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STUDIES OF SOME CANADIAN TOPOGRAPHIC MAPS

(PRELIMINARY REPORT)

By
L. J. Weeks, E. D. Kindle, Y. O. Fortier
and Mary E. B. Hamilton

OTTAWA
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PREFACE

Late in 1947, Professor T.H. Clark, of McGill University, suggested that the Geological Survey of Canada compile a list of Canadian topographic maps on which definite physiographic or geomorphological features were recognizable. It was thought that such a list would enable Canadian colleges and secondary schools to use maps of Canada in teaching physiography, in conjunction with the very excellent topographic maps issued by the United States Geological Survey, which generally are used in teaching such courses.

A consideration of Professor Clark's suggestion led to the examination of a random number of Canadian maps, from which it became obvious that most of the contoured, and many of the uncontoured maps illustrate recognizable physiographic features, varying from such as are 'textbook examples' to others less readily apparent. The question then arose as to whether only the best illustrated features should be listed, and, if so, whether attention should be called to those less apparent on the same maps. Eventually, the conclusions were reached: that in its final form, the publication would require an exhaustive study of all Canadian topographical maps; that a large proportion of these should be listed; and that a cross-index should be supplied to the feature or features illustrated by each of these maps. With such a list, and such an index, the more prominent features illustrated could then be indicated in special type or by some other means. Such a publication may be considered to be the eventual objective of the authors.

The present contribution is no more than a preliminary effort towards the final goal. The short list of maps, most of which represent regions familiar to the authors, is presented with a two-fold purpose: first, to indicate a few Canadian topographic maps that might be included in a course on physiography during the scholastic year of 1948-49; and second (and of more present importance to the authors), to attract constructive criticism from teachers and other interested persons. Only if such criticism is received can it be decided whether to continue the project, what should be included in the final publication, and how best to arrange the subject matter.

INTRODUCTION

Canadian topographic maps have been issued in the past by several Federal and Provincial institutions, including the Geological Survey (Topographical Division), the Topographical Survey, the Geographical Section of the General Staff, and the British Columbia Department of Lands. At present, topographic maps are compiled and issued by two Federal administrative units, the Topographical Survey of the Surveys and Mapping Bureau, Department of Mines and Resources, and the Geographical Section of the General Staff, Department of National Defence. Most, if not all, of the provinces compile and issue maps intended primarily for land subdivision, but not in general suited for the study of physiographic features. Contoured maps issued by the British Columbia Department of Lands are, however, suited for this purpose.

Early topographic maps were all produced by ground methods and contain many inaccuracies, particularly in the location of drainage and contours, as all parts of the area could not be traversed nor pictured in detail by photographic methods. Modern maps, although controlled by ground traverses, are almost wholly compiled from air photographs, which, in effect, permit the compiler to visit every part of the area. Not only does this result in increased accuracy, but also in more efficient compilation.

Each map has a name, based usually on some contained geographic or cultural feature, and in addition may carry one or more publication, serial, or reference numbers. Commencing about 25 years ago, maps issued by the Topographical Survey, and more recently, all Federal topographic maps, have been numbered according to a grid system applicable to all of Canada, which enables the position of any standard-sized map-area to be plotted accurately within the boundaries of the Dominion.

In this paper, topographic maps will be referred to primarily by name, which is not duplicated for any province or territory, and secondarily by the name of the province or territory in which the map-area lies. Map and grid-reference numbers are also included where these appear on the map-sheets.

For the purposes of this report, the index of land forms will be referred directly to the names of the maps on which those forms are depicted, although as the list of maps expands, it may be found necessary to substitute some more condensed system of reference.

In studying the literature of physiography, it may be noticed that not uncommonly terms are defined differently by different authors. A more complete publication should, perhaps, include a glossary of terms, with the definitions accepted by the authors, but for the present those given by Lobeck[1] have been

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[1] Lobeck, A.K.: Geomorphology; McGraw-Hill Book Company Inc., 1939.

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adopted. Choice of his work in no way reflects on other authoritative publications, but was made on its general recognition as a standard text, and because it had been used as a textbook by two of the authors of this paper.

HOW TO OBTAIN MAPS

All listed maps having a serial or publication number, as, for example, 732A (Bass River) or 2033 (Mount Albert), may be obtained from the Distribution Office, Geological Survey of Canada, Ottawa. All other maps may be obtained from the Map Distribution Office, Surveys and Mapping Bureau, Ottawa. The charge for most of these maps is 25 cents each.

LIST OF MAPS

The following is a list of the topographic maps for which descriptions are given on subsequent pages. They are listed alphabetically, and are described in the same order.

Name	No. and/or grid	Scale (miles)	Lat. and long.
Artillery Lake, N.W.T.	75 NW. and NE	8	62°-64°; 104°-112°
Bass River, N.S.	732A; $11\frac{E}{5}$ (W/2)	1	$45^\circ15'$-$45^\circ30'$; $63^\circ45'$-64°
Beaverton, Ont.	$31\frac{D}{6}$	1	$44^\circ15'$-$44^\circ30'$; 79°-$79^\circ30'$
Beloeil, Que.	$31\frac{H}{11}$	1	$45^\circ30'$-$45^\circ45'$; 73°-$73^\circ30'$
Bolton, Ont.	$30\frac{M}{13}$	1	$43^\circ45'$-44°; $79^\circ30'$-80°
Brandon, Man.	Sect. Map No. 72	3	$49^\circ43'$-$50^\circ25'$; 98°-$100^\circ10'$
Camsell River, N.W.T.	86 SW. and SE.	8	64°-66°; 112°- 120°
Collingwood, Ont.	$41\frac{A}{8}$	1	$44^\circ15'$-$44^\circ30'$; 80°-$80^\circ30'$
Dufferin, Man.	Sect. Map No. 22	3	49°-$49^\circ40'$; 98°-$100^\circ10'$
Hamilton, Ont.	$30\frac{M}{5}$	1	$43^\circ15'$-$43^\circ30'$; $79^\circ30'$-80°
Hazelton, B.C.	449A; 93M(W/2)	4	55°-56°; 127°-128°
Kennedy Channel, N.W.T.	$29A^{S}/2, 19A^{S}/2, 9A^{S}/2$	8	80°-82°; 50°-72°
Mackenzie River Delta, N.W.T.	(Blue print)	3	$67^\circ30'$-$70'$; 129°-$136^\circ30'$
Medicine Hat-Maple Creek, Alta. and Sask.	----------	8	49°-51°; 108°-112°
Medicine Lake, Alta.	924A; $83\frac{C}{13}$	1	$52^\circ45'$-53°; $117^\circ30'$-118°
Mira, N.S.	$11\frac{F}{16}$	1	$45^\circ45'$ to 46°; 60°-$60^\circ30'$
Montreal, Que.	31H	4	45°-46°; 72°-74°

Con't.

