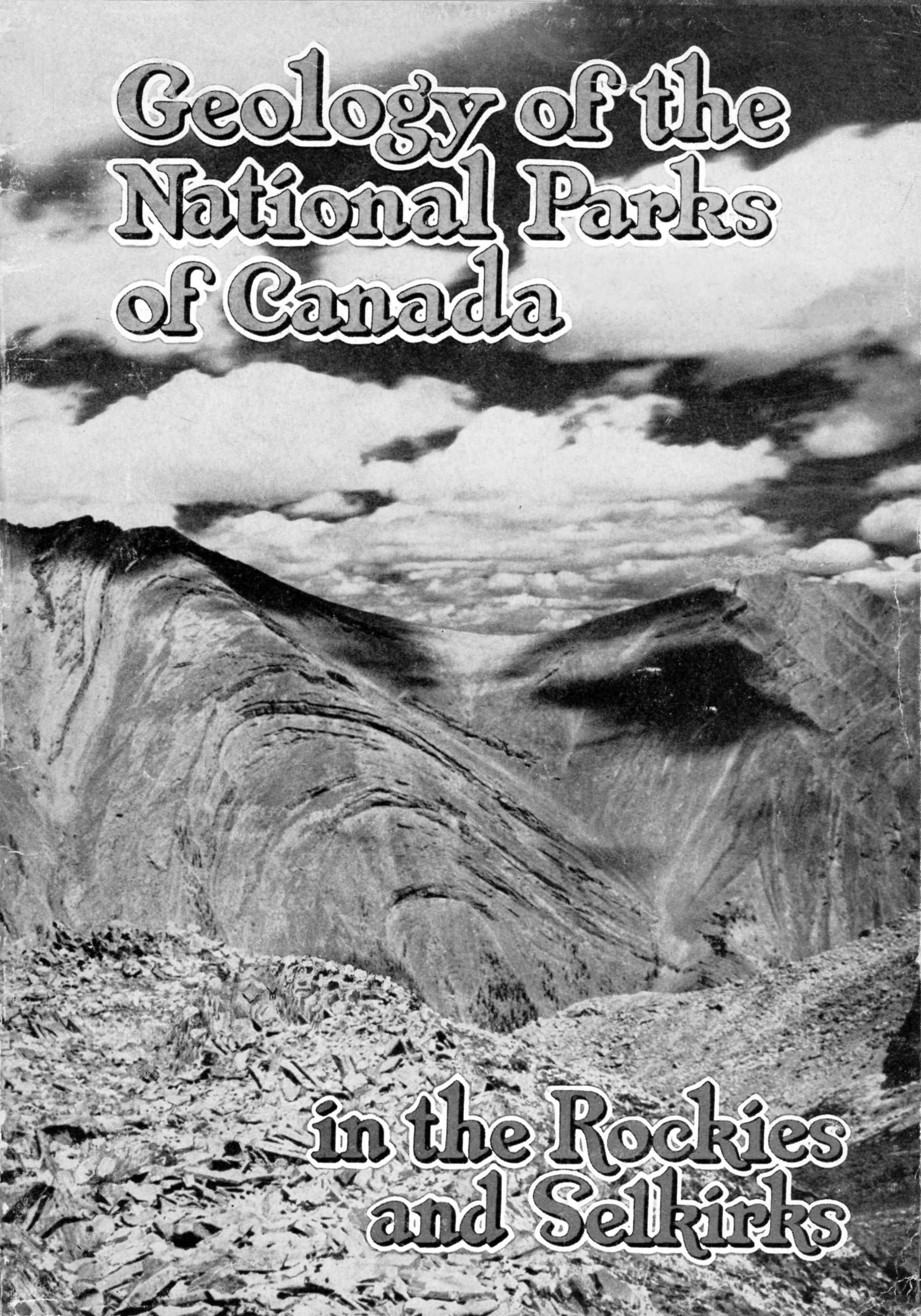
Geology of the National Parks of Canada



in the Rockies and Selkirks

Crevasses on Athabasca Glacier, which issues from the Columbia Icefield, caused by change in gradient of the bed over which the glacier moves (see pages 17, 22, 36). Jasper National Park.

GEOLOGY OF THE NATIONAL PARKS OF CANADA IN THE ROCKIES AND SELKIRKS

by

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Cover Subject:—View looking northwest from range summit (7,800 ft.) eight miles due east of south end of Medicine Lake, Jasper National Park, showing the intricate folding that characterizes the mountain ranges of Palaeozoic rocks in the 10-mile-wide belt between Rocky River and Medicine Lake (see page 22).

1. Mount Robson, the "Monarch" of the Canadian Rockies (12,972 ft.), the highest peak in the Canadian Cordillera, as viewed from northeast at Robson Pass Chalets (5,417 ft.) at the western boundary of Jasper Park, showing Berg glaciers cascading down the northern slope into Berg Lake. On the face is exposed a 7,500-foot-thick section of flat-lying Precambrian and overlying Cambrian sediments. Jasper National Park (see pages 6, 18).

2. View from hill slope near Bow Pass (6,878 ft.) on west side of Banff-Jasper Highway looking northerly across Peyto Lake and down Mistaya River valley with Mt. Patterson (10,490 ft.) on left. A glacial modified valley and rock-basin lake. Banff National Park.

Geology of The National Parks of Canada in The Rockies and Selkirks

by B. R. MacKAY

WESTWARD FROM THE Canadian prairies the level landscape of the plains gradually gives place to the undulating topography of the foothills, and this, in turn, is terminated, generally abruptly, by a great palisade rising to several thousand feet above the general level and consisting, throughout most of its length, of either steel-grey limestones or quartzites. The base of the escarpment, lying 3,200 feet or more above sea-level, marks the eastern edge of a belt, 60 to 80 miles wide, of northwesterly-trending and overlapping mountain ranges collectively known as the Rocky Mountains (see map in centre).

The Rocky Mountains form the great watershed of the continent, and rank third among the great mountain ranges of the world. They extend from far south of the International Boundary north to beyond the Liard River, a distance in Canada of approximately 900 miles, 450 miles of which is exceptionally scenic territory. Within this belt numerous peaks tower to heights of 11,000 feet, the highest, Mount Robson, having an elevation of 12,972 feet (photo 1).

The Rocky Mountains are bordered on the west throughout most of their length in Canada by a trough or depression which varies in elevation from 2,300 to 3,000 feet, and extends from the International Boundary northwesterly to the headwaters of Liard River. This great depression known as the "Rocky Mountain Trench" is one of the most pronounced topographic features in the whole Canadian Cordillera or western mountain belt. It is occupied from south to north successively by the headwaters of Kootenay, Columbia, Canoe and Fraser Rivers, and farther north by tributaries of the Peace and the Liard Rivers.

West of this great trough in southern British Columbia is a succession of three overlapping mountain ranges known as the Purcell Mountains, Selkirk Mountains and the Monashee Mountains or Columbia Range. Each of these ranges begins at the Rocky Mountain Trench and extends southerly into the United States. The conspicuous change in trend of these ranges from that of the Rocky Mountains shows that they belong to a different mountain system. The Purcell Mountains, the most easterly of the three ranges, are commonly regarded as part of the Selkirk System, but they are separated from the Selkirk Mountains by a great fault valley, the "Purcell Trench" (photo 51), which is occupied successively from north to south by Beaver River, Duncan River, Duncan Lake, Kootenay Lake and Kootenay River.

The Selkirk Mountains, to the west and north, lie within the great northern loop of the Columbia River, and extend from it southward to beyond the International Boundary, a distance in Canada of 230 miles. They have an average width of 40 miles and are bounded on the west by the valley containing the Columbia River and the Arrow Lakes, which is referred to geologically as the "Selkirk Trench". As the valley of the Columbia River at Revelstoke is at an elevation of 1,500 feet, and the highest peak, Hasler Peak, has an elevation of 11,123 feet, there is a vertical relief within the Selkirk Mountains of over 9,600 feet (photo 56).

Lying immediately west of the Selkirk Trench are the Monashee Mountains of the Columbia System. In the latitude of Revelstoke, this belt has a width of about 30 miles. These mountains extend southerly to near the International Boundary and northerly to the headwaters of the Canoe and Thompson Rivers, a distance of about 250 miles. To the west of the Monashee

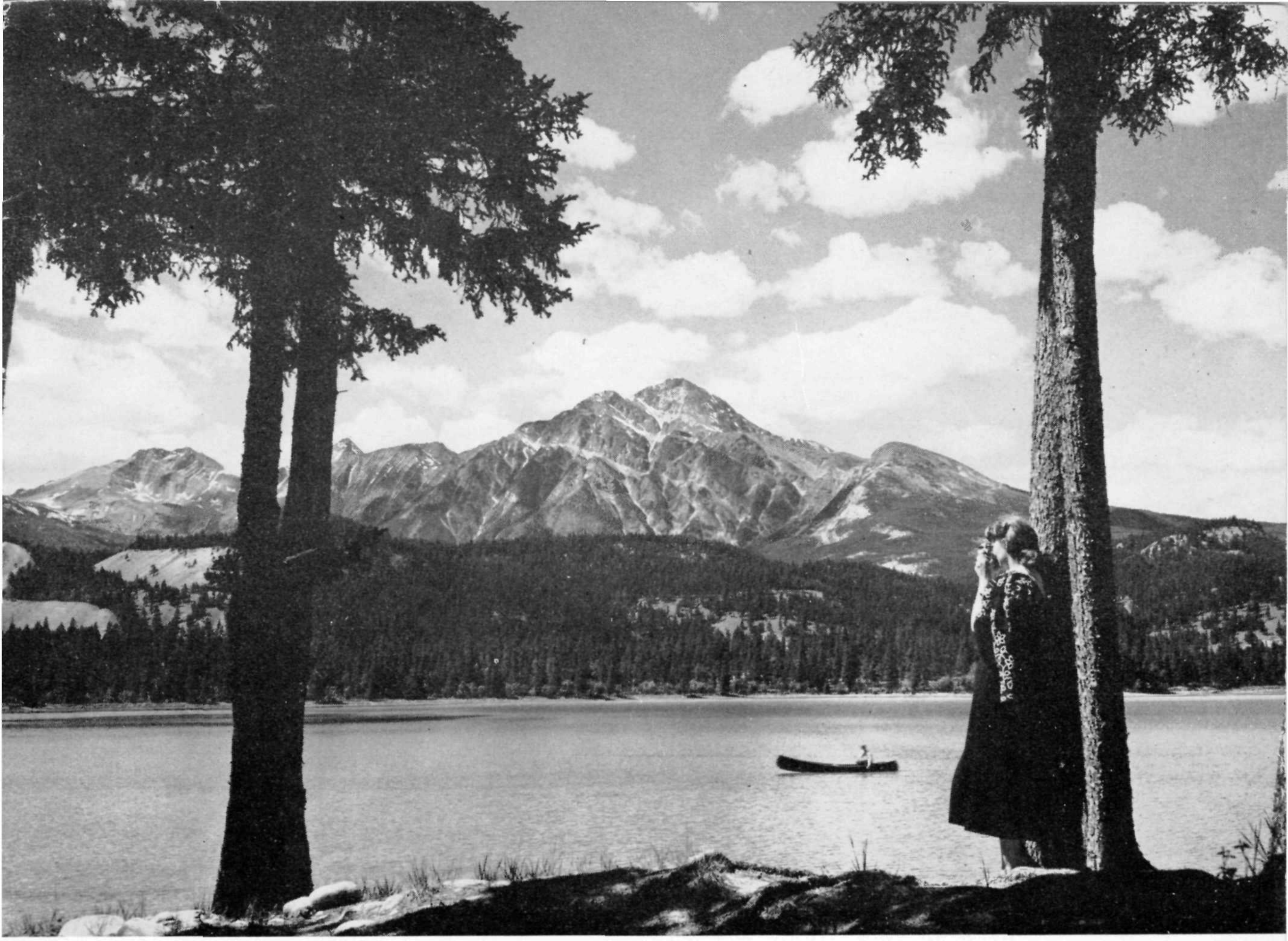
Mountains the ranges are lower in elevation, much shorter, and plateau-like in character, and gradually merge into the belt of Interior Plateau, most of which lies at an elevation of less than 5,000 feet.

The Rocky and Selkirk Mountain Systems possess some of the finest alpine scenery in North America. A panoramic view of the region from the air resembles a veritable "sea of mountains" in which the roughly parallel ranges rise like waves one after another as far as the eye can reach. Ever since David Thompson, the celebrated fur-trader, explorer, geographer, astronomer and scientist, crossed the Rockies by way of Howse Pass in 1807, and by Athabasca Pass in 1811, additional marvels of scenic grandeur in mountain structure, canyon and subterranean erosion, extensive ice-fields, glaciers, and glacial sculptured landforms, have come to the notice of succeeding exploratory expeditions, fur-traders and mountaineers, and vast areas of as yet uncharted mountain territory still remain to challenge the adventurous explorer, the daring mountain-climber, and the enquiring naturalist. The deep drainage channels that have been cut through the heart of these mountain ranges have laid bare the very roots of the mountains, and have exposed rocks which are among the most ancient of the earth's crust.

The facilities offered by the two transcontinental Canadian railway systems that cross the Canadian Cordillera via the Crowsnest Pass in the south, the Kicking Horse Pass in the central part, and the Yellowhead Pass farther north, have opened up this immense alpine wonderland and have made it possible for the ordinary traveller to view from the observation platform of the train an assemblage of scenic features unsurpassed in any part of the world. Along these routes are exposed sequences of rock formations representative of most of the geological time-scale from the earliest era in the earth's history up to recent time. (See chronological table inset on map.) In some places the sedimentary formations are flat-lying, in others, they are gently warped, but over much of the mountain belt they are inclined, folded, faulted, and in some places overturned. From the motor highways there can be observed many a glacier with its rock-basin lake that mirrors the uplands, exquisite in its hues of emerald and turquoise blue. From many nearby points of vantage can be counted numerous cliff glaciers ornamenting the flanks of mountain ranges, and accentuated by a profusion of glacial-sculptured landforms in all stages of development. (See photos 2, 6, 14, 15, 17, 55.)

