson, W.S.B., 1960, Glaciological research in western Canada in 1959—Expedition to Athabasca Glacier: Canadian Alpine Journal, v. 43, p. 99–102.

———1961, Glaciological research on Athabasca Glacier in 1960: Canadian Alpine Journal, v. 44, p. 110–111.

———1962, Glaciological research on Athabaska Glacier in 1961: Canadian Alpine Journal, v. 45, p. 148.

———1964, Variations in velocity of Athabasca Glacier with time: Journal of Glaciology, v. 5, no. 39, p. 277–285.

Paterson, W.S.B., 1966, Test of contour accuracy on a photogrammetric map of Athabasca Glacier: Canadian Journal of Earth Sciences, v. 3, no. 6, p. 909–915.

———1968, A temperature profile through the Meighen Ice Cap, Arctic Canada, *in* General Assembly of Bern 1967—Snow and Ice: Association Internationale d'Hydrologie Scientifique Publication No. 79, p. 440–449.

———1969, The Meighen Ice Cap, Arctic Canada—Accumulation, ablation and flow: Journal of Glaciology, v. 8, no. 54, p. 341–352.

Paterson, W.S.B., 1970, The sliding velocity of Athabasca Glacier, Canada: Journal of Glaciology, v. 9, no. 55, p. 55–63.

———1971, Temperature measurements in Athabasca Glacier, Alberta, Canada: Journal of Glaciology, v. 10, no. 60, p. 339–349.

———1972, Temperature distribution in the upper layers of the ablation area of Athabasca Glacier, Alberta, Canada: Journal of Glaciology, v. 11, no. 61, p. 31–41.

———1976a, Temperatures in the Devon Island ice cap, Arctic Canada: Journal of Glaciology, v. 16, no. 74, p. 277.

———1976b, Vertical strain-rate measurements in an Arctic ice cap and deductions from them: Journal of Glaciology, v. 17, no. 75, p. 3–12.

———1977, Secondary and teritiary creep of glacier ice as measured by borehole closure rates: Reviews of Geophysics and Space Physics, v. 15, no. 1, p. 47–55.

———1985, Flow law for ice in polar ice sheets: Nature, v. 318, no. 6041, p. 82–83.

———1994, The physics of glaciers (3d ed.): Oxford, Elsevier, 480 p.

Paterson, W.S.B., and Clarke, G.K.C., 1978, Comparison of theoretical and observed temperature profiles in Devon Island ice cap, Canada: Geophysical Journal of the Royal Astronomical Society, v. 55, no. 3, p. 615–632.

Paterson, W.S.B., and Koerner, R.M., 1974, Radio echo sounding on four ice caps in Arctic Canada: Arctic, v. 27, no. 3, p. 225–233.

Paterson, W.S.B., and Savage, J.C., 1963a, Geometry and movement of the Athabasca Glacier: Journal of Geophysical Research, v. 68, no. 15, p. 4513–4520.

———1963b, Measurements on Athabasca Glacier relating to the flow law of ice: Journal of Geophysical Research, v. 68, no. 15, p. 4537–4543.

Paterson, W.S.B., and Waddington, E.D., 1984, Past precipitation rates derived from ice-core measurements—Methods and data analysis: Reviews of Geophysics and Space Physics, v. 22, no. 2, p. 123–130.

Paterson, W.S.B., Koerner, R.M., Fisher, D.A., Johnsen, S.J., Clausen, H.B., Dansgaard, Willi, Bucher, Peter, and Oeschger, Hans, 1977, An oxygen-isotope climatic record from the Devon Island ice cap, Arctic Canada: Nature, v. 266, no. 5602, p. 508–511.

Perchanok, M.S., 1980, Reconnaissance of glacier-dammed lakes in the Stikine and Iskut River basins, British Columbia: Ottawa, Ont., Environment Canada, Inland Waters Directorate, National Hydrology Research Institute, Contract No. KL229–0–4292, Unpublished report, 38 p. and maps.

Pfeffer, W.T., Illangasekare, T.H., and Meier, M.F., 1990, Analysis and modeling of melt-water refreezing in dry snow: Journal of Glaciology, v. 36, no. 123, p. 238–246.

Pietroniro, Alain, and Demuth, Michael, 1999, Inferring glacier mass balance using Radarsat: Results from Peyto Glacier, Canada: Geografiska Annaler, v. 81A, no. 4, p. 521–540.

Post, A.[S.], 1966, The recent surge of Walsh Glacier, Yukon and Alaska: Journal of Glaciology, v. 6, no. 45, p. 375–381.

———1969, Distribution of surging glaciers in North America: Journal of Glaciology, v. 8, no. 53, p. 229–240.

Post, A.S., and LaChapelle, E.R., 1971, Glacier ice: Seattle, WA, Toronto, Ont., University of Toronto Press, 110 p.

Post, A.[S.], and Mayo, L.R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geological Survey Hydrological Investigations Atlas HA–455, 10 p. and 3 maps.

Post, A.[S.], Meier, M.F., and Mayo, L.R., 1976, Measuring the motion of the Lowell and Tweedsmuir surging glaciers of British Columbia, Canada: U.S. Geological Survey Professional Paper 929, p. 180–184.