Name	No. and/or grid	Scale (miles)	Lat. and long.
Moose Jaw, Sask.	Sect. Map No. 69	3	49°43'-50°25'; 104°05'-106°
Mount Albert, Que.	2033	1	48°45'-49°; 66°-66°15'
Niagara, Ont.	$30\frac{M}{3}$	1	43°-43°15'; 79°-79°30°
Orford, Que.	$31\frac{H}{8}$	1	45°15'-45°30'; 72°-72°30'
Parrsboro, N.S.	818A; $21\frac{H}{8}$ (W/2)	1	45°15'-45°30'; 64°15'-64°30'
Peterborough, Ont.	$31\frac{D}{8}$	1	44°15'-44°30'; 78°-78°30'
Rae, N.W.T.	85 NW. and NE.	8	62°-64°; 112°-120°
River Hebert N.S.	764A; $21\frac{H}{9}$ (W/2)	1	45°30'-45°45'; 64°15'-64°30'
Steveville, Alta.	(Blue-line print)	2,000 ft.	tps. 20-21, rges. 10-12, W. 4th mer.
Sunwapta, Alta.	879A; $83\frac{C}{6}$	1	52°15'-52°30'; 117°-117°30'
Tofino, B.C.	909A; $92\frac{F}{4}$ and $92\frac{E}{1}$	1	49°-49°15'; 125°30'-126°
Wentworth, N.S.	813A; $11\frac{E}{12}$ (W/2)	1	45°30'-45°45'; 63°30'-63°45'

DESCRIPTIONS OF MAPS

The descriptions of individual maps, which follow, are arranged in the same order as in the preceding list. Each map is described on a separate page, and the description is limited to that page. The object of this is twofold; first, to enable later descriptions of other maps to be inserted alphabetically among those already prepared, and, second, to facilitate extraction of those map descriptions desired for separate filing or for attaching to copies of the maps.

ARTILLERY LAKE, N.W.T. Sheets 75 NE. and NW.

Prominent Features Displayed

1. Eskers
2. Moraine
3. Fault scarp
4. Fault lakes
5. Sand dunes

Eskers are indicated on the map by symbols. They are long, sinuous, and branching or have tributaries. Some are associated with sand plains, probably outwash plains. In a few localities, as north of Walmsley Lake, some eskers apparently lie across the trend of others; field work would be required here to obtain the true relations. It should be noted that the southwest part of the area, which has more rock exposed, has fewer eskers, whereas the rest of the area has much drift and eskers are plentiful. This is characteristic of this part of the Northwest Territories.

A scarp, extending from McDonald Lake northeastward to Charlton Bay, is the locus of a large fault that has been mapped. The straight, southeast shoreline of McDonald Lake is due to the escarpment. Some smaller lakes, at the foot of the escarpment, are elongated parallel with it. The fault may be traced northeastward along a series of small, elongated, and alined lakes that locally appear at the foot of an escarpment, as, for example, Burbanks Lake, and along small rivers, which locally flow in deep valleys, as, for example, the river flowing through Burbanks Lake.

The series of parallel alined lakes east of Clinton-Colden Lake are thought to be controlled either by jointing or gneissic structure.

MAP 732A-BASS RIVER, NOVA SCOTIA   Sheet $11\frac{E}{5}$ (W/2)

Prominent Features Displayed

1. Uplifted and dissected peneplain
2. Fault scarp
3. Superimposed stream
4. Subsequent stream
5. Stream capture or piracy
6. Meanders in tidal alluvium

Along the north side of the map-area, the surface of the post-Triassic peneplain is exposed in the rolling, featureless top of Cobequid Mountain. Into this surface, Economy and Bass Rivers have cut youthful valleys. Near the south end of its gorge, Economy River displays two distinct valley slopes. (Actually three are visible in the field.) Some 3 to 4 miles south of the north side of the map-area, Cobequid Mountain ends in a pronounced scarp, caused by the downfaulting of softer Carboniferous strata to the south of, and against the harder rocks of, Cobequid Mountain. Some 2 to 3 miles south of the Cobequid fault, block faulting has caused a ridge of relatively harder Carboniferous beds to rise above a low plain of very soft Triassic rocks. This ridge does not reach the level of Cobequid Mountain. Economy River is an excellent example of stream superposition; it cuts a deep gorge through the Carboniferous ridge to the Triassic plains where its banks are low. East Economy River, in its last 2 miles before joining Economy River, is a subsequent stream, which has captured part of a stream originally flowing south across the Carboniferous ridge. Tidal alluvium has been deposited in the estuaries of Economy, Bass, and Tennycape Rivers, and in these deposits the respective streams have cut meanders.

BEAVERTON, ONTARIO

Sheet 31-$\frac{D}{6}$

Prominent Features Displayed

1. Drumlins
2. Abandoned shorelines
3. Eskers
4. Moraine

The drumlins of this area have a northeast trend and are accompanied by similarly trending eskers, indicating regional glaciation by a continental ice-sheet.

During the period of recession of the last ice-sheet, Lake Algonquin was formed. The principal, ancient shoreline of this lake occupies about the position of the present 800-foot contours, and those land masses shown in the southwestern half of the sheet, above this level, stood as islands in Lake Algonquin.

Typically, the eskers appear as long, narrow ridges or islands within the marsh lands.

Innumerable gravel pits are evidence of reworked glacial till, deposited by the ice. The disorganized drainage and many marshes or swamps are also indicative of glacial deposition in a region of relatively low relief.