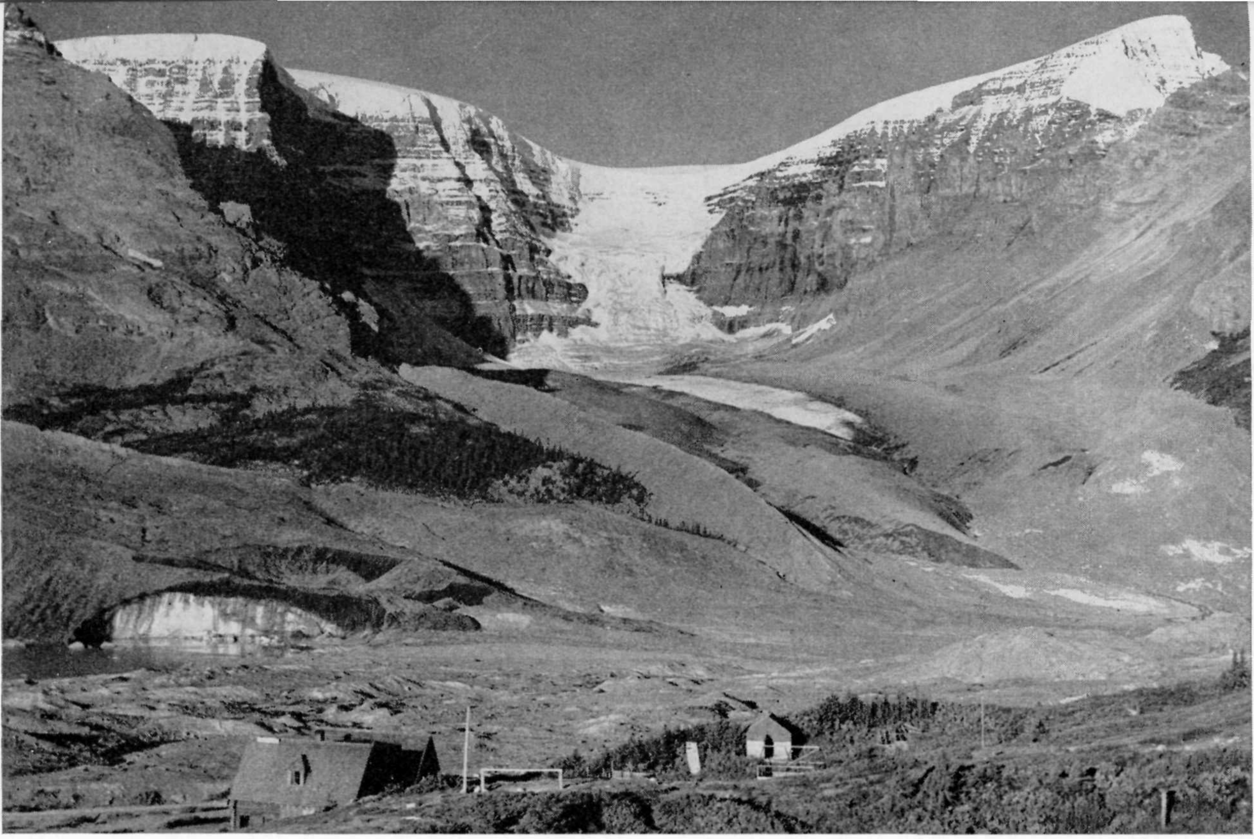
The Canadian Government, fully conscious of the value of this alpine wilderness as a national asset has, over a period of sixty-five years, set aside and maintained for recreational purposes, and for preservation for future generations, seven large park areas embracing 8,640 square miles of the most easily accessible and picturesque parts of the Rockies and Selkirks. The areas covered by these seven national parks are shown on the accompanying map. The boundaries of each conform, as far as possible, to natural features such as watersheds and rivers or established landlines. Three of the parks, Banff, Jasper and Waterton Lakes, lie on the eastern or Alberta side of the Continental Divide of the Rocky Mountains; two of them, Yoho and Kootenay, lie on the western or British Columbia side of the Rockies, and the remaining two, Glacier and Mount Revelstoke, are located in the Selkirk mountain system farther west.

The Rocky and Selkirk Mountains have a complex history extending over a period of more than half a billion years, and involving the accumulation and burial of great thicknesses of sediments, their upheaval, and the erosion of the uplifted masses into their present landforms. Both mountain systems consist predominantly of stratified rocks that were deposited as sands, muds, and calcareous oozes, in a more or less horizontal position in a broad inland sea that stretched from what is now California to the Arctic. As the sea-bottom gradually subsided, bed after bed was added,



3. *Pyramid Mountain (9,076 ft.) consisting of Cambrian and Precambrian sediments, viewed from northeast at Jasper Park Lodge on Lac Beauvert. Jasper National Park (see page 22).*

4. *Mount Eisenhower (9,030 ft.) located on the north side of Bow River Valley about midway between the world-famous resorts of Banff and Lake Louise, stands as a gigantic turreted castle-like rampart that rises from a valley level of 4,676 feet. The bottom and lower slopes of the mountain consist of Lower Cambrian quartzites, the higher slopes and precipitous cliffs of Middle Cambrian limestone, and its summit of Upper Cambrian red weathering limestone. Banff National Park (see page 13).*



5. View from Banff-Jasper motor highway at Columbia Icefield chalet (6,675 ft.) looking southward up Dome glacier that cascades from Columbia Icefield (12,294 ft.). On left is Snow Dome (11,340 ft.), and on right is Mt. Kitchener (11,500 ft.). In lower left foreground is moraine-covered tongue of Athabasca Glacier, and in centre foreground are abandoned lateral and recessional moraines of Dome Glacier. Jasper National Park (see page 22).

one on top of the other, the character of the sediments and the thickness of the bed deposited at any one locality being controlled by various factors such as the nature of the source rock, the transporting agency, the distance from the shore and the depth of the water. As the sediments were being deposited, there were buried with them remains of plant and animal life that existed at that time. Some of these were destined to be preserved and to contribute to a record of the gradual development of life upon the earth; in some beds the fossil content is meagre; in others very abundant.

The earliest sediments in the Rockies and Selkirks are sandstones, shales and limestones that were laid down long before the life record began, and are, consequently, placed as Proterozoic or Precambrian in age.

They are believed to have been derived by erosion from an ancient land area, Cascadia, that lay to the west of the Cordilleran trough. During successive geological ages as the fore-shore deposits and some of the off-shore muds and marls were being deposited in a sinking sea-basin, the land area on the west was being elevated above sea-level causing the shore-line to be moved progressively eastward. The rocks of these newly elevated lands in turn contributed by their erosion detritus that went to form the strata of later geological ages. Thus the Precambrian rocks contributed sediments that went to form the Cambrian strata; the Cambrian and older rocks contributed sediments that went to form the Palaeozoic formations; the Palaeozoic and older formations contributed to the Mesozoic sediments, and the Mesozoic and older rocks to the Tertiary sediments.

During the hundreds of millions of years that have elapsed, there have been many oscillations of sea-level, some of which resulted in a pronounced elevation of the coastal regions and the immediate subjection of new land areas to the agencies of denudation.

In some localities the general uplift or depression was accompanied by extrusions of molten liquid rock from the earth's interior, which overspread large areas of upland and sea-bottom and greatly altered the sediments with which the molten lava came in contact.

The history of the Selkirk and Rocky Mountains dates back to the time when each of these large areas emerged from water-level and was subjected to the agents of denudation and erosion. It is believed that the Selkirk region was elevated in early Palaeozoic time, estimated at more than four hundred million years ago, which was approximately more than a hundred million years before the uplift of the western Rockies. The uplift in each case was, on the whole, slow and gradual, but occasionally interrupted by stages of more rapid upheaval which resulted in a steepening of the gradients of existing streams and a corresponding increase in their erosive and transporting power. As a result, with few exceptions the larger streams by eroding their channels into the rising land were able to maintain their original courses in spite of a tendency to cut new channels in harmony with the slopes formed by the uplift. This accounts for the major transverse valleys such as the upper parts of Kicking Horse, Bow, Athabasca, Liard and Peace Rivers being cut across the structure of pronounced mountain ranges.

As the horizontal compressive forces generated in the earth's shell increased through the contraction of the earth's core and the settling of the immense Pacific segment on the west, the uplifted areas gradually became arched upward and folded or broken into large blocks which were tilted and thrust eastward one over the other. It was this sequence of events that produced the folded and faulted mountain ranges of the Selkirk system, the major longitudinal breaks that constitute the Selkirk, Purcell and Rocky Mountain Trenches, the western Rocky Mountain belt, and the thrust fault that brings early Palaeozoic and Precambrian rocks of the western Rockies in contact with rocks of late Palaeozoic and

6. Landforms developed in Cambrian rocks by alpine glaciation. View from shoulder of Mt. St. Piram near Lake Louise chalet looking south towards Mt. Victoria (11,365 ft.) and glacier in centre distance, and Mt. Lefroy (11,230 ft.) on left. The drainage from rock-basin Lake Agnes (6,865 ft.) in cirque in upper right falls into rock-basin Mirror Lake (6,665 ft.) in cirque in centre foreground and this in turn drains into rock-basin Lake Louise (5,680 ft.) in lower left. Banff National Park.

7. Seven Sisters Falls, located between Lake O'Hara below and Lake Oesa above, with section of flat-lying Lower Cambrian quartzites. Banff National Park (see page 13).

early Mesozoic ages of the eastern Rockies. Other pronounced thrust faults which took place in late Tertiary time form the eastern border of the Rocky Mountains. Along these fault planes, Lower Cretaceous, Palaeozoic and, in the south, Precambrian strata have been thrust upward and eastward for many miles over younger Cretaceous and Tertiary sediments of the Alberta foothills. As a result of these uplifts and overthrusts, fossil remains of ancient marine life entombed in the sediments that were formed as deep sea-bottom deposits are now to be found on many peaks of the Rockies at elevations of over 10,000 feet.

The subsequent history of the mountains is largely a record of erosion and denudation by atmosphere, water and ice. The ultimate effect of these agencies is to wear down the uplifted masses and reduce them to base level, but for a long time the effect of such denudation is to increase the ruggedness of the region. The Selkirk system being the older, and subjected to denudation over a much longer period, its mountains are of lower relief and more subdued than those of the younger Rockies; however, many of the Selkirk ranges are still in the youthful stage of erosion, being characterized by pyramid-shaped peaks, precipitous mountain scarps, deeply incised canyons, waterfalls, and myriads of landforms that either have been or are now in the process of being sculptured by alpine glaciers.

The upturning and thrust faulting of the rocks have made possible the exposures of great thicknesses of beds which otherwise would never have been known to exist, and these have extended considerably our knowledge of the geological history of the region. Every mountain scarp, canyon wall and waterfall reveals to the geologist some phase of earth history. At no one area in the mountain belt is a complete sequence of the rock formations to be observed, but data lacking at one locality can generally be supplied from some other nearby region. By correlating the geological data gathered in various areas a complete sequence of the rock formations of the whole area can be drawn up and the geological history of the region deciphered. From a study of their fossil content different formations can be assigned to their proper place in the chronological world scale. (See inset on map.)

The most complete representation of the various rock systems that occur in the Canadian Cordillera is to be found along the Canadian Pacific Railway through the Kicking Horse Pass (photo 38). It has been estimated that along this route there is exposed in the Rocky Mountains alone a thickness of more than 50,000 feet of sediments, and the thickness of the strata in the Selkirks is believed to be almost as great. Along this route also, in the western Rockies and Selkirks as well as in Waterton Lakes Park (photo 30), are areas of ancient Precambrian sedimentary rocks that have been intruded by rocks of volcanic origin at a much later geological period; in some localities both the intruded and the intruding rocks have been so altered by subsequent igneous and dynamic metamorphism that it is difficult to determine whether the original rocks were of sedimentary or igneous origin.

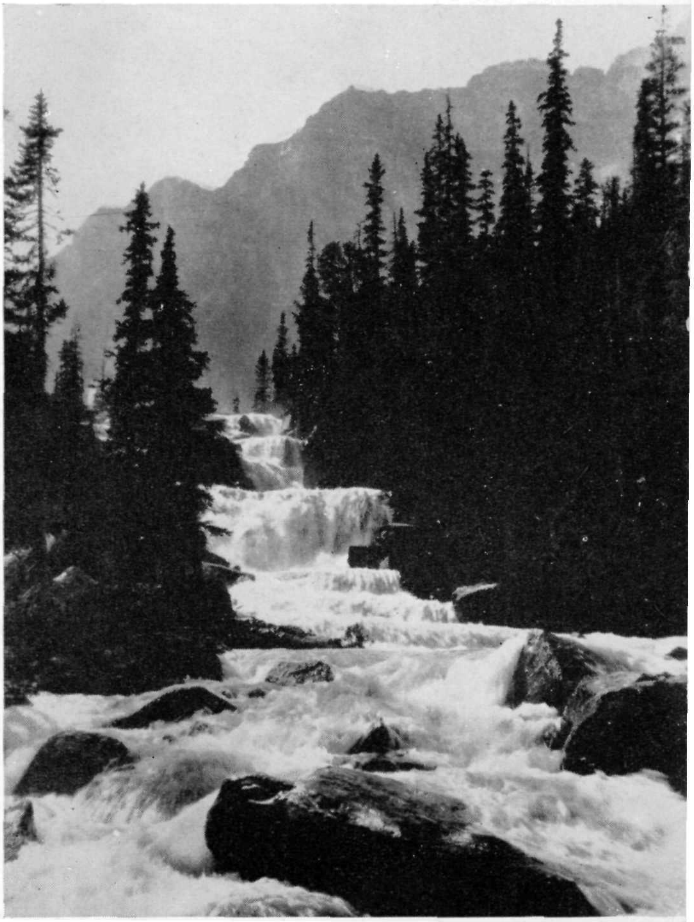
On the chronological "Table of Eras and Periods of Earth History" that forms the inset of the accompanying map is indicated the relative and approximate time intervals of each of the periods represented, the predominant nature of the sediments, and the portion of the geological column represented in each of the seven National Parks in the Rocky and Selkirk Mountains. On a map of such small scale it is obviously impossible to outline the narrow areas occupied by individual formations, but to show their general distribution and structural relationship they have been grouped into larger stratigraphic units, only one of which, group (2), represents an individual period. These four groups, given in descending order as to geological age, are:

(1) Upper Cretaceous and Tertiary.
(2) Lower Cretaceous.
(3) Upper Palaeozoic (Permian, Carboniferous and Devonian) and Early Mesozoic (Jurassic and Triassic).
(4) Precambrian and Early Palaeozoic (Silurian, Ordovician and Cambrian).