Pourchet, Michel, Pinglot, J.F., Reynaud, Louis, and Holdsworth, Gerald, 1988, Identification of Chernobyl fall-out as a new reference level in Northern Hemisphere glaciers: Journal of Glaciology, v. 34, no. 117, p. 183–187.

Power, J.M., 1985, Canada case study—Water supply, *in* Young, G.J., ed., Techniques for prediction of runoff from glacierized areas: International Association of Hydrological Sciences Publication No. 149, p. 59–71.

Power, J.M., and Young, G.J., 1979, Application of the UBC watershed model to Peyto Glacier basin, *in* Canadian Hydrology Symposium 79, Cold Climate Hydrology, Vancouver, B.C., 10–11 May 1979, Proceedings: Ottawa, Ont., National Research Council of Canada (NRCC 17834), Associate Committee on Hydrology, p. 217–228.

Prager, B.T., 1983, Digital signal processing of UHF radio echo sounding data: M.Sc. thesis, Vancouver, B.C., University of British Columbia, Department of Geophysics and Astronomy, 88 p.

Prest, V.K., 1983, Canada's heritage of glacial features/l'héritage glaciaire du Canada: Geological Survey of Canada Miscellaneous Report No. 28, 119 p.

Ragle, R.H., 1964, The Icefield Ranges research project, 1963: Arctic, v. 17, no. 1, p. 55–57.

———1973, The Icefield Ranges research project, 1972: Arctic, v. 26, no. 3, p. 258–263.

Ragle, R.H., Blair, R.G., and Persson, L.E., 1964, Ice core studies of Ward Hunt Ice Shelf, 1960: Journal of Glaciology, v. 5, no. 37, p. 39–59.

Rains, R.B., 1990, Cline Glacier and Shoe Leather Creek, Alberta—Morphology and hydrology: Edmonton, Alberta, University of Alberta, Department of Geography, 20 p.

Raisbeck, G.M., and Yiou, F., 1985, ^{10}Be in polar ice and atmospheres: Annals of Glaciology, v. 7, p. 138–140.

Raymond, C.F., 1971a, Determination of the three-dimensional velocity field in a glacier: Journal of Glaciology, v. 10, no. 58, p. 39–53.

——1971b, Flow in a transverse section of Athabasca Glacier, Alberta, Canada: Journal of Glaciology, v. 10, no. 58, p. 55–84.

Raymond, C.F., 1973, Inversion of flow measurements for stress and rheological parameters in a valley glacier: Journal of Glaciology, v. 12, no. 64, p. 19–44.

Redpath, B.B., 1965, Seismic investigation of glaciers on Axel Heiberg Island, Canadian Arctic Archipelago: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Geophysics No. 1, 26 p.

Reeh, Niels, 1991, The last interglacial as recorded in the Greenland ice sheet and Canadian Arctic ice caps: Quaternary International, v. 10–12, p. 123–142.

Reeh, Niels, and Paterson, W.S.B., 1988, Application of a flow model to the ice-divide region of Devon Island Ice Cap, Canada: Journal of Glaciology, v. 34, no. 116, p. 55–63.

Reeh, Niels, Hammer, C.U., Thomsen, H.H., and Fisher, D.A., 1987, Use of trace constituents to test flow models for ice sheets and ice caps, *in* Symposium on the Physical Basis of Ice Sheet Modelling, Vancouver, British Columbia, Canada, 9–22 August 1987, Proceedings: IASH Publication No. 170, p. 299–310.

Reid, I.A., 1961, Triangulation survey of the Athabasca Glacier, July 1959: Ottawa, Ont., Department of Northern Affairs and National Resources, Water Resources Branch, Internal report, p. 20 and 2 maps.

———1973, Glacier surveys by the Water Survey of Canada, *in* The role of snow and ice in hydrology, Proceedings of the Banff Symposium, September 1972: IAHS-AISH Publication No. 107, v. 2, p. 1133–1143.

Reid, I.A., and Charbonneau, J.O.G., 1972, Glacier surveys in Alberta: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Report Series No. 22, 17 p. and maps.

———1975, Glacier surveys in British Columbia—1970: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Report Series No. 32, 23 p. and 5 maps.

———1979a, Glaciers surveys in Alberta—1977: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Report Series No. 65, 17 p. and maps.

———1979b, Glaciers surveys in British Columbia—1976: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Report Series No. 63, 21 p. and maps.

Reid, I.A., and Paterson, W.S.B., 1973, Simple method for measuring the average amount of water produced annually by melting of ice on a glacier, *in* Symposium on the Hydrology of Glaciers, Cambridge, 7–13 September 1969: Association Internationale d'Hydrologie Scientifique Publication No. 95, p. 215–218.

Reid, I.A., and Shastal, John, 1970, Glaciers surveys in British Columbia—1968: Ottawa, Ont., Department of Energy, Mines and Resources, Inland Waters Branch Report Series No. 10, 26 p. and maps.

Reid, I.A., Charbonneau, J.O.G., and Warner, L.A., 1978, Glacier surveys in Alberta—1975: Ottawa, Ont., Fisheries and Environment Canada, Water Resources Branch, Inland Waters Directorate Report Series No. 60, 17 p. and maps.

Rentsch, Hermann, Welsch, Walter, Heipke, Christian, and Miller, M.M., 1990, Digital terrain models as a tool for glacier studies: Journal of Glaciology, v. 36, no. 124, p. 273–278.