BELOEIL, QUEBEC

Sheet 31 H/11

Prominent Features Displayed

1. Sea terraces
2. Igneous residuals
3. Drainage patterns

Beloeil map-area lies within the St. Lawrence Plain, which rises gradually to a height of some 100 feet in the southeast, from near sea-level at the St. Lawrence River.

The contours are generally parallel with the St. Lawrence, and are suggestive of slight terraces, which may be those left from the wave action of the post-Glacial, Champlain Sea.

St. Bruno and St. Hilaire Mountains are two of the eight Monteregian Hills, which are residuals of igneous intrusions through the much older, flat-lying, Palaeozoic sedimentary formations. These hills are almost circular in outline, and rise to 715 and 1,437 feet, respectively, above sea-level, providing, thereby, a striking contrast with the flat, plains region.

The consequent and youthful streams are seen to illustrate both dendritic and rectangular drainage patterns.

BOLTON, ONTARIO Sheet $30\frac{M}{13}$

Prominent Features Displayed

1. Divide (or watershed)
2. Potholes
3. Moraine
4. Glacial dam
5. Dendritic drainage
6. Kames
7. Abandoned shorelines

A divide or watershed crosses this area about 3 miles south of the north boundary. The small lakes are spring-fed potholes, and lie in line along the south side of the divide. The height of land is topped by kames, which are ridges of gravel or sand deposited in depressions along an ice front. The area was occupied by two ice lobes, one from the south, the other from the north, which met in the vicinity of the divide and account for the wide distribution of morainic material. Some glacial damming may have taken place in the vicinity of Kinghorn, in the northeast quarter of the sheet.

The former Lake Algonquin is known to have existed in this region, and its main shoreline is represented in the south of the area at a height of between 750 and 775 feet. A sharp contrast appears between the topography of the northern part of the area, which is moraine covered, and the southern part, which was part of the basin of a late-Glacial lake.

Most of the drainage has a dendritic pattern, and the streams appear to represent an early cycle of erosion.

BRANDON, MANITOBA | Sectional Map No. 72

Prominent Features Displayed

1. Lake terraces

2. Lake plain

3. Escarpment

4. Moraine

5. Meandering and misfit streams

The extensive plain of glacial Lake Agassiz, with its featureless topography and clay deposits, covers most of the east half of the area. Many of the old terraces or abandoned shorelines of this lake can be distinguished, and are an outstanding feature of the map.

Along the southern edge of the area, Assiniboine River meanders through a depth of three or four hundred feet of terraced drift, and has constructed a deltaic formation on the margin of the old lake plain.

Much of the western half of the area is sand covered, resulting in forest growth and some underground drainage.

Brandon Hills, in the southwest corner of the area, are formed of morainic materials, whereas, the Riding Mountains of the north are hill remnants of the Manitoba (Cretaceous) escarpment.

Minnedosa River is a 'misfit' stream, as it flows in a wide valley made by a former river.

The confused drainage of the area is a result of glacial processes, and of the nearly flat-lying sedimentary formations so typical of the Intarior Plains.

Prominent Features Displayed

1. Eskers
2. Moraine
3. Glacial and fault lakes

The Palaeozoic plain to the west is in contrast with the Canadian Shield, which occupies the rest of the map-area and contains many more lakes.

Within the Shield, many divisions can be made. The area east of 115° is mostly drift covered, and north of 64°30' the lakes have a general orientation parallel with the regional trend of the eskers. In this northern part are a great many drumlins not shown on the map, and they trend westerly. It is concluded that most of the lakes lie in drift, and that their orientation indicates the direction in which the Pleistocene ice-sheet moved.

West of 115°, more bedrock is exposed, eskers are fewer, and most lakes occupy rock basins probably dammed by glacial debris. This conclusion is reached from the following observations: (a) between Grant Lake and Calder River is a narrow zone of parallel lakes and rivers that coincides with a belt of sedimentary and volcanic strata; (b) between Little Crapeau and Turmoil Lakes, a belt of curving lakes reflects the structure of granitic gneiss and included strata; (c) belts of strata marked by parallelism of lakes also appear in the areas of Mattberry and Indin Lakes; (d) in longitude 116°38', elongated narrow lakes are in alinement from the south edge of the map-area to the right-angle bend of Wopmay River; (e) northeast of Lever Lake, evenly distributed lakes occupy an area of massive granite; and (f) towards the edge of the Shield, many rivers and lakes are oriented to the southwest in line with many known giant quartz veins and faults.

The contact zone of the Shield and the Palaeozoic plain is marked by many lakes. The plain has a thick cover of drift, and the strata dip gently southwestward forming local cuestas facing northeastward. Both may have been factors in the formation of the lakes. Streams flowing northeastward are obsequent in relation to the southwestward-trending strata, but as the latter are covered with glacial drift, most of the streams might be better termed superimposed.

COLLINGWOOD, ONTARIO Sheet 41-$\frac{A}{8}$

Prominent Features Displayed

1. Escarpment

2. Abandoned shorelines

3. Moraine

4. Superimposed stream

The northern extension of the Niagara escarpment passes through the centre of this map-area, trending north. Towards the northern boundary of the area the escarpment is particularly steep and forms the east-facing flank of the Blue Mountains.

The topography of the west half of the area is typical of glacial drift, as evidenced by the many closed contours, swamp lands, and confused drainage patterns.

East of the escarpment are seen the old abandoned shorelines of the former Lake Algonquin, which existed in this region as a late-Glacial lake during the retreat of the continental ice-sheet.

Both Mad and Noisy Rivers cross the Niagara escarpment, and may be superimposed streams.

DUFFERIN, MANITOBA Sectional Map No. 22

Prominent Features Displayed

1. Piracy or stream capture
2. River channel
3. Preglacial highland
4. Escarpment
5. Lake plain
6. Lake terraces
7. Stream dams
8. Residuals, buttes and mesas
9. Knob and kettle topography

An interesting example of stream capture or piracy is illustrated in the northwest quarter of the map, where a tributary of Assiniboine (now Souris) River has intercepted the former, deeply incised river channel of the southeasterly flowing Souris, and has diverted that stream to the northeast, almost at right angles, to the parallel Assiniboine River. The old river channel was initially deepened when much of the drainage in Glacial times was diverted into it, but more recently the present tributaries of the Souris have partly filled the old channel at their junctions with the main stream, resulting in the formation of a chain of lakes, of which Pelican, Rock, and Swan Lakes are examples.