The sediments of these four groups differ considerably in composition, density, hardness and resistance to weathering. Those of group (1) consist largely of soft shales, slightly compacted sandstones and loosely cemented conglomerates. They readily disintegrate, are easily eroded, and hence constitute the areas of lower topography. Those of group (2) consist mainly of more compacted shales, harder sandstones and firmly cemented conglomerates which are more resistant to weathering and erosion. Those of group (3) consist of hard siliceous shales and marine limestones which are far more resistant to weathering, and which, therefore, form prominent ridges and ranges. Those of group (4) are essentially hard compact quartzites, shales, slates and granular limestones accompanied in some places by dense igneous rocks, and these form the older mountains of the Western Rockies and Selkirks.

On referring to the accompanying map it will be noted that the areas of group (1) are in the foothills region to the east of the Rocky Mountains proper, and have their most westerly extension in the vicinity of Crowsnest Pass in the south, and Smoky River in the north. The eastern boundaries of only two of the National Parks extend sufficiently far east to overlap these rocks in two small areas in Jasper Park and one in Waterton Lakes Park. The areas of group (2) occur as a series of northwesterly and southeasterly trending troughs and basins in the outer foothills belt, extending into the eastern part of Banff Park and as two narrow troughs in the eastern part of Jasper Park. The areas of group (3) comprise most of the 20- to

8. View looking southwest up the Giant's Stairway in Paradise Valley down which Paradise Creek cascades over cliffs of Lower Cambrian strata. Mount Ringrose (10,765 ft.) in right background. Banff National Park (see pages 13 to 17).

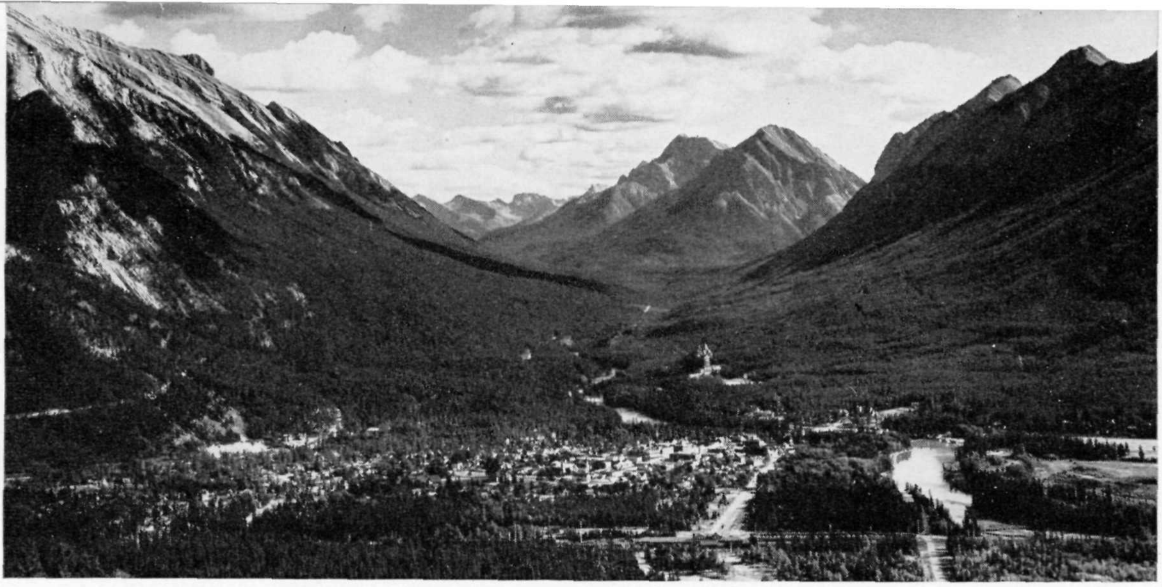


28-mile-wide belt underlying the eastern parts of Jasper Park and much of the 5- to 25-mile-wide belt in the eastern part of Banff Park. These younger Palaeozoic and early Mesozoic strata occur as a series of parallel trending ranges and ridges, each one of which represents a fault-block that has been tilted and thrust eastward over much younger strata. The ranges are characterized by a steep eastern escarpment developed along joint planes normal to the bedding, and a gentle westerly slope conforming to the dip of the bedding planes. This belt is bordered on the west by a major longitudinal thrust fault that passes to the east of Mount Sir Douglas in Banff Park and extends northwesterly to pass east of Pyramid Mountain in Jasper Park. From Mount Sir Douglas this fault continues southward to Elko in southeastern British Columbia and then swings southeasterly to cross the International Boundary five miles west of Flathead River.

To the west of this fault the area is underlain by rocks of group (4) consisting mainly of hard resistant quartzites and limestones of Precambrian and early Palaeozoic ages. These rocks underlie the western parts of Banff and Jasper Parks, and all of Yoho and Kootenay Parks on the western slope of the Rockies. They form the broad arch that constitutes the backbone of the Rocky Mountain system. In it the fault blocks are less tilted than are those that occur on the eastern part of the Rockies in Banff National Park.

Farther south in Waterton Lakes Park the area is underlain by group (4) but the rocks consist mainly of siliceous limestones, quartzites, argillites and basalts, and thus differ from those in the two other National Parks on the east side of the Continental Divide. The stratigraphic section, totalling over 13,000 feet in thickness, is similar to that of the Precambrian section at the International Boundary west of Flathead River. The Waterton Lakes Precambrian area is bounded on the east, north and west by faults that dip into it. It is believed to represent an eastward extension of the fault-plate of Precambrian rocks lying to the west of the Fernie coal basin, which had been severed from the parent body by a northwesterly-trending fault lying east of Flathead River and subsequently thrust northward. The present most northerly boundary of these Precambrian rocks occurs over thirty miles to the north of those that cross Flathead River south of the International Boundary. The close folding along the northern part of this Precambrian fault-block indicates that there was a considerable northward movement, but just how much has not been determined. These Precambrian rocks overlie highly folded and faulted Upper Cretaceous rocks of the Crowsnest Pass region of southern Alberta and the Lower Cretaceous coal-bearing rocks of the Flathead River basin (photo 9 and map). The structure is further complicated by the folding of thrust fault plates and their subsequent partial erosion.

9. View looking northeasterly from Bertha Lake Trail across Upper Waterton Lake, and the Precambrian rocks of Vimy Peak (7,825 ft.) and over Lower Waterton Lake, the Dardanelles, Maskinonge Lake to Waterton River. Waterton Lakes National Park (see pages 12, 24).



10. View from Stoney Squaw Mountain (6,180 ft.) looking southeast over Banff townsite and up the broad glacial-modified valley of Spray River, which is floored with soft Permian and Jurassic shale formations. On the left are the underlying westerly-dipping Carboniferous rocks that form Rundle Mountain, and on the right, the over-thrusted westerly-dipping limestones of Devonian age which form Sulphur Mountain and Goat Range (see pages 13, 15).

BANFF NATIONAL PARK

ALBERTA

Banff, oldest of the national parks, was established in 1885 as a health and recreational resort in the vicinity of the then newly discovered hot springs at Banff which were found to possess medicinal properties. From its original small area of ten square miles, the size of the park has grown steadily, along with its popularity, and at present it embraces an area of 2,564 square miles of the east slope of the Rockies, possessing mountain and alpine glacial scenery of unsurpassed grandeur (photos 2, 4, 6, 7, 8, 10-19, 23, 59, 60).

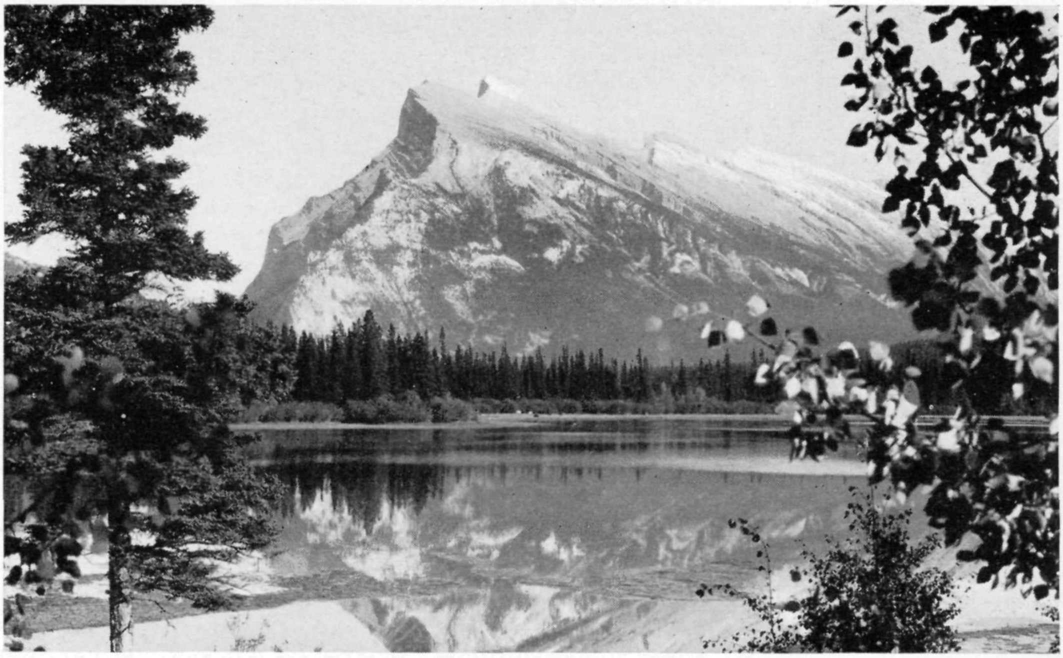
The Continental Divide forms its western boundary from Mount Sir Douglas on the south to Snow Dome on the north, a distance of 210 miles. Within the park there is a difference of elevation or a relief of 7,500 feet, the lowest elevation, 4,362 feet, being on Bow River at the eastern entrance to the park, and the highest summit being that of Mount Assiniboine, "the Matterhorn of the Rockies", with an elevation of 11,870 feet (photo 15).

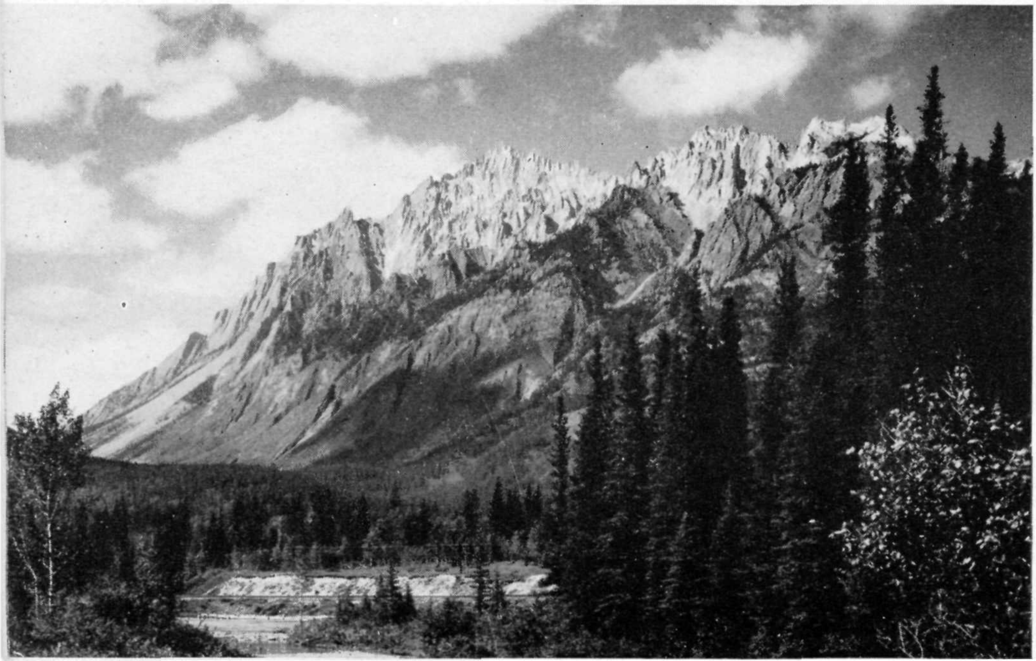
The main artery of travel through the park is the broad valley of the Bow River which is traversed by both the Canadian Pacific Railway and the government motor highway from the eastern entrance to near Kicking Horse Pass, the main western gateway, where both railway and highway cross the Continental Divide into Yoho Park. In the Bow River valley, situated 40 miles apart in two entirely different settings of mountain architecture, are the beautiful resorts of Banff and Lake Louise, and from these and other centres roads and trails lead up the valleys and ridges into the surrounding mountain wilderness. In the centre of these inspiring settings is the castellated prominence of Mt. Eisenhower which rises precipitously from the valley like an ancient turreted fortress (photo 4). From the main motor route the Banff-Windermere Highway runs westerly, crossing the Continental Divide at Vermilion Pass into Kootenay Park, and the Banff-Jasper Highway runs northwesterly, crossing Bow Pass and the basin of the North Saskatchewan River, and through Sunwapta Pass into Jasper Park.