Reynolds, J.R., 1992, Dendrochronology and glacier fluctuations at Peyto Glacier, Banff National Park: B.A. thesis, London, Ont., University of Western Ontario, Department of Geography, 73 p.

Reynolds, J.R., and Young, G.J., 1997, Changes in areal extent, elevation and volume of Athabasca Glacier, Alberta, Canada, as estimated from a series of maps produced between 1919 and 1979: Annals of Glaciology, v. 24, p. 60–65.

Ricker, K.[E.], 1962, Polar ice-dammed lakes: Canadian Alpine Journal, v. 45, p. 149–151.

———1976, Tchaikazan Valley earth science notes: Canadian Alpine Journal, v. 59, p. 16–19.

———1977, Wedgemount Lake and lower Glacier basin: Vancouver, B.C., Mountain Equipment Coop., map-scale 1:5,000. [Map drawn by K. Ricker with additional contour information provided by K. Bracewell, W. Tupper, and the British Columbia Institute of Technology].

———1979, Earth Science Studies—Snowcap Lakes—a dramatic record of diachronous glacier movement, drainage reversals, and fluctuating water levels: Canadian Alpine Journal, v. 62, p. 59–65.

———1980, Earth science features and glacier regimen of the Clendenning and Elaho Ranges, Coast Mtns., British Columbia: Canadian Alpine Journal, v. 63, p. 57–65.

———1990, Overlord Glacier—A 1989 update: The British Columbia Mountaineer, v. 60, p. 108.

Ricker, K.E., and Jozsa, L., 1984, Retreat of the New Moon Glacier, Buckley Ranges, Hazelton Mountains, western British Columbia: Canadian Alpine Journal, v. 67, p. 66–69.

Ricker, K.E., and Parke, B.[A.], 1984, Caltha Lake moraines and other natural history matters, Stein River Divide in the Lillooet Ranges of the Coast Mountains: Canadian Alpine Journal, v. 67, p. 62–65.

Ricker, K.[E.], and Tupper, W.A., 1988, A recent advance of the Overlord Glacier: British Columbia Mountaineer, v. 59, p. 84–86.

———1992, Glacier variations in northern Garibaldi Park—1991 update: British Columbia Mountaineer, v. 61, p. 104–105.

———1996, Overlord and Wedgemount Glaciers—a century of shrinkage: British Columbia Mountaineer, v. 63, p. 99–104.

Ricker, K.[E.], Tupper, W.A., Lyon, R.D., and Fairley, J., 1983, Wedgemount Lake and Glacier studies, northern Garibaldi Park—1982 progress report: Canadian Alpine Journal, v. 66, p. 58–61.

Rigsby, G.P., 1958, Fabrics of glacier and laboratory deformed ice, *in* Symposium on Physics of the Movement of the Ice, Symposium of Chamonix, 16–24 September 1958: Association Internationale d'Hydrologie Scientifique Publication No. 47, p. 351–358.

———1960, Crystal orientation in glacier and experimentally deformed ice: Journal of Glaciology, v. 3, no. 27, p. 589–606.

Robertson, B., 1997, Mass balance methods in the accumulation zone of the White Glacier, Axel Heiberg Island, N.W.T., Canada: B.Sc. thesis, Peterborough, Ont., Trent University, Department of Geography.

Rogerson, R.J., 1985, Measured re-advance of a debris-covered glacier terminus in the President Range, Yoho National Park, British Columbia, Canada: Journal of Glaciology, v. 31, no. 107, p. 13–17.

Rogerson, R.J., 1986, Mass balance of four cirque glaciers in the Torngat Mountains of northern Labrador, Canada: Journal of Glaciology, v. 32, no. 111, p. 208–218.

Rogerson, R.J., and Eyles, Nicholas, 1979, Subglacial, englacial, and supraglacial sediment differentiation and erosion in glacial basins [abs.]: Journal of Glaciology, v. 23, no. 89, p. 413.

Rogerson, R.J., Olson, M.E., and Branson, D., 1986, Medial moraines and surface melt on glaciers of the Torngat Mountains, northern Labrador, Canada: Journal of Glaciology, v. 32, no. 112, p. 350–354.

Römmer, S., and Hell, Günther, 1986, Veräungen der Zunge eines Gletschers am Harefjord (NWT, Kanada) zwischen 1958 und 1978: Diplomarbeit im Studiengang Kartographie, FH Karlsruhe, FRG, map.

Roots, E.F., 1967, Yukon Centennial projects—A variety of survey problems: Canadian Surveyor, v. 21, no. 3, p. 250–259.

———1984, Glacier mass balance measurements—An honourable past, an important future: Geografiska Annaler, v. 66A, no. 3, p. 165–167.

Rossiter, J.R., LaTorraca, G.A., Annan, A.P., Strangway, D.W., and Simmons, Gene, 1973, Radio interferometry depth sounding—Part II. Experimental results: Geophysics, v. 38, no. 3, p. 581–599.

Russell, R.D., Jacobs, J.A., and Grant, F.S., 1960, Gravity measurements on the Salmon Glacier and adjoining snowfield, British Columbia: Geological Society of America Bulletin, v. 71, no. 8, p. 1223–1229.