Pembina River is another stream making progress in downcutting as headward erosion continues.

Turtle Mountain, in the lower left corner of the area, is part of a preglacial highland, now covered with glacial moraine deposited as the continental ice-sheet melted. This highland is more properly termed a mesa, as it is flat-topped, and is an erosional remnant of a former, probably much higher, plateau.

The 'knob and kettle' topography of the central part of the area is typical of ground moraine. Within this area, too, lie erosional remnants of a harder formation, which are known as residuals or buttes, an example of which is Nebogwawin Butte, seen in the south centre of the sheet.

The Manitoba escarpment, also known as the Cretaceous escarpment, is the more easterly and more prominent of the two prairie escarpments. Here it is formed by the northeasterly flank of Pembina Mountains, and crosses the map-area diagonally. It can be seem that the 'scarp' faces the Manitoba Lowland and rises above it some 500 or 600 feet. It has been dissected by erosion and is cut by several wide valleys, so that from the east it appears as a series of hills, the tops of which are at the level of the second prairie steppe. The 'scarp' bedrock is of Cretaceous age and its lower slopes are covered by the deposits of glacial Lake Agassiz.

To the east of the Manitoba escarpment can be seen the terraces, shorelines, and lake plain of the ancient Lake Agassiz, which at one time occupied a large area in southern Manitoba.

Much of the drainage in the map-area is confused, as a result of glacial processes, though Assiniboine and Souris Rivers have maintained their channels, and have meandering courses, as have the smaller rivers and streams; but this is a result of the almost featureless topography of the young interior plain, and cannot be attributed to an 'old age' stage in the stream cycle.

Pembina River is a 'misfit' stream to the degree that it flows in a wide valley not of its own making.

HAMILTON, ONTARIO Sheet 30 $\frac{M}{5}$

Prominent Features Displayed

1. Escarpment
2. Wave-built beach or bar
3. Shoreline of emergence
4. Abandoned beaches
5. Superimposed stream

The Niagara escarpment extends northerly across this area, having made a right-angled turn from the east just south of the city of Hamilton. The course of the escarpment is irregular, and is broken by river valleys that cross it. The steep flank of the scarp faces easterly.

A young shoreline of emergence is seen along Lake Ontario, together with former beach levels, as indicated by relatively straight contours parallel with the present shore. The Burlington Bar is a wave-built beach or bar, of a bay-mouth type.

Most of the drainage is consequent, flowing down the slopes away from the escarpment. Bronte and Oakville Creeks may, however, be superimposed, as they have deep valleys, and that of Bronte Creek crosses the escarpment and may have existed before the scarp was formed.

MAP 449A HAZELTON SHEET, B.C. Sheet 93M (West Half)

Prominent Features Displayed

1. Mature complex mountains
2. Alpine glaciation
3. Matterhorn peaks
4. Snowfields
5. Monadnocks
6. Cirques and arêtes
7. Hanging valleys
8. Incised river

The Hazelton sheet (west half) displays an area of mature, complex mountains characterized by deep valleys and high, rugged peaks, many of the latter of the matterhorn type rising to elevations of more than 8,000 feet. Most of the higher peaks are known to be formed of granodiorite, which intrudes folded and faulted Jurassic and Cretaceous sedimentary and volcanic formations. The main valleys were scoured by valley glaciers during the Ice Age, and as a result some of them, such as Bulkley River Valley south of the mouth of the Suskwa, are U-shaped.

Glacial cirques are abundant on the high easterly slopes of Rocher Déboulé Mountains. They are also plentiful in the Blunt Mountains and in the mountains at the head of Thomlinson Creek. Atna Mountains and neighbouring high mountains that lie 8 miles farther east exhibit extensive snowfields with monadnocks as well as numerous cirques, arêtes, and matterhorn peaks.

An area of high, plateau country in the vicinity of Gunanoot Lake contains some hanging valleys.

The drainage pattern is dendritic. Bulkley River is incised in bedrock, forming a deep, rock-walled canyon for 15 miles above Hagwilget.

KENNEDY CHANNEL, N.W.T. Sheet 29A S½, 19A S½, and 9A S½

Prominent Features Displayed

1. Continental ice-sheet
2. Ice-caps
3. Outlet glaciers
4. Ice-field
5. Fiords
6. Shoreline of submergence

In the eastern half of the map-area is part of the Greenland ice-sheet, which is part of one of the two remaining continental ice-sheets. Also shown are isolated ice-caps. Outlet glaciers from the ice-sheet, namely Steensby Glacier and Petermann Glacier, flow into fiords, such as St. George and Petermann Fiords, thus giving a clue to one of the contributing factors to the formation of fiords.

Petermann Glacier feeds an ice-field lying in the Arctic waters at Petermann Fiord. Icebergs originate from such glaciers where they reach the sea.

The deep indentations of the coast lines indicate a submergence of land due to the great load of ice.

MACKENZIE RIVER DELTA, N.W.T. (Blue print map)

Prominent Features Displayed

1. Estuarine delta
2. Delta lakes
3. Meandering channels
4. Submerged deltaic coastline
5. Sandbars

The head of Mackenzie River delta is at Point Separation, some 20 miles below the mouth of Arctic Red River. Here the river begins to spread into a great fan-shaped labyrinth of channels, which at the coast, some 100 miles to the north, is more than 100 miles wide. The mouth of the river is submerged beneath the Arctic Ocean, with the result that alluvium is being deposited in the form of a long, narrow, estuarine filling.

The huge, triangle-shaped delta consists of numerous channels, large and small; tributaries, and distributaries flow in various directions, mostly with meandering courses. The maze of islands within the delta is composed of interstratified mud, sand, and gravel, and is supplemented by sandbars of all shapes and sizes. The islands themselves, both large and small, carry innumerable lakes, most of which are closely spaced. Even the middle or main, channel is meandering, and encloses several islands and island groups.

Some alinements of lakes are suggestive of former channels, as, for example, that through Sitidgi and Eskimo Lakes, now abandoned and partly clogged with alluvium.