In few parks is it possible to view to better advantage Nature's handiwork in a great variety of landforms, and to see her actually engaged in her work of mountain sculpturing. The great process of mountain building and evidences of the mighty forces of Nature are revealed in all their grandeur, challenging both the skill and daring of the mountaineer and the imagination of the geologist. Within

11. View from slope of Sulphur Mountain looking northeast across Bow River Valley and Cascade coal basin to Cascade River and Lake Minnewanka, with Banff Springs Hotel and Tunnel Mountain (in lower left foreground), Mount Rundle (right foreground), and Palliser Range in distance (see pages 13, 15, 17).

12. View looking southeast across Vermilion Lakes to Mt. Rundle which represents the westerly-dipping type of fault block that exists in the eastern part of the Rocky Mountain belt, characterized by a precipitous east face and a gentle westerly slope (see pages 13, 15).





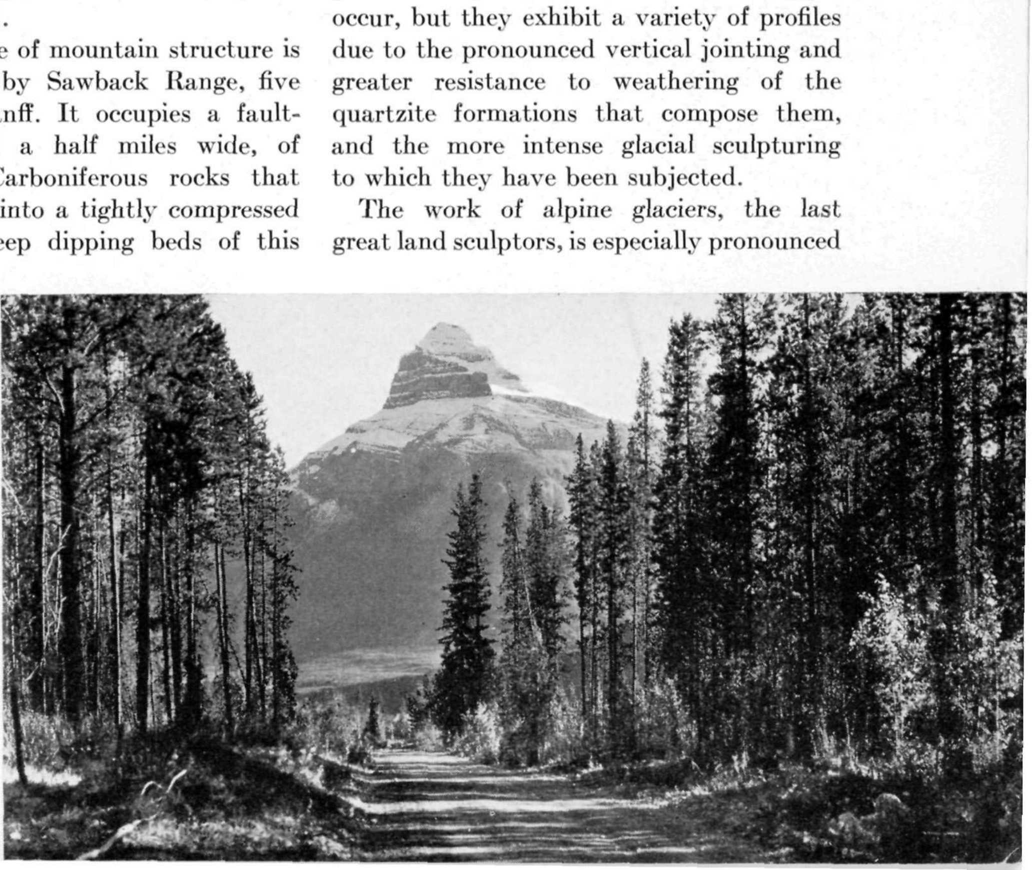
13. Mt. Ishbel, on the west flank of Sawback Range, a tightly folded and faulted anticlinal structure whose steeply dipping beds of Carboniferous limestones weather into high smooth cliffs, cock's-comb ridges, and needle-shaped peaks (see pages 13, 15).

the park are three types of mountain structure. The eastern belt, which near Bow River is 16 to 25 miles wide, consists of three westerly-tilted fault-block ranges of Palaeozoic and Mesozoic rocks, e.g., Palliser Range on the east, Cascade Range and Rundle Mountain in the centre, and Sulphur Mountain Range on the west (photos 10, 11, 12). Each of these ranges is characterized by a gentle westerly slope conforming to the general southwesterly dip of the rock formations, and a steep eastern face that is governed largely by joint planes normal to the bedding. The Palliser fault-block is 8 to 15 miles in width and extends a short distance east of the park boundary where normally deep-lying Devonian strata have been thrust eastward over much younger Upper Cretaceous sediments of the Alberta Foothills. The Cascade-Rundle Mountain fault-block is three and a half miles wide, and its still older Devonian strata have been thrust over Lower Cretaceous beds of the Cascade coal basin (photo 11). The Sulphur Mountain fault-block is 2½ to 6 miles in width, and its basal Devonian limestone overlies much younger Triassic shales which cap the western slope of the Cascade-Rundle Range. It is along this fault that the Banff Hot Springs, five in number, are located (photo 10).

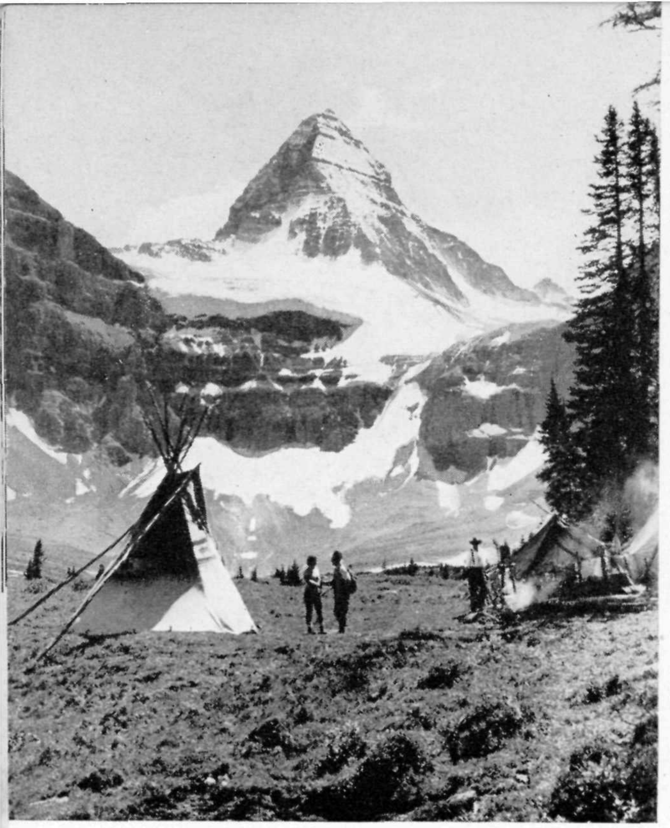
The second type of mountain structure is that represented by Sawback Range, five miles west of Banff. It occupies a fault-block, three and a half miles wide, of Devonian and Carboniferous rocks that have been folded into a tightly compressed anticline. The steep dipping beds of this fold form smooth, high, precipitous cliffs and weather into cock's-comb ridges and needle-shaped peaks such as Mount Edith and Mount Ishbel (photo 13).

The third type of mountain structure is that which characterizes the inner belt, seven to ten miles in width, that lies immediately west of Sawback Range. The mountains here are carved out of flat-lying to gently inclined rocks of Devonian and younger ages and have beehive or wedge-shaped summits, the hard limestones forming precipitous cliffs and softer shales the gradual slopes, as in Pilot Mountain (photo 14). This belt is bounded on the west by a major longitudinal fault which crosses Bow River Valley at Johnston Canyon and Brewster Creek, and along which a block of Cambrian and Precambrian rocks has been thrust upward and eastward over rocks of Devonian age. It extends west to beyond the Continental Divide. In the three-and-a-half mile-wide belt lying immediately west of the fault, Precambrian rocks are exposed, the oldest exposed rocks in the central Rockies, whereas to the west of this the remainder of the outcropping strata are mainly of Cambrian age. In this wide belt of Precambrian and Cambrian rocks that forms the greater part of the park, mountains of three types occur, but they exhibit a variety of profiles due to the pronounced vertical jointing and greater resistance to weathering of the quartzite formations that compose them, and the more intense glacial sculpturing to which they have been subjected.

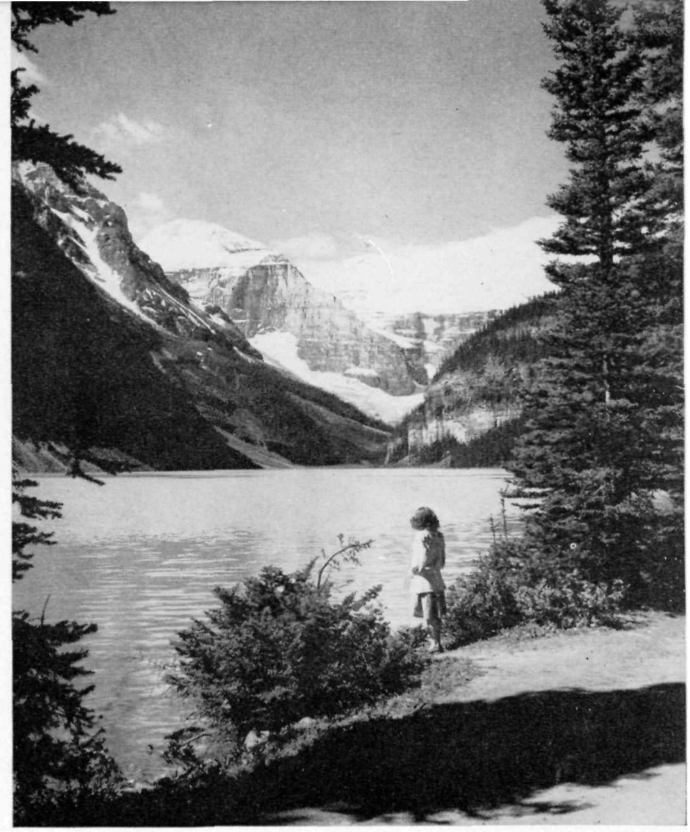
The work of alpine glaciers, the last great land sculptors, is especially pronounced



14. Pilot Mountain (9,680 ft.) towers 5,000 feet above the valley. It represents the type of mountain carved out of flat-lying Carboniferous and Devonian limestones that occur in the eastern part of the Rocky Mountain belt. The beehive outline of the mountain is due to beds of varying hardness; its peak consists of Rocky Mountain quartzite, the cliffs are of Rundle limestone, and the base consists of Devonian limestone (see page 15).

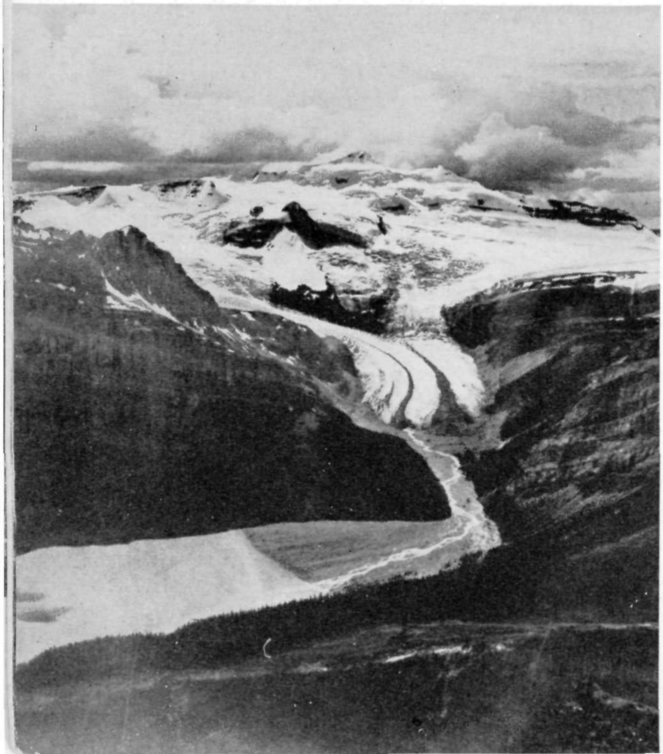


15. Mount Assiniboine, "The Chief" or "the Matterhorn of the Canadian Rockies" (11,870 ft.) a high pyramid-shaped ice-sculptured peak on the Continental Divide, with precipitous-walled cirque and rock-basin lake, and other features resulting from alpine glaciation. It is the seventh highest peak in the Canadian Rockies (see pages 13, 17).