Sackinger, W.M., Serson, H.V., Jeffries, M.O., Shoemaker, H.D., and Yan, M.-H., 1985, Ice island generation and trajectories north of Ellesmere Island, Canada: POAC85, International Conference on Port and Ocean Engineering under Arctic Conditions, 8th, Narssarssuaq, Greenland, 7–14 September 1985, Proceedings, v. 2: Hørsholm, Danish Hydraulic Institute, p. 1009–1040.

Sagar, R.B., 1964, Meteorological and glaciological observations on the Gilman Glacier, northern Ellesmere Island, 1961: Geographical Bulletin, v. 22, p. 13–56.

———1966, Glaciological and climatological studies on the Barnes Ice Cap, 1962–64: Geographical Bulletin, v. 8, no. 1, p. 3–47.

Savage, J.C., and Paterson, W.S.B., 1963, Borehole measurements in the Athabasca Glacier: Journal of Geophysical Research, v. 68, no. 15, p. 4521–4536.

———1965, Additional borehole measurements in the Athabasca Glacier: Journal of Geophysical Research, v. 70, no. 14, p. 3511–3513.

Schmok, J.P., 1990, 1989 mass balance determination and geodetic survey of Sentinel, Place and Helm Glaciers, British Columbia: Saskatoon, Sask., Environment Canada, Physical Hydrology Division, National Hydrology Research Institute Contract Report No. 90001, 29 p.

Sedgwick, J.K., and Henoch, W.E.S., 1975, Peyto Glacier, general information: Ottawa, Ont., Department of the Environment, Inland Waters Directorate, Water Resources Branch, Glaciology Division, 30 p. and map.

Serreze, M.C., and Bradley, R.S., 1987, Radiation and cloud observations on a High Arctic plateau ice cap: Journal of Glaciology, v. 33, no. 114, p. 162–168.

Serson, H.V., 1979, Mass balance of the Ward Hunt Ice Rise and Ice Shelf—An 18-year record: Victoria, B.C., Department of National Defence, Research and Development Branch, Defence Research Establishment Pacific Technical Memorandum No. 79–4, 14 p.

Sharp, R.P., 1950, Report of glaciological work on Project Snow Cornice in 1949: American Alpine Journal, v. 7, no. 4, p. 432–435.

Sharp, R.P., and Epstein, Samuel, 1958, Oxygen-isotope ratios and glacier movement, *in* Symposium on Physics of the Movement of the Ice, Symposium of Chamonix, 16–24 September 1958: Association Internationale d'Hydrologie Scientifique Publication No. 47, p. 359–369.

Sherzer, W.H., 1907, Glaciers of the Canadian Rockies and Selkirks (Smithsonian Expedition of 1904): Washington, D.C., Smithsonian Institution, Smithsonian Contributions to Knowledge, v. 34, art. 4 (1692), 135 p.

———1908, The nature and activity of Canadian glaciers: Canadian Alpine Journal, v. 1, no. 2, p. 249–263.

Shilts, Elizabeth, Fick, Steven, Murray, Andrew, and McLean, Janice 1998, The glaciers of Canada: Canadian Geographic, v. 118, no. 7, p. 51–52 (8-page foldout, color map).

Shimizu, Hiromu, and Wakahama, Gorow, 1965, Kasukaurushu hyoga (Kanada) genryuiki ni okeru sekisetsu chosa (On the firn study in the accumulation area of Kaskawulsh Glacier, Canada): Teion Kagaku (Low Temperature Science), Series A, v. 23, p. 137–156.

Shoemaker, E.M., 1991, On the formation of large subglacial lakes: Canadian Journal of Earth Sciences, v. 28, no. 12, p. 1975–1981.

Short, S.K., and Holdsworth, Gerald, 1985, Pollen, oxygen isotope content and seasonality in an ice core from the Penny Ice Cap, Baffin Island: Arctic, v. 38, no. 3, p. 214–218.

Slaney, V.R., 1981, Landsat images of Canada—A geological appraisal: Canada Geological Survey Paper No. 80–15, 102 p.

Sloan, V.F., 1987, Relationships between glacier terminus melt processes and climatic conditions, Boundary Glacier, Alberta: Eastern Snow Conference, 43rd Annual Meeting, Hanover, New Hampshire, 5–6 June 1986, Proceedings, p. 222–227.

Smart, C.C., 1984, Glacier hydrology and the potential for subglacial karstification: Norsk Geografisk Tidsskrift, v. 38, no. 3–4, p. 157–161.

———1986, Some observations on subglacial ground-water flow: Journal of Glaciology, v. 32, no. 111, p. 232–234.

———1988, Exceedance probability distributions of steady conduit flow in karst aquifers: Hydrological Processes, v. 2, no. 1, p. 31–41.

———1992, Temperature compensation of electrical conductivity in glacial meltwaters: Journal of Glaciology, v. 38, no. 128, p. 9–12.

———1998, Statistical evaluation of glacier boreholes as indicators of basal drainage systems, *in* Sharp, M.J., Richards, K.S., and Tranter, Martyn, eds., Glacier hydrology and hydrochemistry: Chichester, Wiley, p. 175–189.

Smart, C.C., and Ford, D.C., 1983, The Castleguard karst, Main Ranges, Canadian Rocky Mountains: Journal of Hydrology, v. 61, no. 1–3, p. 193–197.