MEDICINE HAT-MAPLE CREEK, ALBERTA-SASKATCHEWAN

Prominent Features Displayed

1. Nunataks
2. Plateau region
3. Radial drainage patterns
4. Consequent streams

Most of this area has been glaciated, and is covered with morainic materials deposited during the recession of the continental ice-sheet. The tops of the Cypress Hills, however, owing to their height of more than 4,000 feet, lay a ove the ice level and were not glaciated; thus, these peaks are nunataks.

The remainder of the area is illustrative of the plateau surface of the Interior Plains. This surface is gently undulating, and is sharply incised by the principal streams. The larger drainage channels and many of the smaller ones are cut well below the plains level to depths of 100 to 400 feet, as in the case of South Saskatchewan River Valley. These larger rivers occupy wide valleys, mostly with steep banks and flat bottom lands. During late-Glacial times they carried much larger streams.

An excellent example of a radial drainage pattern is displayed around the Cypress Hills, where consequent streams flow in all directions from the hill tops.

MAP 924A-MEDICINE LAKE, ALBERTA Sheet 83C/13

Prominent Features Displayed

1. Folded, mature mountains
2. ~~U-shaped, glaciated valleys~~
3. Cirques and tarns
4. Matterhorn peaks
5. Salt (?) lakes
6. Underground drainage
7. Finger lakes

Mature, folded mountains deeply dissected by valley glaciers and by mountain streams are displayed. A few, small cirques and tarns are present in Malingne Range and on the east sides of two high peaks about 5 miles east of Medicine Lake, and there are many matterhorn peaks in the area.

Two exceptionally good examples of depression contours, with small lakes occupying the bottoms of the depressed areas, are seen in the mountainous area 5 to 8 miles southeast of Medicine Lake. As these lakes have no visible outlets, they are thought to be salt lakes.

The outlet of Medicine Lake is through underground channels for a distance of half a mile. The water probably follows channels dissolved from the limestone bedrock.

Jacques and Beaver Lakes are examples of finger lakes that occupy hollows eroded by small valley glaciers. Medicine Lake is a larger finger lake whose basin was excavated by the larger valley glacier.

MIRA, NOVA SCOTIA Sheet 11 F/16

Prominent Features Displayed

1. Uplifted and tilted peneplain
2. Submerged shoreline
3. Bay-mouth bars and spits
4. Drowned estuaries
5. Topography dependent on structure

Those parts of Cape Breton Island underlain by harder rocks, mainly of intrusive and volcanic origin, present a remarkably even surface that dips below the Atlantic Ocean on the southeast, and rises to more than 1,500 feet on the northwestern side of the island. This surface is the relict of a post-Triassic peneplain, which has been uplifted to the northwest and depressed to the southeast. On the Mira map, the remains of this peneplain surface may be seen on the ridge just southeast of East Bay, on the ridge parallel with it and some 3 miles farther southeast, on Gillis Mountain, and probably in the high country north of Gabarus Bay. Depressions in this surface are generally due to the presence of softer rocks that have been infolded into the harder, surrounding formations. In the case of the valley at Roar Big Pond, the valley of Salmon and Gaspereaux Rivers, the depression of Gabarus and Belfrey Lakes, and probably the larger depression of Gabarus Bay, the softer sediments are Carboniferous, and are surrounded mainly by older volcanic rocks.

Recent submergence of the shoreline is indicated by the young bay-mouth bars and spits separating the sea from Mullouish, Belfry, and Lever Lakes. Mira River is at sea-level, and in fact is salt some 18 miles inland from its mouth, and as far as Marion Bridge. It could quite well be termed a drowned estuary.

MONTREAL, QUEBEC Sheet 31 H

Prominent Features Displayed

1. Lowland between two uplands
2. Igneous residuals
3. Fault scarp
4. Finger lakes

The St. Lawrence Lowlands, a flat plain, has been developed on unfolded, relatively soft, sedimentary Palaeozoic rocks, Cambrian to Silurian in age. The St. Lawrence River has its course, roughly, through the centre of this plain, which slopes gradually upwards from the river to a height of some 400 feet above sea-level, at which elevation it is bounded by the hilly region of crystalline rocks of the Precambrian Shield to the northwest, and the Appalachian Mountain system to the southeast. The latter boundary of the lowlands is the Logan fault-line, which crosses the area southwesterly, passing through Yamaska Mountain.

The most interesting physiographic feature illustrated on this map-sheet is the prominent group of residuals that break the general flatness of the St. Lawrence plain, as they rise abruptly from it. These are the Monteregian Hills, of which there are eight. They occur in a curved line easterly from Montreal for a distance of some 50 miles, are circular or oval in outline, and have a combined area of only a few square miles. These, with their heights above sea-level, are: Mount Royal, 730 feet; St. Bruno, 715 feet; St. Hilaire, 1,437 feet; Rougemont, 1,250 feet; Mount Johnson, 875 feet; Yamaska, 1,470 feet; Shefford, 1,725 feet; and Brome, 1,755 feet. The latter three occur east of the Logan fault, and are, therefore, within the Appalachian region. The cores of these hills are alkaline igneous intrusions, projecting through the older Palaeozoic formations.

The map-area has been glaciated and drift covered, as is evidenced by the marsh lands and the many varied and confused drainage patterns of the plains, and the several finger lakes within the Appalachian upland. The most prominent of these lakes is Lake Memphremagog.

MOOSE JAW, SASKATCHEWAN — Sectional Map No. 69

Prominent Features Displayed

1. Lake plain
2. Terraces
3. Knob and kettle topography
4. Preglacial highland
5. 'Alkali' lakes
6. Drainage outlet channel
7. Consequent streams

The glacial Lake Regina plain occupies the eastern half of the area, where varved clays from the late-Glacial lake have been deposited. West of this plain are the boulder clay-covered terraces of the ancient lake. The western half of the area is covered by morainal deposits, yielding typical 'knob and kettle' topography. The glacial deposits are superimposed on preglacial highlands of Upper Cretaceous rocks, which, as in the Cactus and Dirt Hills, are partly exposed. The boulder clay of the morainal area is relatively impervious to water, and is occupied by 'alkali' lakes. Without drainage outlets, these lakes have become enriched with mineral salts leached from the surrounding glacial material.