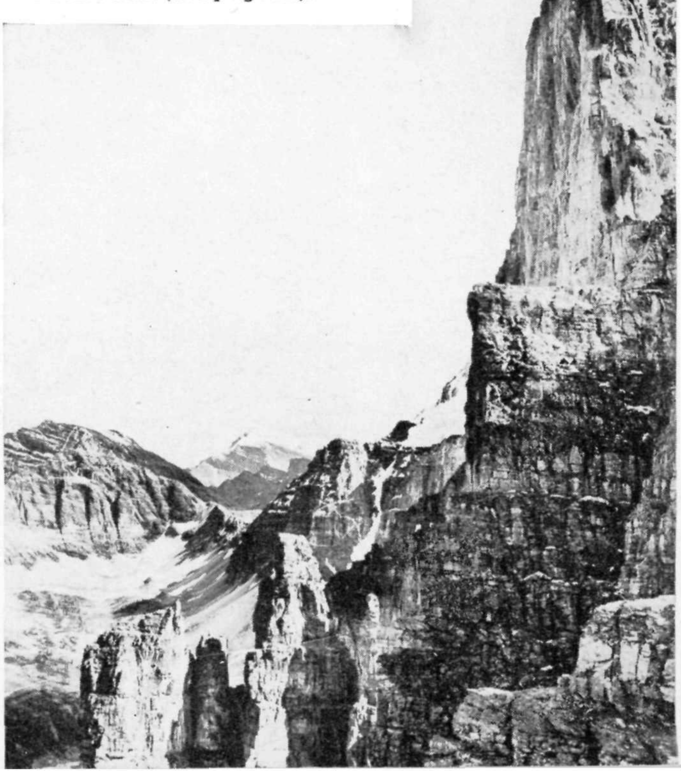


16. Looking southwest across Lake Louise (5,680 ft.) showing Victoria Glacier in centre, Mount Lefroy (11,230 ft.) at left, and Mount Victoria (11,365 ft.) carved out of Middle and Lower Cambrian sediments, right background (see pages 6, 13).

17. View from south slope of Bow Peak looking southwest across glacial Lake Hector (5,704 ft.) to Mount Balfour (10,741 ft.) that forms the Continental Divide, showing Balfour Glacier with its abandoned lateral moraines and outwash delta (see pages 6, 13, 17).



18. Looking southeast from the craggy cliffs or "gendarmes" on east side of Eiffel Peak, developed by vertical jointing of Middle Cambrian limestone. Below, carved in Lower Cambrian sediments is Moraine Lake (6,190 ft.) occupying the large glacial amphitheatre or cirque at the head of the Valley of the Ten Peaks (see page 17).

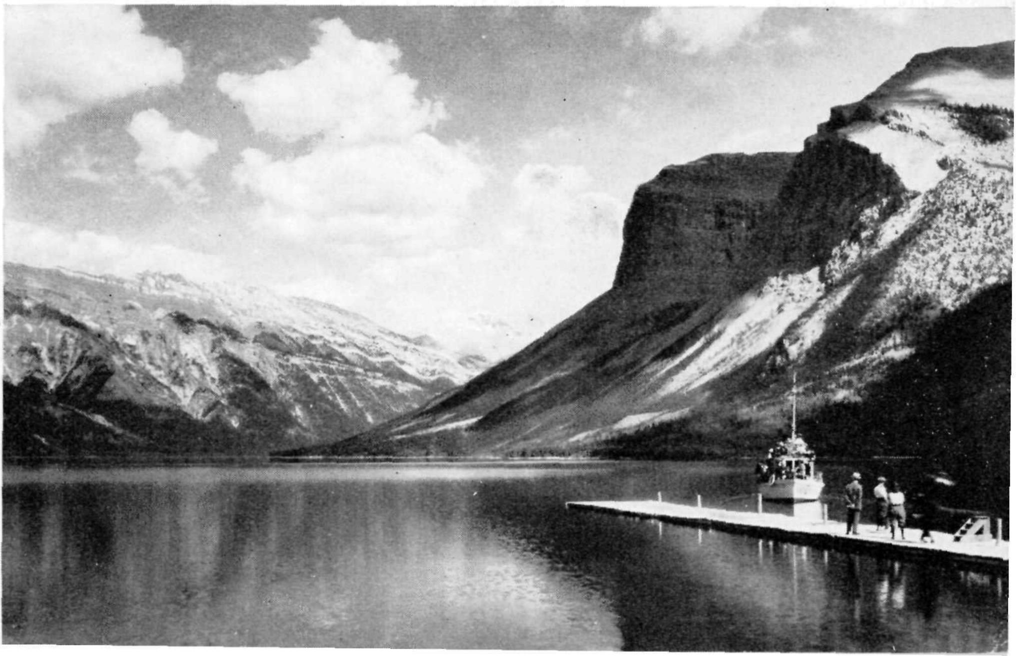


within the park area. At its northern end the park shares with Jasper Park the great Columbia Icefield, a remnant of the Ice Age, over 100 square miles in extent, which straddles the Continental Divide, and sends down the valleys tongues of ice, the waters of which drain into three oceans, the Pacific, the Arctic, and through Hudson Bay into the Atlantic. Saskatchewan Glacier (photos 23, 59) is the largest of these tongues.

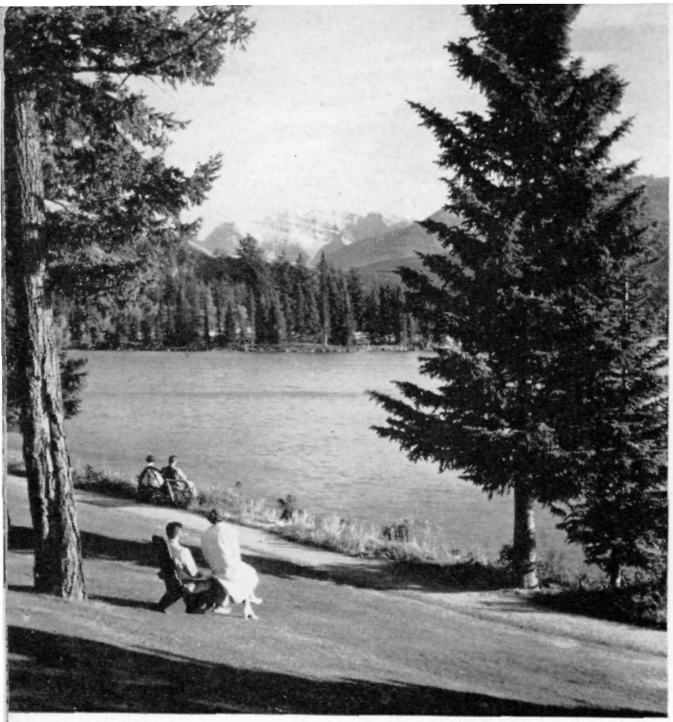
Along the entire western part of the park and over most of its northern area are scores of cliff and valley glaciers whose crevassed surfaces are streaked with morainic debris and bordered by an infinitude of glacial-sculptured landforms in all stages of development. They include most of the high pyramid-shaped peaks along the Continental Divide, Mt. Sir Douglas, Mt. Assiniboine (photo 15), Mt. Deltaform, Mt. Victoria and Mt. Balfour; hundreds of cirques with high precipitous walls and beautiful rock basin lakes, one of which, Lake Louise, is widely recognized as one of the most beautiful mountain tarns in the world; numerous U-shaped valleys with glacial-smoothed walls, truncated mountain spurs, hanging valleys, and giant waterfalls (photo 16). Many of these valleys contain lakes, such as Moraine Lake, that have been formed partly by glacial gouging and partly by the deposition of a terminal or recessional moraine of rock debris deposited by the glacier at the termination of the ice tongue or where it halted for a period in its retreat. In some of these lakes, for instance Hector Lake, large deltas are built by alluvium or rock flour carried down by the streams issuing from the glaciers (photos 17, 18).

At lower altitudes the deposition of glacial debris in some of the valleys has caused a diversion of the drainage to other stream channels. This is apparent at Tunnel Mountain, opposite Banff Springs Hotel (photo 11), where Bow River abandoned its preglacial channel and turned southward into the valley of Spray River, the erosion of the new channel forming Bow Falls. Farther downstream, three miles east of Banff, the stream has cut its channel deep into the boulder clay, exposing sections of the glacial drift over 200 feet thick, and rain-water has sculptured the hard cemented boulder clay into fantastic forms called "hoodoos".

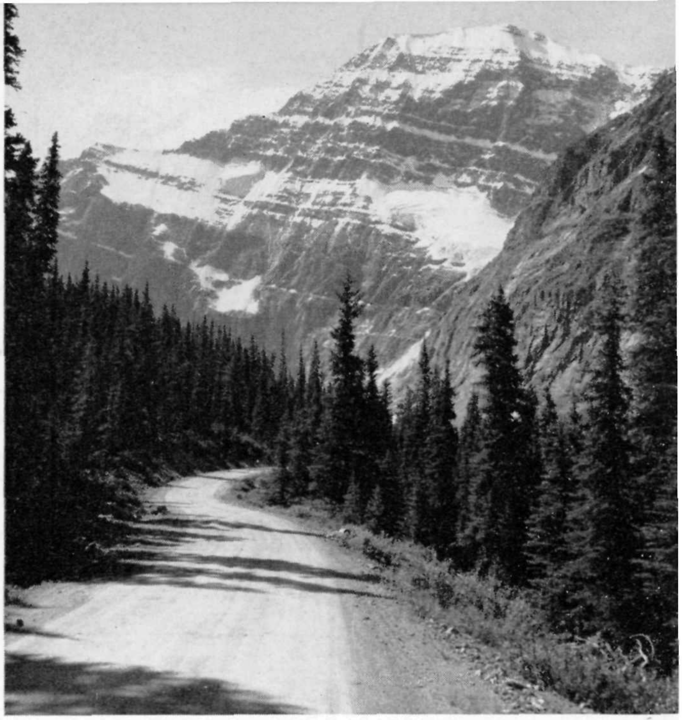
One of the largest and most scenic topographic features in Banff Park is Lake Minnewanka, located eight miles east of the town of Banff. The lake is twelve miles in length, over half a mile wide, and in places over 300 feet deep. It occupies a glacial modified U-shaped valley, with high precipitous walls, which continues eastward through Palliser Range as Devil's Gap and opens into Ghost River Valley. Minnewanka Lake valley is a former course of the Bow River from which the water was diverted south down Cascade valley by the headward erosion of a tributary of Spray River during the last mountain uplift, long before the Glacial Period (photos 11, 19).



19. Looking northeast from west end of Lake Minnewanka, a glacial-deepened ancient channel of Bow River that had been cut through Upper Palaeozoic limestone of Palliser Range. On the right is Gibraltar Rock, in the centre distance is Mt. Costigan (9,775 ft.), and on the left, the southern slope of Mt. Aylmer. Banff National Park (see pages 13, 17).



20. Mount Edith Cavell and Angel Glacier as viewed from Jasper Park Lodge on Lac Beauvert (see pages 18, 22).



21. View of Mount Edith Cavell (10,033 ft.) showing 5,000-ft. section of Precambrian sediments and south wing of Angel Glacier (see pages 18, 22).

JASPER NATIONAL PARK

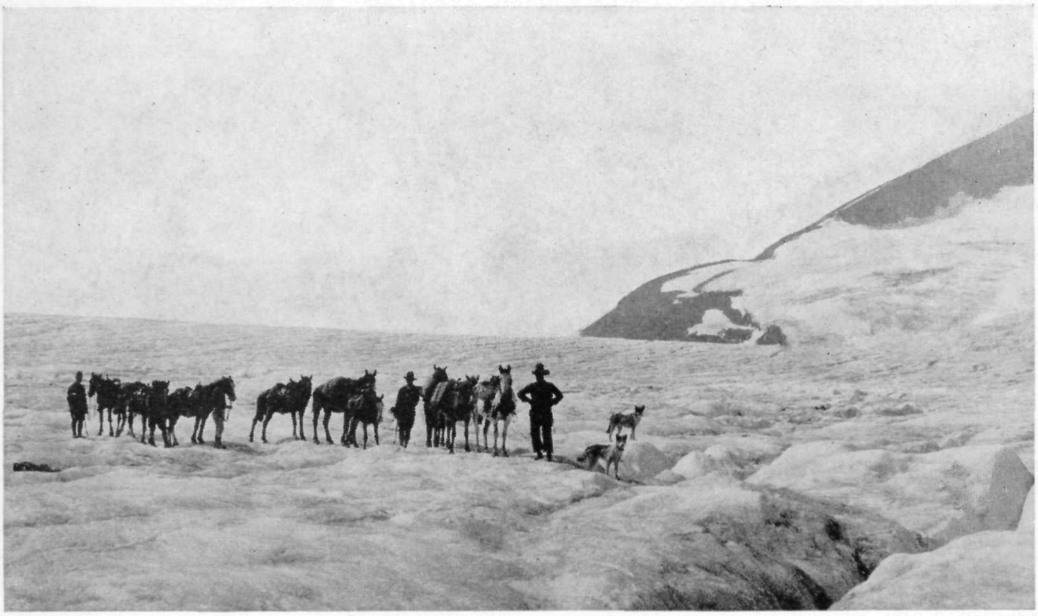
ALBERTA

Jasper National Park, the largest scenic national park in Canada, was established in 1907, and has an area of 4,200 square miles, much of which is still an unexplored mountain wilderness. The park extends approximately 75 miles northwest and southeast of the broad, flat-bottomed valley of Athabasca River, and its tributary, Miette River. These valleys form the main route of travel through the park, being followed by the Canadian National Railways which crosses the Continental Divide at Yellowhead Pass at an elevation of 3,711 feet. This is the lowest pass across the Rockies on the continent. The divide forms the western border of the park for 220 miles. Within the park there is a total difference in elevation of over 9,000 feet, the lowest point being on Athabasca River at the eastern entrance of the park, 3,232 feet, and the highest peak, Mount Columbia, 12,294 feet. Mount Robson, the highest peak in the Canadian Rockies, 12,972 feet, is five miles west of the Continental Divide (photo 1). The little town of Jasper, the Park administrative centre, and the celebrated Jasper Park Lodge are situated near the centre of the park, three miles apart, on opposite sides of the Athabasca River immediately below the confluence of Miette River. They are surrounded by majestic snow-clad mountain peaks and attendant glaciers lying a mile or more above them (photos 3, 20, 21).