Smart, C.C., 1986, Structure and function of a conduit aquifer: Canadian Journal of Earth Sciences, v. 23, no. 7, p. 919–929.

Smith, D.J., 1994, Field investigations in Strathcona Provincial Park—1993: Victoria, Ministry of Environment, Lands and Parks, British Columbia Parks Branch, Strathcona District.

Smith, R.F., 1997, Final report of the Joint Services Expedition to the Blue Mountains, Ellesmere Island, High Arctic Canada, 1994: Elmwood Avenue, Feltham, Middlesex TW13 7AH, U.K., Military Survey, 174 p.

Souchez, R.A., and De Groote, J.M., 1985, δD–$\delta^{18}O$ relationships in ice formed by subglacial freezing—Paleoclimatic implications: Journal of Glaciology, v. 31, no. 109, p. 229–232.

Souchez, R.[A.], Lorrain, R.[D.], Tison, J.L., and Jouzel, Jean, 1988, Co-isotopic signature of two mechanisms of basal-ice formation in Arctic outlet glaciers: Annals of Glaciology, v. 10, p. 163–166.

Spector, Allan, 1966, A gravity survey of the Melville Island ice caps: Journal of Glaciology, v. 6, no. 45, p. 393–400.

Stanley, A.D., 1969, Observations on the surge of the Steele Glacier, Yukon Territory, Canada: Canadian Journal of Earth Sciences, v. 6, no. 4, pt. 2, p. 819–830.

———1975, Mass and water balance studies at selected glacier basins in western Canada, *in* Snow and Ice Symposium, Moscow, August 1971, Proceedings: IAHS-AISH Publication No. 104, p. 181–184.

Stenning, A.J., Banfield, C.E., and Young, G.J., 1981, Synoptic controls over katabatic layer characteristics above a melting glacier: Journal of Climatology, v. 1, no. 4, p. 309–324.

Stewart, T.G., 1991, Glacial marine sedimentation from tidewater glaciers in the Canadian High Arctic, *in* Anderson, J.B., and Ashley, G.M., eds., Glacial marine sedimentation; paleoclimatic significance: Boulder, Colo., Geological Society of America Special Paper No. 261, p. 95–105.

Stolle, D.F.E., 1986, Two-dimensional line element for glacier flow problems: Engineering Analysis, v. 3, no. 3, p. 161–165.

———1988, A one-dimensional finite-element model for two-dimensional glacier flow: Journal of Glaciology, v. 34, no. 117, p. 236–241.

Stone, D.B., and Clarke, G.K.C., 1993, Estimation of subglacial hydraulic properties from induced changes in basal water pressure: A theoretical framework for borehole-response tests: Journal of Glaciology, v. 39, no. 132, p. 327–340.

———1998, In situ measurements of basal water quality and pressure as an indicator of the character of subglacial drainage systems, *in* Sharp, M.J., Richards, K.S., and Tranter, Martyn, eds., Glacier hydrology and hydrochemistry: Chichester, Wiley, p. 205–218.

Stone, D.B., Clarke, G.K.C., and Blake, E.W., 1993, Subglacial measurement of turbidity and electrical conductivity: Journal of Glaciology, v. 39, no. 132, p. 415–420.

Strilaeff, P.W., 1961, Glacier surveys in British Columbia: Western Snow Conference, 29th Annual Meeting, Spokane, Washington, 11–13 April 1961, Proceedings, p. 1–5.

Sturges, W.T., Penkett, S.A., Atlas, E.L., and Chappellaz, J.[A.], 1998, Evidence from trace gas profiles of biogenic activity in deep firn layers from Devon Island, Canada [abs.]: EOS, Transactions, American Geophysical Union, v. 79, no. 45, Fall Meeting Supplement, p. F58.

Taylor-Barge, Bea, 1969, The summer climate of the St. Elias Mountains Region, *in* Icefield Ranges Research Project: Scientific Results, v. 1: American Geographical Society and Arctic Institute of North America, p. 33–49.

The Ice Age Co., 1989, Cline Glacier ice mining project—Environmental impact assessment: Edmonton, Alberta, The Ice Age Co. Inc., 62 p.

Thorington, J.M., 1938, Notes on Saskatchewan and Freshfield Glaciers: American Alpine Journal, v. 3, no. 2, p. 219–220.

Tison, J.L., Souchez, Roland, and Lorrain, Reginald, 1989, On the incorporation of unconsolidated sediments in basal ice—Present-day examples: Zeitschrift für Geomorphologie, Supplementband 72, p. 173–183.

Tolland, L., Dicks, W., Buttle, J.[M.], Ecclestone, M.[A.], and Adams, W.P., 1991, Observations of discharge from the Baby Glacier, Axel Heiberg Island, N.W.T, *in* Third National Student Conference on Northern Studies, Ottawa, Ontario, 23–24 October 1991, Abstracts of Papers: Ottawa, Ont., Association of Canadian Universities for Northern Studies, p. 205–206.

Trabant, D.C., Krimmel, R.M., and Post, A.[S.], 1991, A preliminary forecast of the advance of Hubbard Glacier and its influence on Russell Fiord, Alaska: U.S. Geological Survey Water-Resources Investigations Report No. 90–4172, 34 p.