Lake of the Rivers was part of the drainage outlet channel during Glacial times, and was overdeepened by the water and ice. It is suspected that damming of this channel by glacial debris in the vicinity of the towns Expanse and Ardill resulted in the formation of Johnstone Lake and Lake of the Rivers, the former spreading to shallow depths over relatively level ground.

Moose and Avanlea Creeks, with their tributaries, are consequent streams, their meandering courses due to low topographic relief.

MAP 2033-MOUNT ALBERT, QUEBEC

Prominent Features Displayed

1. Uplifted and dissected peneplain
2. Cirques
3. Water gap
4. Reversed drainage
5. Glacial dam

Mount Albert and Tabletop Mountain display, in their rolling featureless tops, an uplifted peneplain, believed to be part of the same surface exposed on Cobequid Mountain and northern Cape Breton Island. The axis of the Shickshock Mountains runs through these two mountains, and, therefore, Ste. Anne River crosses this axis in a water gap at, or south of, its junction with Rivière du Diable. The present height of land between the St. Lawrence River and Chaleur Bay is 1 mile or so south of Ste. Anne Lake, where a glacial dam reversed the drainage north of the lake, as is shown by the southerly flowing tributaries, Poplar Creek, Little Lake River, Rivière du Bois, and possibly Isabella River. Whether this reversal was sufficient to create the water gap, or whether the water gap existed in pre-Glacial time is not known. Gaspe is believed to have been glaciated by valley glaciers, and a splendid example of a cirque is seen at Lac aux Américains on the west flank of Tabletop Mountain.

NIAGARA, ONTARIO

Sheet $30\frac{M}{3}$

Prominent Features Displayed

1. Escarpment
2. Waterfalls
3. Moraine
4. Youthful consequent streams
5. Abandoned beaches

The Niagara escarpment is the prominent physiographic feature of this map-area. It extends westward from the Niagara River at Queenston, where it rises abruptly 250 to 300 feet above the river. The escarpment is the result of erosion acting upon a region of simple structure and normal alternation of resistant and easily eroded strata; in other words, it is an illustration of the effects of differential erosion of sedimentary beds. The Niagara gorge was formed by the river on the face of the escarpment, the fall being some 160 feet. The erosion and downcutting action of the river has carried the falls from their point of origin at Queenston to their present site, some 7 miles upstream, at Niagara Falls. The resistant ledge of the escarpment is the Silurian Lockport dolomite.

This area has been glaciated, and bedrock is covered by a mantle of boulder clay, sand, gravel, and clay. The extreme youth of the region, in terms of erosion, is shown by the narrowness of the gorge of the main stream, the absence of considerable tributary valleys, and the shortness of the gorges of the tributaries that join the main valley below the falls.

The escarpment is much dissected by rivers cutting headward through the drift. The dendritic pattern displayed by Twelve Mile Creek and other streams, indicates youthful and consequent drainage in a heavily drift-covered area. Enormous amounts of this drift have been spread by these streams over the low-lying area below the escarpment, providing excellent lands for farming and fruit growing.

Former beach lines of abandoned shores are to be seen along the southern shore of Lake Ontario, and are indicated on the map by the contour lines, which parallel the lake shore.

ORFORD, QUEBEC

Sheet $31\frac{H}{8}$

Prominent Features Displayed

1. Finger lakes
2. Glacial damming
3. Post-Glacial streams
4. Fault scarp
5. Wind gaps
6. Stream piracy
7. Ancient superposed stream
8. Subsequent streams

The Eastern Townships region of Quebec appears to have been peneplained during Tertiary time and later in the same period to have been uplifted, with a slope toward the St. Lawrence River. Probably the uplift was accompanied by faulting.

Subsequent erosion has developed three types of topography: (1) the St. Lawrence Lowland, a rather flat plain developed on the soft, flat-lying Palaeozoic rocks near the St. Lawrence River. The plain slopes gradually upward from the river to a height of some 500 feet above sea-level; (2) Sutton Mountains, which extend northeast into the Shickshock Mountains of Gaspe. These hills, composed of hard, metamorphic rocks, represent the least eroded parts of the ancient peneplain; (3) the interior platoau, lying southeast of the hilly range, has an average elevation of some 1,200 feet above sea-level, but is broken by various hills or short ranges where hard rocks have resisted erosion. Most of the beds, however, are somewhat metamorphosed Palaeozoic strata.

As this topography developed, some of the larger streams flowing toward the St. Lawrence were able to cut down their beds rapidly enough to maintain their courses across the hard core of the developing mountain range. Smaller ones were beheaded by tributaries of the larger streams that rapidly excavated valleys along faults or soft beds of the interior plateau. In this section drainage tended to develop parallel with the folded beds.

In Pleistocene time, glacial deposits choked many of these valleys, forming lakes and forcing them to drain into new courses.

Memphremagog Lake, East Branch Pond, and Brompton Lake all lie in one great pre-Glacial valley that seems to have drained formerly into the valley of Salmon Brook. Drift deposits filled much of the old valley, creating glacial dams that held back the waters of these lakes, and forced Memphremagog Lake to drain by a post-Glacial stream into Magog Lake. Both Brompton and Memphremagog Lakes are finger lakes.

Magog Lake lies in a pre-Glacial valley that extends south of the lake several miles. The original direction of drainage in the valley is not known, but the present outlet follows an obviously post-Glacial course. Magog Lake is also a finger lake.

Bowker Lake, Mud Lake, and The Gulf lie in a valley developed along a major fault. Differential erosion has formed a pronounced scarp to the west of this fault. Glacial dams have choked this fault valley, forming finger lakes and forcing them to drain eastward.

Castle Brook, Orford Lake, Eastman Lake, and the small pond at Eastray all lie along the valley of what was a superposed stream that crossed the structure toward the St. Lawrence. Eventually this stream was captured in several places by subsequent streams, like those of Lake Memphremagog and Missisquoi River, which were able to deepen much more rapidly than the captured stream because they developed along fault zones, or along the strike of softer beds.

On the Orford map, the St. Lawrence plain is represneted by a small area, 4 miles wide, in the northwest corner. The central hilly area, 9 miles or more in width, lies between this and the Bowker-Missiquoi valley. To the southeast is the central plateau, broken by the hills northeast and south of Orford Mountain. These hills are composed of rocks relatively resistant to erosion.