As Jasper Park lies in the same mountain belt as Banff, a similarity in their geological features is to be expected. This similarity extends even to such peculiar phenomena as a group of hot springs of medicinal value, and earth pillars or "hoodoos". Practically every feature of geological interest of Banff Park has its counterpart somewhere in Jasper Park, but the development of most of the geological features in Jasper is on a much more colossal scale than in Banff (photo 28).

There is both a similarity and a diversity in the mountain structure of these areas. In the eastern part of Jasper Park the ranges are carved from a corresponding series of fault-blocks composed of sediments mainly of Devonian and Carboniferous ages that have been uplifted and thrust eastward for many miles, but the strata over most of the eastern part of Jasper Park are much more highly folded than are those of the eastern part of Banff Park, and

22. The Ramparts that form the Continental Divide, and Amethyst Lake at their eastern base. The castellated peaks have been developed by the plucking action of alpine ice in quartzites of Precambrian age (see page 22).



23. View looking toward Mt. Athabasca (11,452 ft.) showing major crevasses of Saskatchewan Glacier that flows easterly from Columbia Icefield forming the headwaters of the North Saskatchewan River. Banff National Park (see pages 17, 22).

24. Crevasses on tongue of Athabasca Glacier that issues from Columbia Icefield, and buttresses of Mount Athabasca, as viewed from Banff-Jasper Highway in Jasper National Park (see page 22).

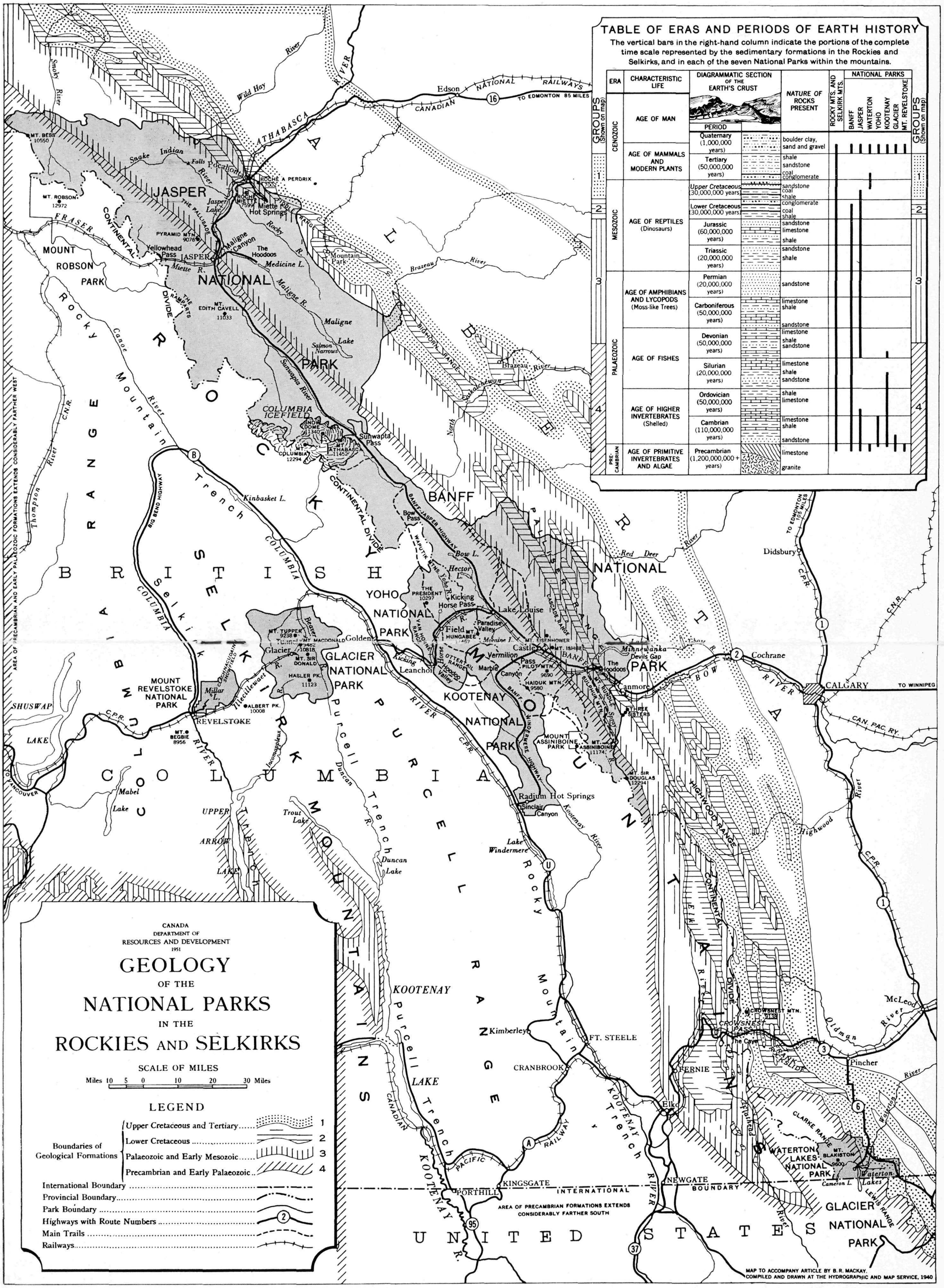


TABLE OF ERAS AND PERIODS OF EARTH HISTORY

The vertical bars in the right-hand column indicate the portions of the complete time scale represented by the sedimentary formations in the Rockies and Selkirks, and in each of the seven National Parks within the mountains.

GROUPS (Shown on map)	ERA	CHARACTERISTIC LIFE	PERIOD	NATURE OF ROCKS PRESENT
	CENOZOIC	AGE OF MAN	Quaternary (1,000,000 years)	boulder clay, sand and gravel
1		AGE OF MAMMALS AND MODERN PLANTS	Tertiary (50,000,000 years)	shale sandstone coal conglomerate
	MESOZOIC	AGE OF REPTILES (Dinosaurs)	Upper Cretaceous (30,000,000 years)	sandstone coal shale
2			Lower Cretaceous (30,000,000 years)	conglomerate coal shale
3			Jurassic (60,000,000 years)	sandstone limestone shale
			Triassic (20,000,000 years)	sandstone shale
	PALAEOZOIC	AGE OF AMPHIBIANS AND LYCOPODS (Moss-like Trees)	Permian (20,000,000 years)	sandstone
			Carboniferous (50,000,000 years)	limestone shale sandstone
4		AGE OF FISHES	Devonian (50,000,000 years)	limestone shale sandstone
			Silurian (20,000,000 years)	limestone shale sandstone
		AGE OF HIGHER INVERTEBRATES (Shelled)	Ordovician (50,000,000 years)	shale limestone
			Cambrian (110,000,000 years)	limestone shale sandstone
	PRE-CAMBRIAN	AGE OF PRIMITIVE INVERTEBRATES AND ALGAE	Precambrian (1,200,000,000 + years)	limestone granite

DIAGRAMMATIC SECTION OF THE EARTH'S CRUST

ROCKY MTS. AND SELKIRK MTS. — NATIONAL PARKS: BANFF, JASPER, WATERTON, YOHO, KOOTENAY, GLACIER, MT. REVELSTOKE

CANADA
DEPARTMENT OF
RESOURCES AND DEVELOPMENT
1951

GEOLOGY
OF THE
NATIONAL PARKS
IN THE
ROCKIES AND SELKIRKS

SCALE OF MILES

Miles 10 5 0 10 20 30 Miles

LEGEND

Boundaries of Geological Formations
- Upper Cretaceous and Tertiary...... 1
- Lower Cretaceous 2
- Palaeozoic and Early Mesozoic...... 3
- Precambrian and Early Palaeozoic.. 4

International Boundary ....
Provincial Boundary..............................
Park Boundary ....
Highways with Route Numbers .... ②
Main Trails ....
Railways..............................

MAP TO ACCOMPANY ARTICLE BY B.R. MACKAY.
COMPILED AND DRAWN AT THE HYDROGRAPHIC AND MAP SERVICE, 1940

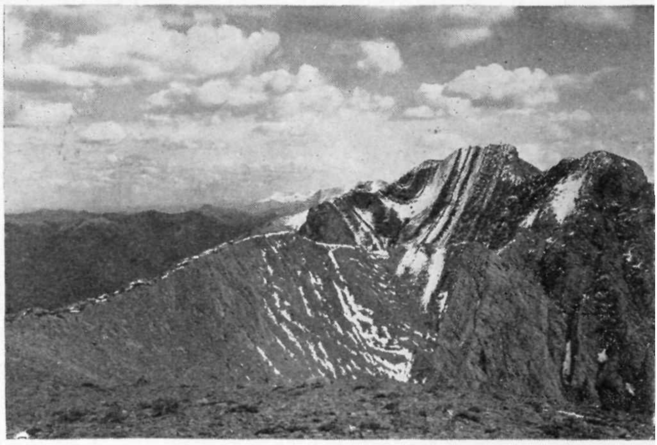
25. Roche Miette (7,599 ft.) as viewed looking south from Mountain Creek at Punchbowl Falls near Pocahontas. It is a fault block of strongly folded Devonian and underlying Cambrian strata that has been thrust upward and eastward over Lower Cretaceous coal-bearing sediments (see page 22).

numerous examples of tightly folded anticlines and synclines occur, such as Roche Miette at the north end of Miette Range (photo 25) and Roche à Perdrix on the north end of Fiddle Range (photos 26, 27) and on Rocky River.

West of Rocky River is a belt 10 miles wide in which the ranges are carved out of tightly folded Devonian and Carboniferous strata (see cover). To the west of this is the Palisade, a narrow, westerly-dipping fault-block formed of early Palaeozoic sediments characterized by a steep joint-controlled east face and a gentle west slope conforming to the bedding planes. To the west of the Palisade the mountains are carved out of Cambrian and Precambrian sediments that are less severely folded and in places flat-lying. These mountains assume different outlines depending on the inclination of the strata and the kind of sediment involved. Some of them, like Pyramid Mountain six miles north of Jasper (photo 3) are formed of northeasterly-dipping strata, and have pyramid-shaped summits, whereas others, where the strata are flat-lying, present domed, castellated and beehive summits such as the Ramparts and Mt. Athabasca (photos 22, 24) and numerous other peaks along the Continental Divide.

26. A tightly folded anticline of Devonian limestone on Roche à Perdrix at the north end of Fiddle Range near the east entrance to Jasper Park (see page 22).

27. A tightly folded syncline in Devonian limestone at Roche à Perdrix on Fiddle Range near east entrance to Jasper Park (see page 22).

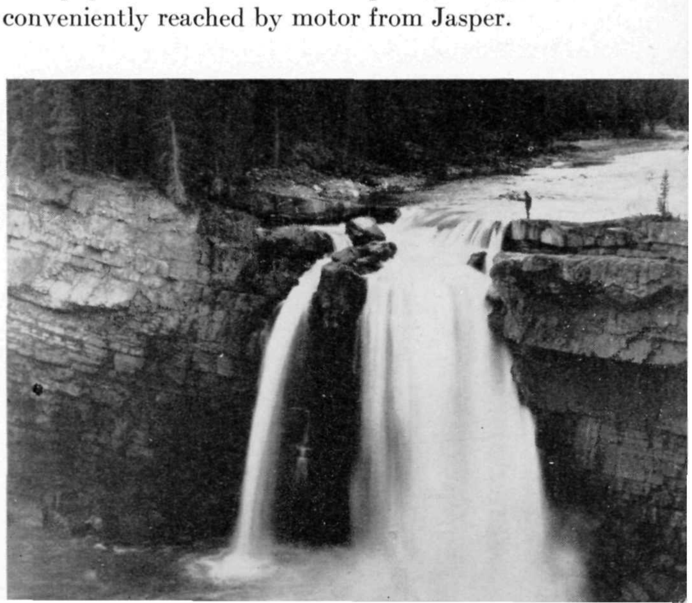


Jasper Park shares with Banff the Columbia Icefield, much of which is above 10,000 feet in elevation. From it many glaciers reach far down the bordering valleys to elevations of about 6,000 feet; two of these, Dome and Athabasca Glaciers (photos 61, 62) are among the most spectacular, being characterized by large crevasses, ice-cascades, water channels, rock-tables and moraines. Some of the glaciers end in rock-basin lakes, but in most the ice tongue has retreated a considerable distance from the lake and bears evidence of several halts by its recessional moraines; some of these moraines occur almost a quarter of a mile beyond the end of the ice tongue. All these features may be observed on Angel Glacier on the north slope of Mount Edith Cavell, comfortably reached by one of the most popular scenic motor routes from Jasper (photos 20, 21) or on the north slope of Mount Athabasca (photos 5, 61, 62).

28. Looking southeast to upper reaches of Maligne Lake near Salmon Narrows, showing valley and alpine glacial sculpturing; Mount Paul on extreme left; Mt. Monkhead, Mt. Brazeau and Mt. Henry McLeod on left side of Coronet Valley; and Mts. Mary Vaux and Llysfran Peak on right (see pages 18, 23).