Trombley, T.J., 1986, A radio echo-sounding survey of Athabasca Glacier, Alberta, Canada: M.Sc. thesis, Manchester, N.H., University of New Hampshire, Department of Earth Science, 64 p.

Tupper, W.A., and Ricker, K.E., 1982, Wedgemount Lake and Glacier studies, northern Garibaldi Park—1981 progress report: Canadian Alpine Journal, v. 65, p. 51–52.

Tupper, B.[W.A.], Ricker, K.E., Bremner, R., Frankich, K., and Fairley, J., 1984, Wedgemount Lake and Glacier studies, northern Garibaldi Park—1983 progress report: Canadian Alpine Journal, v. 67, p. 61–62.

Tupper, B.[W.A.], Ricker, K.[E.], Fairley, J., and Lyon, R.D., 1986, Wedgemount Lake and Glacier, northern Garibaldi Park—1985 progress report: Canadian Alpine Journal, v. 69, p. 44–45.

Tupper, W.A., Ricker, K.E., and McKnight, B., 1985, Wedgemount Lake and Glacier, northern Garibaldi Park—1984 progress report: Canadian Alpine Journal, v. 68, p. 41.

Untersteiner, Norbert, and Nye, J.F., 1968, Computations of the possible future behaviour of Berendon Glacier, Canada: Journal of Glaciology, v. 7, no. 50, p. 205–213.

Vachon, P.W., Geudtner, D., Mattar, K.[E.], Gray, A.L., Brugman, M.[M.], and Cumming, I., 1996, Differential SAR interferometry measurements of Athabasca and Saskatchewan Glacier flow rate: Canadian Journal of Remote Sensing, v. 22, no. 3, p. 287–296.

VanDine, D.F., 1985, Debris flows and debris torrents in the southern Canadian Cordillera: Canadian Geotechnical Journal, v. 22, no. 1, p. 44–68.

Vaux, George, 1910, Observations on glaciers in 1909: Canadian Alpine Journal, v. 2, no. 2, p. 126–129.

Vaux, George, [Jr.] and Vaux, W.S., Jr., 1900a, Additional observations on glaciers in British Columbia: Proceedings of the Academy of Natural Sciences of Philadelphia, p. 501–511.

———1900b, Some observations on the Illecillewaet and Asulkan Glaciers of British Columbia: Proceedings of the Academy of Natural Sciences of Philadelphia, p. 121–124.

———1901, Observations made in 1900 on glaciers in British Columbia: Proceedings of the Academy of Natural Sciences of Philadelphia, p. 213–215.

———1907a, Glacier observations: Canadian Alpine Journal, v. 1, no. 1, p. 138–148.

———1907b, Observations made in 1906 on glaciers in Alberta and British Columbia: Proceedings of the Academy of Natural Sciences of Philadelphia, p. 568–579.

———1908, Observations made in 1907 on glaciers in Alberta and British Columbia: Proceedings of the Academy of Natural Sciences of Philadelphia, p. 560–563.

Vaux, M.M., 1911, Observations on glaciers in 1910: Canadian Alpine Journal, v. 3, p. 127–129.

———1913, Observations on glaciers: Canadian Alpine Journal, v. 5, p. 59–61.

Vaux, M.M., and Vaux, George, Jr., 1911, The glaciers of the Canadian Rockies and Selkirks (2d ed.): Bryn Mawr, Pennsylvania, privately printed, 20 p.

Vaux, W.S., [Jr.] 1907, Modern glaciers: their movements and the methods of observing them: Proceedings of the Engineers Club of Philadelphia, v. 24, no. 3, p. 1–25.

———1909, Modern glaciers: Canadian Alpine Journal, v. 2, no. 1, p. 56–78.

Vögtli, Kurt, 1967, D.C. resistivity soundings on Devon Island, N.W.T., Canada: Journal of Glaciology, v. 6, no. 47, p. 635–642.

Waddington, B.S., and Clarke, G.K.C., 1995, Hydraulic properties of subglacial sediment determined from the mechanical response of water-filled boreholes: Journal of Glaciology, v. 41, no. 137, p. 112–124.

Waddington, E.D., and Clarke, G.K.C., 1988, Stable-isotope pattern predicted in surge-type glaciers: Canadian Journal of Earth Sciences, v. 25, no. 5, p. 657–668.

Waddington, E.D., Fisher, D.A., Koerner, R.M., and Paterson, W.S.B., 1986, Flow near an ice divide—Analysis problems and data requirements: Annals of Glaciology, v. 8, p. 171–174.

Walford, M.E.R., Holdorf, P.C., and Oakberg, R.G., 1977, Phase-sensitive radio-echo sounding at the Devon Island ice cap, Canada: Journal of Glaciology, v. 18, no. 79, p. 217–229.

Wallace, A.L., 1995, The volumetric change of the Peyto Glacier, Alberta, Canada 1896–1966: M.A. thesis, Waterloo, Ont., Wilfred Laurier University, 110 p.

Ward, W.H., 1954, Glaciological studies in the Penny Highland, Baffin Island, 1953, *in* General Assembly of Rome, v. 4: Association Internationale d'Hydrologie Scientifique Publication No. 39, p. 297–308.

———1955, Studies in glacier physics on the Penny Ice Cap, Baffin Island, 1953. Part IV—The flow of Highway Glacier: Journal of Glaciology, v. 2, no. 18, p. 592–599.