MAP 818A-PARRSBORO, NOVA SCOTIA Sheet $21\frac{H}{8}$ (West Half)

Prominent Features Displayed

1. Uplifted peneplain
2. Wind gap
3. Fault scarp
4. Resequent streams
5. Obsequent streams

Cobequid Mountain extends some 5 miles south from the northern limits of the map-area, and displays, in its rolling, featureless top, an uplifted peneplain, much dissected since its uplift. Two streams were originally superposed on Cobequid Mountain, one due north of Parrsboro and the other at, and south of, Welton Lake, but both streams have since been captured on the north side of the mountain, creating wind gaps in the two valleys mentioned. The height of land in the Parrsboro wind gap at Lakeland is only 88 feet above sea-level. Cobequid Mountain is bounded on the south by a scarp caused by the differential erosion of soft Carboniferous sediments downfaulted on the south against harder earlier rocks of the mountains. In the south of the map-area, the arcuate spur enclosing Scotsman Bay is formed by hard Triassic lava flows in the form of a syncline plunging to the west. Jess, Dan Jess, Tupper, Huntley, and Ells Brooks flow down the dip of a hard member exposed by erosion, and are consequently, resequent streams. Conversely, Indian Springs and Borden Brooks flow in the opposite direction and are, therefore, obsequent streams.

PETERBOROUGH, ONTARIO Sheet 31-D/8

Prominent Features Displayed

1. Drumlins
2. Eskers
3. Finger lake
4. Youthful and consequent drainage

The Peterborough sheet is a textbook illustration of true drumlin topography, characteristic of a 'drumlin upland'. Drumlins have been defined by Lobeck as "smooth oval hills composed mainly of till but sometimes including lens-like masses of gravel and sand". Their long axes are parallel with the direction of ice movement, which in this area is southwestward, and they commonly occur in 'swarms', more or less radiating in plan as if deposited by a lobe of ice moving outward from an axis. They are roughly half a mile long and 100 feet high, with their 'stoss' ends, facing the glacier, usually blunter and steeper than their tail or 'lee' slopes. Many of the drumlins shown on this sheet, however, are perfectly symmetrical, being high and narrow with steep slopes.

It may be seem that the stream patterns as well as the courses of some of the roads and railroads are controlled by the drumlins.

Numerous undrained areas, represented by marshes and lakes, are characteristic features of topography developed by glaciation in a region of rather slight relief. This youthful topography was superimposed upon surfaces in various stages of erosional history in pre-Glacial times.

Finger lakes are those that occupy the former trough floors of glaciers, and it seems probable that Kaichiwano Lake is one of these.

A few eskers are apparent; for example, the ridge trending southwestward, about 1½ miles northeast of Westwood in the southeast quarter of the area.

For much of the area, the drainage is poorly organized, as indicated by the abundant marshes. Exceptional features are the parallel flowing Otonabee, Indian, and West Ouse Rivers, whose courses are seen to be partly directed by the irregularities of the drumlin upland. Youthful drainage is represented throughout, and is typical of topography resulting from glacial and fluvio-glacial deposition.

RAE, N.W.T. Sheet 85 NW. and NE.

Prominent Features Displayed

1. Physiographic provinces related to bedrock geology

2. Drainage control

The map shows four main physiographic provinces:
(a) The Canadian Shield, an area of much bare rock, extends east of a line drawn from Great Slave Lake, through Marian Lake, northwestward to Faber Lake. It is occupied by numerous lakes, many of which are elongated and narrow; others have irregular shorelines and contain numerous islands. Although their orientation is locally parallel, their arrangement appears decussate throughout. Most of these lakes filled rock basins dammed by glacial debris: the basins resulted from differential rock erosion controlled by loci of rock weakness such as joint fractures, faults, or shear zones, and by differential resistance of rocks to erosion, such as is exhibited at geological contacts, by stratification, and by dykes. Glacial erosion contributed only locally, as is shown by the decussate orientation of lakes throughout the area.

Drainage control is exemplified in this part of the Canadian Shield by the following means: by joints, in the area east of Bigspruce Lake, which is underlain by granitic rocks; by faults or shear zones, in the series of elongated and alined lakes extending from Wheeler Lake slightly east of south to the town of Yellowknife; by geological contacts, in Duncan or Harding Lakes which are along the contact of sedimentary strata and granitic rocks, or by Allan Lake along the contact of sedimentary strata and volcanic rocks; by stratification, in the area of parallel lakes northwest of Duncan Lake; and by dykes in the bay and series of lakes oriented northwesterly at the south end of Gordon Lake.

(b) The Palaeozoic plain southwest of the Canadian Shied is low, as shown by the extensive areas of marshes or muskegs. It is covered by much glacial debris, the uneven surface of which forms the site for numerous small lakes. In contrast with lakes of the Shield, the lakes of the Palaeozoic plain have more regular and more rounded outlines. The parallel orientation of the lakes in a southwest direction between Great Slave Lake and Birch Lake is probably due to the arrangement of glacial debris.

The contact between the Canadian Shield and the Palaeozoic plain is marked, as in many other places in Canada, by large lakes and a drainage system, Marion River.

(c) The Horn Mountains constitute a plateau underlain by Cretaceous rocks, and lying some 2,000 feet above the Palaeozoic plain. The plateau is drift covered, and the lakes are not unlike those of the Palaeozoic plain. However, drainage is better organized. The slope of the plateau onto the low plain is a zone of mature topography, with rare lakes and a dendritic drainage pattern radiating from the plateau, whereas Horn River and Willowlake River, in its lower section, form parts of an annular drainage system. To obtain a better view of this peripheral drainage zone the adjoining Providence sheet (85 SW. and 85 SE) should also be consulted.

(d) The area northwest of Lac La Martre and including Cartridge Mountain has a different type of topography. The numerous elongated and similarly oriented lakes and rivers are in contrast with the low Palaeozoic plain. Little is known of the geology of this area.