The valley of Maligne River is teeming with interest for the ordinary tourist as well as for the physical geographer. It is cut in limestone of Devonian age and its upper part has been deepened and widened into a U-shaped cross-section by a large valley glacier. In it are two large lakes; one, Maligne Lake, fourteen miles long and one-quarter mile to two miles wide, lies near the head of the valley (photo 28), and the other, Medicine Lake, four miles long and one-half mile wide, occurs eight miles downstream. The outflow of Medicine Lake is through a subterranean channel. A considerable part of this underground drainage emerges a short distance below the lake and becomes Maligne River. Nine miles below the lake this river has carved out a gorge known as Maligne Canyon, which is several hundred feet deep, its vertical walls in places being only a few feet apart. The cutting of this canyon began at the close of the Glacial Period, and was caused by the river being diverted from its preglacial channel by the deposition of glacial drift, and thus forced to follow a new course which led along joint planes and over the rock wall of Athabasca River. This resulted in a waterfall and the development of potholes by the churning action of large boulders carried by the stream. During the succeeding centuries pot-hole after pot-hole was formed, enlarged, and cut away, and the waterfall migrated slowly upstream, leaving behind the deep gorge. In the bottom of this gorge, about a mile from the Athabasca River, a large stream enters on the west side, and is believed to be the outlet of a subterranean channel from Medicine Lake.

In places along Medicine Lake highway the thick deposits of glacial drift or boulder clay have been cut into high, fantastic earth pillars called "hoodoos" or "demoiselles", similar to those near Banff. Another similarity with Banff is the Miette Hot Springs which issue from Devonian strata on Sulphur Creek in Miette Range. These form one of the popular resorts in the park, being conveniently reached by motor from Jasper.



29. Snake Indian River Falls located 17 miles northwesterly upstream from Jasper Lake.

30. View from Prince of Wales Hotel looking south along Upper Waterton Lake: Mt. Richards (7,900 ft.) on right. Mt. Campbell (8,236 ft.) in centre background lies in Glacier National Park, Montana, U.S.A. (see page 24).

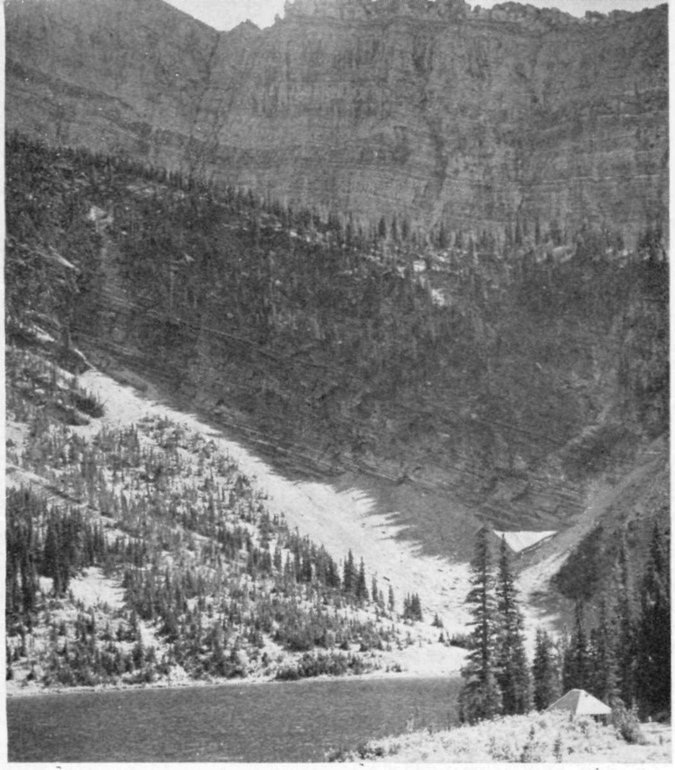
WATERTON LAKES NATIONAL PARK

ALBERTA

Waterton Lakes National Park covers 204 square miles on the east side of the Continental Divide at the International Boundary, and adjoins Glacier National Park in the United States. Most of the park area consists of rugged mountain territory that rises abruptly several thousand feet above the bordering foothills of Alberta. This elevated plateau has been deeply dissected by streams, and further modified by alpine glaciation into sharp peaks, narrow ridges and intervening U-shaped valleys. The highest peak in the park is Mount Blakiston with an elevation of 9,600 feet (photo 32).

Waterton Lakes Park differs from the other national parks on the east side of the Rocky Mountains in having no formations of Palaeozoic age that constitute the mountain ranges of the eastern Rockies in the Banff and Jasper Parks. A small erosion remnant of Cambrian and Devonian rocks occurs on Windsor Mountain 15 miles to the northwest of the park area, but if these and younger formations were ever present over the park area, they have been entirely removed by erosion. The mountains within the park are carved wholly out of Precambrian rocks that are among the oldest exposed sediments of the earth's crust (photos 30, 31). They have a total exposed thickness in the park of over 13,000 feet, and correspond in character and sequence with those lying on the west side of Flathead River.

The rocks of Waterton Lakes Park are folded into three broad undulations which trend in a northwesterly direction. The central fold is a broad arch or anticline, the axis of which conforms to the lower part of Cameron Creek. Erosion near the crest of this fold has exposed, at Cameron Falls, the oldest rocks to be observed anywhere in this part of the Rocky Mountains. To the east and to the west of this anticline is a broad trough or syncline in which occur overlying younger Precambrian formations. Along the motor road from Waterton Lakes Park townsite west to Cameron Lake one may observe, in ascending order, almost the complete sequence of 13,000 feet of Precambrian rocks.



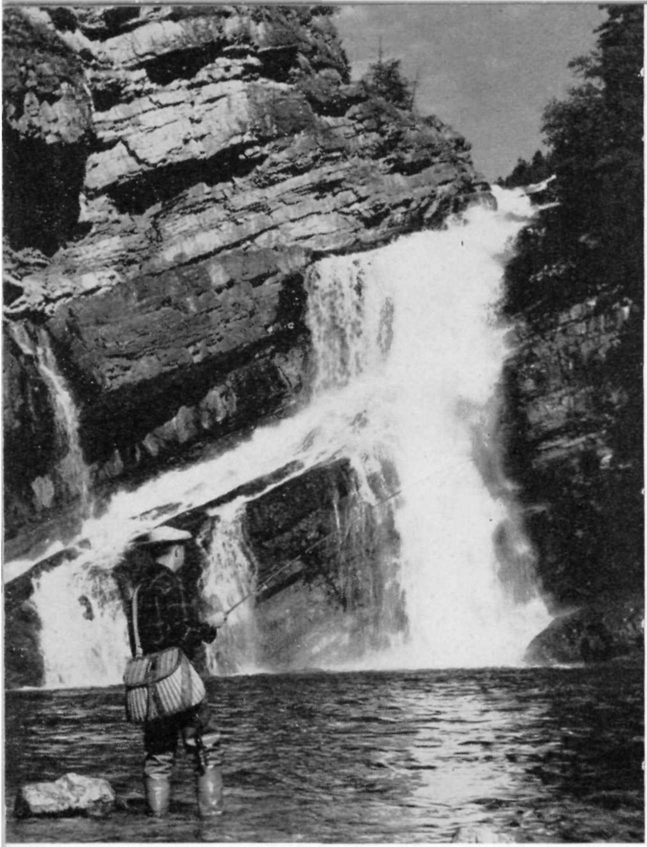
31. On the sheer wall of Bertha Lake cirque forming the north scarp of Mount Richards is exposed an 1,800-ft. section of Precambrian sediments with lens-like injections or sills of volcanic rock (see pages 10, 25).

32. Projecting bench of red argillite of Precambrian age outcropping on north slope of Blakiston Brook with Mt. Blakiston (9,600 ft.) in background (see page 25).

Waterton Lakes Park is unique with respect to its superb glacial sculpturing, and although the glaciers have long since disappeared from the area, it is one of the regions where the work of former glaciers may be observed to advantage as is evidenced by the many cirques, rock-basin lakes, U-shaped valleys, hanging valleys and waterfalls (photos 31, 33, 37). One of the most conspicuous features of the park area is the chain of lakes from which the park is named; the largest is Upper Waterton Lake (photos 9, 30, 35), eight miles in length, one-half mile in width, and in places over 400 feet deep. This lake, which straddles the International Boundary, occupies a northerly-trending fault trench separating Lewis and Clarke Ranges, that has been considerably deepened and widened by a valley glacier. A hanging valley formed by this deepening occurs at Cameron Falls. Here Cameron Creek cascades from its valley to the level of Waterton Lake with a drop of about 200 feet (photo 34).

In the higher regions are numerous landforms sculptured by alpine glaciers. They include such pyramid-shaped peaks as Mount Alderson (8,833 ft.), Mount Carthew (8,600 ft.), Mount Lineham (8,400 ft.), and Sofa Mountain (8,268 ft.) and the Cameronian Mountain (8,500 ft.); arêtes; numerous large cirques, many of which contain beautiful lakes, such as Cameron Lake (photo 33), Bertha Lake (photo 31), Alderson Lake, Crypt Lake, Lineham Lake, Carthew Lake, Rowe Lakes, and Twin Lakes. On the uplands the quarrying effect of the frost, snow and ice action, and channels formed in the rock by snow-water are much in evidence (photo 36).

33. Looking south from camping ground on Cameron Lake: a typical rock-basin lake, in large glacial cirque, the wall of which forms the north escarpment of Mount Custer in Glacier National Park, Montana, U.S.A. (see page 25).

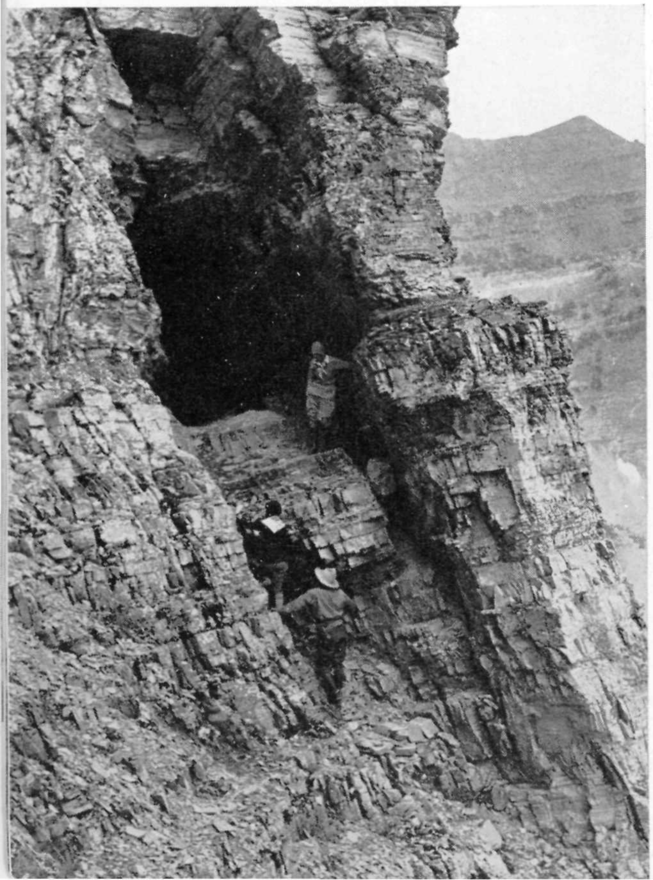


34. *Cameron Creek waterfall and gorge near its mouth cut in thinly-bedded dolomite and argillite of Precambrian age (see page 25).*

35. *Hikers on spur of Mount Crandell viewing the townsite of Waterton Park, built on delta of Cameron Creek showing the folded and faulted Precambrian formations on Vimy Ridge (see page 24).*

36. *A natural tunnel (6,520 ft.) cut in the cliff of Precambrian quartzites at the head of Hell-Roaring Creek. Through this tunnel passes the trail to Crypt Lake (see page 25).*

37. *Falls on Bertha Creek which cascades over a section of Precambrian quartzites and argillite (see page 25).*



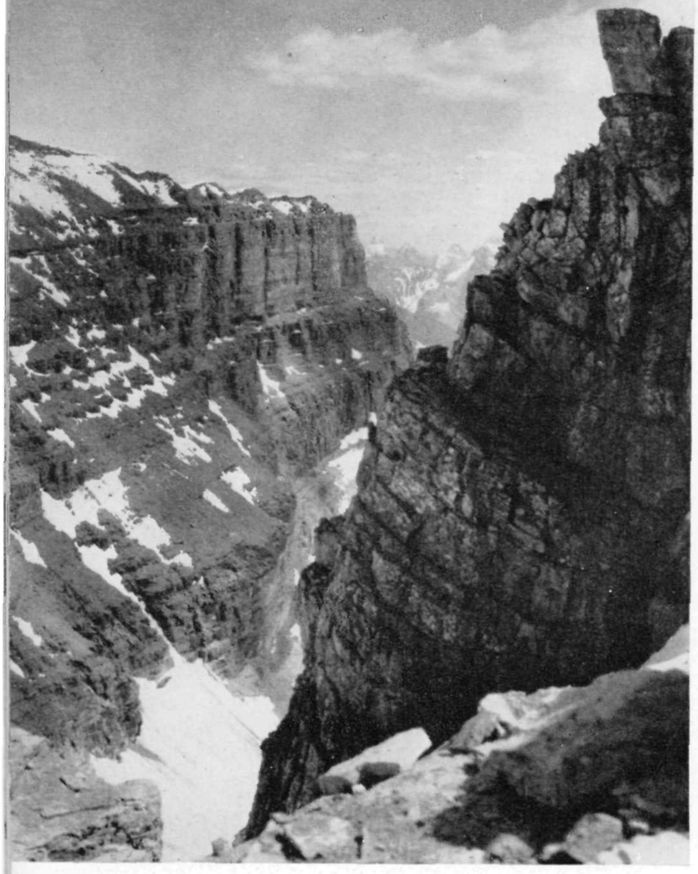
38. Looking northeast up Kicking Horse Valley with town of Field (4,075 ft.) and Mt. Stephen (10,495 ft.) on right and Mount Field (8,655 ft.) on left. Along the railway is exposed a section of over 18,500 ft. of Cambrian sediments which contain a wealth of fossils that have made the locality geologically famous. A lead-zinc mine occurs on the north slope of Mt. Stephen 1,000 ft. above the railway (see pages 10, 27, 28).