Ward, W.H., and Baird, P.D., 1954, Studies in glacier physics on the Penny Ice Cap, Baffin Island, 1953. Part I—A description of the Penny Ice Cap, its accumulation and ablation: Journal of Glaciology, v. 2, no. 15, p. 342–355.

Ward, W.H., and Orvig, Svenn, 1953, The glaciological studies of the Baffin Island Expedition, 1950. Part IV—The heat exchange at the surface of the Barnes Ice Cap during the ablation period: Journal of Glaciology, v. 2, no. 13, p. 158–168.

Warner, L.A., Anderson, J.E., Kerber, R.E., and Robinson, C.P., 1972, 1972 survey of the Athabasca and Saskatchewan Glaciers: Calgary, Alberta, Department of the Environment, Water Survey of Canada, Internal Report, 34 p.

Waskasoo Design Group Limited, 1991, Columbia Icefield visitor centre interpretation media concepts: Jasper, Alberta, Canadian Parks Service, Interpretive Service, Jasper National Park, 171 p.

Weaver, R.L., 1975, "Boas" Glacier (Baffin Island, N.W.T., Canada) mass balance for the five years 1969 to 1974: Arctic and Alpine Research, v. 7, no. 3, p. 279–284.

Webb, C.E., 1948, Glacier studies in British Columbia: Western Snow Conference, Annual Meeting, Reno, Nevada, 15–17 April 1948, Proceedings, p. 46–54.

Weber, J.R., 1961, Comparison of gravitational and seismic depth determinations on the Gilman Glacier and adjoining ice-cap in northern Ellesmere Island, *in* Raasch, G.O., ed., Geology of the Arctic, v. 2: Toronto, Ont., University of Toronto Press, p. 781–790.

Weber, J.R., and Andrieux, Pierre, 1970, Radar soundings on the Penny Ice Cap, Baffin Island: Journal of Glaciology, v. 9, no. 55, p. 49–54.

Weber, J.R., Sandstrom, N., and Arnold, K.C., 1961, Geophysical surveys on Gilman Glacier, northern Ellesmere Island, *in* General Assembly of Helsinki, 25 July–6 August 1960: Association Internationale d'Hydrologie Scientifique Publication No. 54, p. 500–511.

Weiss, Jakob, 1984, Massenhaushalt eines Gletschers, Fragen an glaziologische Untersuchungen und die Resultate der Messreihe am White Glacier in der kanadischen Arktis: Diplomarbeit, Geographisches Institut, University of Zürich and ETH, Zürich, Switzerland, 149 p.

West, Robert, and Maki, Arthur, 1961, An advancing glacier in Canada: Science, v. 133, no. 3461, p. 1361.

Wheeler, A.O., 1905, The Selkirk Range: Ottawa, Ont., Government Printing Bureau, Department of the Interior, v. 1: 459 p., v. 2: maps.

———1911, Motion of the Yoho Glacier: Canadian Alpine Journal, v. 3, p. 123–126.

———1913, Motion of the Yoho Glacier: Canadian Alpine Journal, v. 5, p. 53–58.

———1920, Notes on the glaciers of the Main and Selkirk Ranges of the Canadian Rocky Mountains: Canadian Alpine Journal, v. 11, p. 121–146.

———1932, Glacial change in the Canadian Cordillera, the 1931 expedition: Canadian Alpine Journal, v. 20, p. 120–137.

Wheeler, A.O., 1934, Records of glacial observations in the Canadian Cordillera, 1933 and 1934: Canadian Alpine Journal, v. 22, p. 172–187.

Wheeler, A.O., and Parker, E., 1912, The Selkirk Mountains—A guide for mountain climbers and pilgrims: Winnipeg, Manitoba, Stovel Co., 191 p.

Williams, F.M., and Hutter, Kolumban, 1983, Thermal response of unconfined ice shelves to climatic conditions: Acta Mechanica, v. 48, no. 3–4, p. 131–146.

Williams, L.D., 1974, Computer simulation of glacier mass balance throughout an ablation season: Western Snow Conference, 42nd Annual Meeting, Anchorage, Alaska, 16–20 April 1974, Proceedings, p. 23–28.

———1975, The variation of corrie elevation and equilibrium line altitude with aspect in eastern Baffin Island, N.W.T., Canada: Arctic and Alpine Research, v. 7, no. 2, p. 169–181.

Wolfe, P.M., 1995, Hydrometeorological investigations on a small valley glacier in the Sawtooth Range, Ellesmere Island, Northwest Territories: M.A. thesis, Waterloo, Ont., Wilfrid Laurier University, Department of Geography, 225 p.

Wolfe, P.M., and English, M.C., 1996, Mass balance of a small valley glacier in the Canadian High Arctic, Ellesmere Island, Northwest Territories: Zeitschrift für Gletscherkunde und Glazialgeologie, 1995, v. 31, pt. 1, p. 93–103.

Wood, W.A., 1948, Project Snow Cornice: Arctic, v. 1, no. 2, p. 107.

———1949, Snow Cornice 1949: A preliminary report: Arctic, v. 2, no. 2, p. 118.

———1963, The Icefield Ranges Research Project: Geographical Review, v. 50, no. 2, p. 163–184.