MAP 764A-RIVER HÉBERT, N.S. Sheet 21-H/9 (West Half)

Prominent Features Displayed

1. Topography in relation to structure on low, moraine-covered terrain
2. Uplifted and dissected peneplain

The outstanding feature of this map-area is the development of an east-west surface lineation in the area south and east of Chignecto Bay. This district is covered with thin morainal material, through which bedrock, comprising alternate hard and soft sandstone beds protrudes in parallel ridges. In the southeast corner of the map-area, the uplifted peneplain of Cobequid Mountain may be distinguished.

STEVEVILLE, ALTA (Blue-line print)

Prominent Features Displayed

1. 'Badland' topography

2. Prairie level

Spectacular but limited areas of 'badland' topography occur in the south-central Plains of Western Canada, of which those along Red Deer River, from Drumheller to and beyond Steveville, are the largest and best known. They are particularly famous, within the area of the Steveville map, for the abundant occurrence of dinosaurian remains.

The badlands have developed as a result of easy erosion of soft beds, overlain, in most places, by more resistant sandstones and shales, the whole lying nearly horizontally. The land below the general prairie level has become deeply dissected by sharp valleys between knobs or hills of variable sizes, heights, and shapes, almost entirely devoid of vegetation. Within the map-area the rocks mainly involved are the sandstones and shales of the Oldman formation, overlain, near the elevation of the prairie level, by shales of the Bearpaw formation, both of late Upper Cretaceous age.

Within the area, Red Deer River is deeply and steeply incised to a depth of about 400 feet, and occupies a flat valley floor about twice the average width of the stream, which meanders in its course from wall to wall.

The area is representative of erosion under conditions of semi-aridity, punctuated at intervals by sudden storms and torrential rains.

MAP 879A-SUNWAPTA, ALBERTA   Sheet $83\frac{C}{6}$

Prominent Features Displayed

1. Mature mountains
2. Matterhorn peaks
3. Arêtes
4. Cirques and tarns
5. Hanging valleys
6. U-shaped main valleys
7. Braided stream
8. Alpine glaciers
9. Finger lakes

The Rocky Mountains, as illustrated on this map, are mature folded mountains, that are passing through a period of greatest relief. Deep, U-shaped valleys trending northwesterly have been eroded by valley glaciers, and deep canyons and gorges are being formed by tributary streams working on the steep mountain slopes. Evidence of alpine glaciation is common on all of the high mountains of the area, particularly west of Sunwapta River where good examples of matterhorn peaks, cirques, and arêtes may be noted. Cirques are very abundant on the mountain slope south of Jonas Pass, and several tarns are found there. Three of the tributary streams of Sunwapta River flow northeasterly through hanging valleys before dropping into Sunwapta River Valley, and finger lakes are present in each. Sunwapta River exhibits a braided-stream pattern for about 5 miles near its headwaters.

MAP 909A-TOFINO, B.C. Sheet $92\frac{F}{4}$ and $92\frac{E}{1}$

Prominent Features Displayed

1. Fiord shorelines
2. Embayed mountains
3. Cone mountains
4. Tidal flats
5. Alpine glaciation
6. Cirques

The Tofino map illustrates typical, mountainous country found along the west coast of Vancouver Island.

Tofino and Tranquil Inlets are typical small fiords (partly submerged glacial troughs). The embayed mountains would appear to suggest a shoreline of submergence, but the extensive tidal flats are evidence of emergence.

Lone Cone Mountain has the form of a volcanic cone but may be a granitic stock (geology of this mountain has not been studied). Several, smaller, cone-shaped mountains displayed on the map are thought to be small granitic stocks. The mountains in the northeast part of the map-area are exceedingly rugged, with deeply carved, glacial troughs and steep-walled, ice-free cirques.

MAP 813A-WENTWORTH, N.S. Sheet $11\frac{E}{12}$ (East Half)

Prominent Features Displayed

1. Uplifted and dissected peneplain
2. Scarp
3. Wind gap
4. Glacial dam
5. Subsequent drainage

Along the south side of the map-area, and extending some 7 miles north, Cobequid Mountain displays the rolling, featureless top of an uplifted peneplain, cut into by the youthful valleys of Portapique, Wallace, and Folly Rivers. The height of land between Folly and Wallace Rivers lies just north of Folly Lake, which flows south into the first mentioned stream. Folly Lake lies some 400 feet below the peneplain surface of Cobequid Mountain, and the height of land between these two streams is a wind gap formed by a stream that, prior to uplift of the peneplain, flowed southerly across Cobequid Mountain. Folly Lake is formed in this gap by a dam of glacial material at its north end. Cobequid Mountain ends abruptly on the north in a scarp, which may be due to a fault, but is probably due only to differential erosion of adjacent softer strata that lay unconformably on the harder rocks of Cobequid Mountain. Following the uplift of the mountain and the erosion of the soft rocks to the north, a subsequent, east-west drainage was developed, as exemplified by West Wallace River, Drennan Brook, Montrose Brook, etc.

INDEX OF LAND FORMS

The following index of land forms has been arranged alphabetically to permit ready reference to the 'prominent features displayed' on the preceding descriptions of individual maps. The names of the maps on which these features are shown are underlined.

Monteregian Hills - Beloeil; Montreal

Mountains

Complex - Hazelton

Cone - Tofino

Embayed - Tofino

Folded - Medicine Lake

Mature - Hazelton; Medicine Lake; Sunwapta

Nunataks - Medicine Hat-Maple Creek

Peneplains - Bass River; Mira; Mount Albert; Parrsboro; River Hebert; Wentworth

Plateau - Medicine Hat-Maple Creek; Rae

Piracy (stream) - Bass River; Dufferin; Orford

Potholes - Bolton

Preglacial highland - Dufferin; Moose Jaw

Residuals - See Mesas and Buttes

Igneous - Beloeil; Montreal

Reversed drainage - Mount Albert

Sand dunes - Artillery Lake

Scarps - See Escarpments

Sea terraces - Beloeil

Shorelines

Abandoned - Beaverton; Bolton; Collingwood

Of emergence - Hamilton

Of submergence - Kennedy Channel; Mackenzie River Delta; Mira

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Stream capture - See Piracy

Streams

Braided - Sunwapta

Consequent - Medicine Hat-Maple Creek; Moose Jaw; Niagara; Peterborough

Meandering - See Meanders