Woodward, John, 1996, The influence of superimposed ice formation on the sensitivity of glacier mass balance to climate change: M.Sc. thesis, Edmonton, Alberta, University of Alberta, Department of Geography.

Woodward, John, Sharp, M.[J.], and Arendt, Anthony, 1997, The influence of superimposed-ice formation on the sensitivity of glacier mass balance to climate change: Annals of Glaciology, v. 24, p. 186–190.

Worthington, S.R.H., 1991, Karst hydrology of the Canadian Rocky Mountains: Ph.D. thesis, Hamilton, Ont., McMaster University, Department of Geography, 408 p.

Yang, Qinzhao, Mayewski, P.A., Whitlow, S.[I.], Twickler, M.[S.], Morrison, M.[C.], Talbot, R.[W.], Dibb, J.[E.], and Linder, Ernst, 1995, Global perspective of nitrate flux in ice cores: Journal of Geophysical Research, v. 100, no. D3, p. 5113–5121.

Yao Tandong, 1987, The primary investigation of the Juneau Icefield, U.S.A.: Bingchuan Dongtu (Journal of Glaciology and Geocryology), v. 9, no. 2, p. 183–186. (In Chinese with English abstract.)

Yarnal, B.[M.], 1984a, Relationships between synoptic-scale atmospheric circulation and glacier mass balance in south-western Canada during the International Hydrological Decade, 1965–74: Journal of Glaciology, v. 30, no. 105, p. 188–198.

———1984b, Synoptic-scale atmospheric circulation over British Columbia in relation to the mass balance of Sentinel Glacier: Annals of the Association of American Geographers, v. 74, no. 3, p. 375–392.

Young, G.J., [1971], Mass balance measurements related to surface geometry on Peyto Glacier, Alberta, *in* Glaciers, Proceedings of Workshop Seminar 1970, Vancouver, B.C., 24–25 September 1970: Ottawa, Ont., Canadian National Committee for the I.H.D., p. 11–20.

———1972, White Glacier mass balance, *in* Müller, Fritz, and others, eds., International Geographical Union, Field Tour Ea 2, Arctic Archipelago I, 22nd International Geographical Congress: Montréal, Québec, McGill University, Axel Heiberg Island Research Reports, Miscellaneous Papers, p. 25–30.

———1974, A data collection and reduction system for snow accumulation studies, *in* Santeford, H.S., and Smith, J.L., eds., Advanced concepts and techniques in the study of snow and ice resources: Washington, D.C., National Academy of Sciences, p. 304–313.

———1975, Accumulation and ablation patterns as functions of the surface geometry of a glacier, *in* Snow and Ice Symposium, Moscow, August 1971, Proceedings: IAHS-AISH Publication No. 104, p. 134–138.

———1976, An approach to glacier mass-balance analysis utilizing terrain characterization: Ottawa, Ont., Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 60, 34 p.

———1978, Relations between mass-balance and meteorological variables on Peyto Glacier, Alberta, 1967/1974: Zeitschrift für Gletscherkunde und Glazialgeologie, 1977, v. 13, no. 1–2, p. 111–125.

———1980, Monitoring glacier outburst floods: Nordic Hydrology, v. 11, no. 5, p. 285–300.

———1981, The mass balance of Peyto Glacier, Alberta, Canada, 1965 to 1978: Arctic and Alpine Research, v. 13, no. 3, p. 307–318.

———1982, Hydrological relationships in a glacierized mountain basin: Symposium at Exeter 1982—Hydrological Aspects of Alpine and High Mountain Areas, International Association of Hydrological Sciences Publication No. 138, p. 51–59.

———1985, Canada case study: catastrophic floods, *in* Young, G.J., ed., Techniques for prediction of runoff from glacierized areas: International Association of Hydrological Sciences Publication No. 149, p. 137–143.

———1990, Glacier hydrology, *in* Prowse, T.D., and Ommanney, C.S.L., eds., Northern hydrology—Canadian perspectives: Saskatoon, Sask., Environment Canada, National Hydrology Research Institute Science Report No. 1, p. 135–162.

Young, G.J., and Arnold, K.C., 1978, Orthophotomaps of glaciers; an evaluation of an automated method applied to Peyto Glacier, Alberta: Zeitschrift für Gletscherkunde und Glazialgeologie, 1977, v. 13, no. 1–2, p. 99–110.

Young, G.J., and Stanley, A.D., 1976a, Canadian glaciers in the International Hydrological Decade program, 1965–1974. No. 3. Ram River Glacier, Alberta—Summary of measurements: Ottawa, Ont., Fisheries and Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 70, 54 p.

———1976b, Canadian glaciers in the International Hydrological Decade program, 1965–1974. No. 4. Peyto Glacier, Alberta—Summary of measurements: Ottawa, Ont., Fisheries and Environment Canada, Water Resources Branch, Inland Waters Directorate Scientific Series No. 71, 59 p.

Zdanowicz, C.M., Michel, F.A., and Shilts, W.W., 1996, Basal debris entrainment and transport in glaciers of southwestern Bylot Island, Canadian Arctic: Annals of Glaciology, v. 22, p. 107–113.

Zubok, O.M., 1975, Half decade study of mass balance at Sentinel Glacier, BC, Canada, *in* Snow and Ice Symposium, Moscow, August 1971, Proceedings: IAHS-AISH Publication No. 104, p. 202–207.