YOHO NATIONAL PARK

BRITISH COLUMBIA

Yoho National Park covers 507 square miles of the western or British Columbia slope of the Rocky Mountains. The Continental Divide, which forms the common boundary between Yoho and Banff Parks for a distance of thirty miles, is purely an erosional height of land, with the same rock formations and the same open mountain folds occurring on its opposite sides. The differences that exist between Yoho Park and the western part of Banff Park are largely due to the greater annual precipitation on the west slope of the Continental Divide and the greater denudation resulting from a lower base level. Most of the Yoho Park area lies within the drainage basin of Kicking Horse River which rises near Kicking Horse Pass, elevation 5,359 feet, traverses the park area for a distance of twenty-three miles, and crosses its western border at an elevation of 3,300 feet (photo 38). This river valley is the main artery of travel in the park and is followed by the Canadian Pacific Railway and the government motor highway. Near Yoho Valley the railway gradient was so steep that it was found necessary to reduce it by the driving of a double loop switchback and two rock tunnels on the opposite sides of Kicking Horse River valley. As Mount Hungabee, situated on the Continental Divide eight miles south of the Pass, has an elevation of 11,457 feet, there is a total relief within the park area of 8,157 feet (photos 27, 39).

The rocks from which the mountains have been carved consist of sandstone shale and limestone of Lower, Middle and Upper Cambrian ages (photos 40-42, 44). They have a total exposed thickness within the park of almost three miles and have been

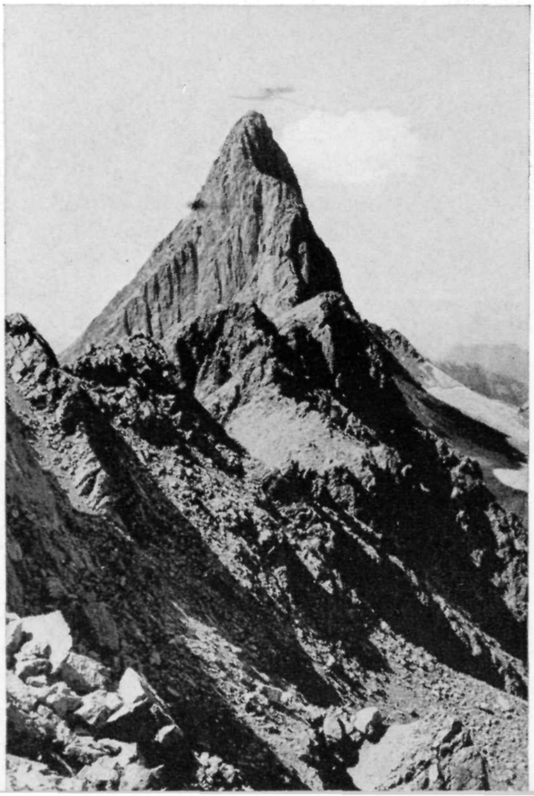


39. View from Emerald Pass (8,899 ft.) located on fault passing between Mt. Maripole (9,832 ft.) on right, and the President (10,297 ft.) on left, looking southeast to Mt. Hungabee (11,467 ft.) on the Continental Divide. Note synclinal and anticlinal folds in strata on right (see page 27).

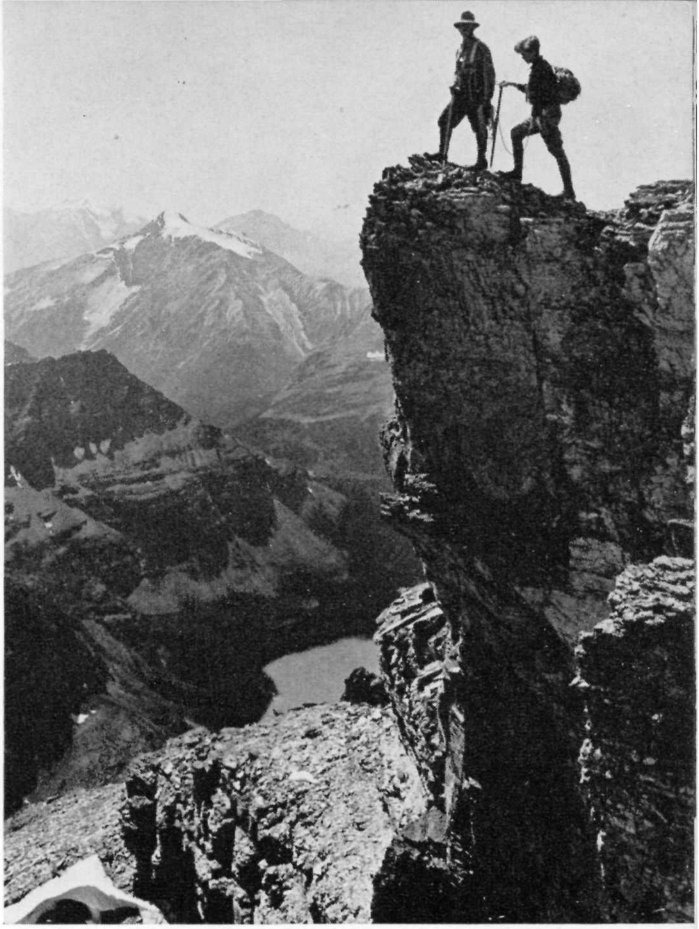
bowed into a series of northwesterly-southeasterly trending folds. The central fold is a broad anticline capped by Middle Cambrian rocks whose faulted crest lies between Mount Stephen and Cathedral Mountain. To the east is a shallow faulted syncline, the centre of which crosses the Continental Divide at Mount Whyte. On the west is another broad shallow syncline whose centre crosses Kicking Horse River five miles southwest of Field. This basin, covering a width of twelve miles, is underlain by Upper Cambrian shales which, being much softer than the underlying limestone formations, form areas of considerably lower relief. The beds on the eastern rim of this basin have a gentle westerly dip, but those on the western rim, which conforms with Van Horne Range, are steeply inclined and in places vertical, being underlain by Middle Cambrian limestones. On the west these rocks are in faulted contact with a much

40. Takakkaw Falls, drop 1,248 ft. over Middle Cambrian limestone. The hanging valley was formed by the lateral planation of a glacier that once occupied Yoho Valley. The Falls are fed by the melting of Daly Glacier that issues from Waputik Icefield (see page 27).

41. Spike Mountain (9,573 ft.) a sharp pyramid-shaped peak or "Matterhorn" on Van Horne Range formed by weathering, ice-plucking, and alpine glaciation in steeply-dipping early Palaeozoic sediments (see page 29).



42. View looking southwest from Abbot Pass (9,898 ft.) near south Peak of Mt. Victoria (11,230 ft.) on Continental Divide, showing section of Upper and Middle Cambrian quartzite formations, and Lake O'Hara (6,664 ft.) in Lower Cambrian strata (see page 27).

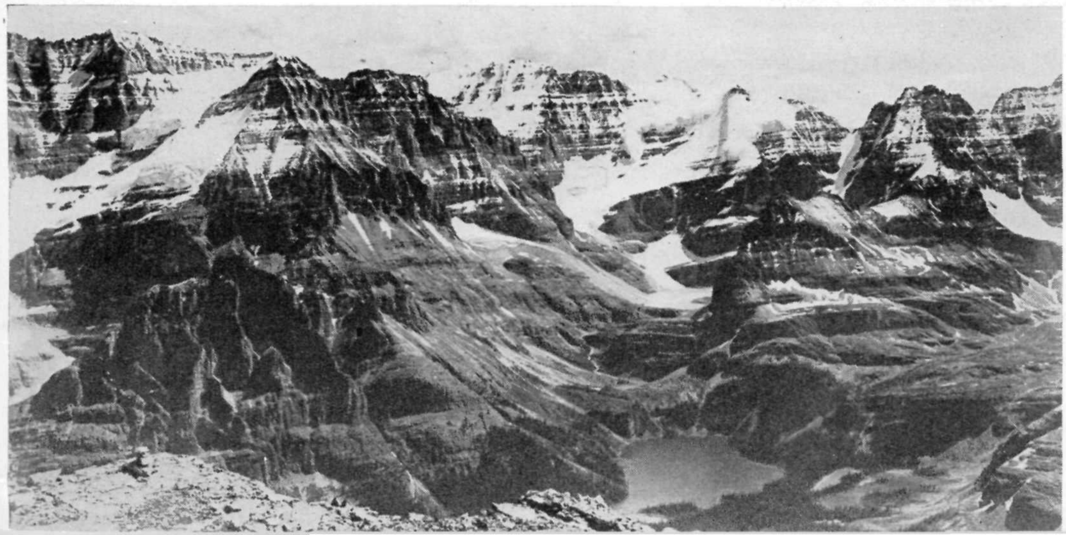


younger Ordovician shale formation that extends beyond the park boundary.

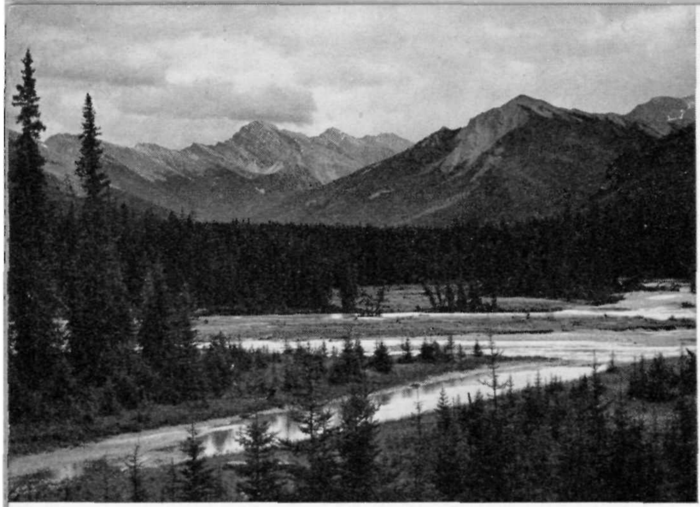
Extensive icefields cover much of the Waputik Mountains and send many large glaciers far down the bordering valleys (photo 40). Much of the summit area of President Range, Van Horne Range, and Ottertail Range is ornamented by cliff glaciers, and the work of former glaciers is evidenced by the myriad of glacial sculptured landforms for which the park is celebrated. They include high pyramid-shaped peaks or "horns" such as Spike Mountain (photo 41), ice-carved passes or cols, large cirques, rock-basin lakes, knife-edged ridges or arêtes, U-shaped valleys, hanging valleys, and waterfalls (photo 39). At Takakkaw Falls in Yoho Valley (photo 40) the water has a precipitous drop of over 1,200 feet. There are numerous other large falls within the park, such as Twin Falls and Laughing Falls, that owe their origin to deepening by valley glaciers.

In Hoodoo Valley opposite Leanchoil, rain-water has cut the cemented boulder clay into fantastic forms called "hoodoos" or "demoiselles" similar to those in Banff and Jasper Parks (photo 43).

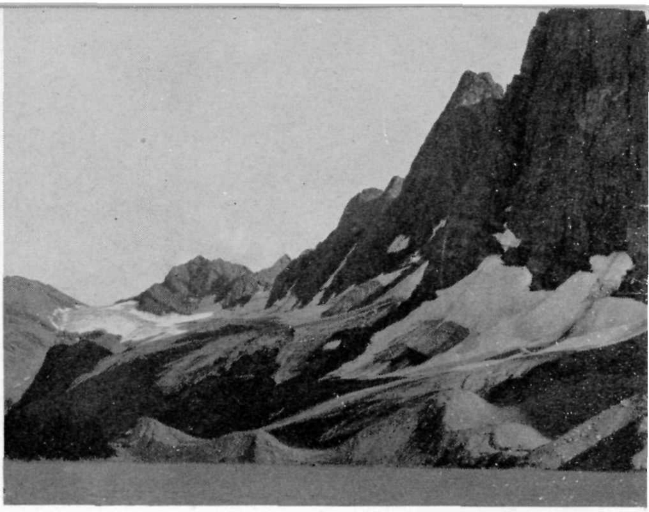
43. Earth pillars, 'hoodoos" or "demoiselles" in Hoodoo Valley opposite Leanchoil in Kicking Horse River Valley. These fantastic forms have been cut by rain erosion in firmly-cemented boulder clay and gravels, the earth pillars forming the portions protected from rain erosion by the capping boulders. The inclination of the capping boulders indicates the original surface slope of the boulder bed (see page 29).



44. Looking east from Mt. Odaray (10,175 ft.) to Mt. Victoria (11,365 ft.) left; Mt. Lefroy (11,230 ft.) centre; and Mt. Hungabee (11,459 ft.) extreme right; with Lake O'Hara (lower foreground) and Lake Oesa (above) showing cliffs, steps, reversed valley slopes and other alpine glacial features (see page 27).



45. View looking east up Simpson River with Hawk Range in background (see page 30).



46. Looking southeast from Floe Lake along the eastern escarpment of Vermilion Range showing steep westerly-dipping beds, cliff glaciers, lateral moraines, and rock-basin lake (see pages 30, 31).

KOOTENAY NATIONAL PARK

BRITISH COLUMBIA

Kootenay National Park was established to preserve the landscape along the 60-mile section of the Banff-Windermere highway between Vermilion Pass on the Continental Divide and Radium in the Columbia River Valley (photos 45 and 46). The park covers a belt ten miles wide, centred along the highway, and embraces 543 square miles of beautiful mountain territory. The highway traverses the western slope of the Rocky Mountains, the Vermilion, Mitchell and Brisco Ranges being crossed by means of three major transverse valleys spaced seventeen miles apart and connecting the three major longitudinal valleys occupied by Vermilion, Kootenay, and Columbia Rivers. The northern and central transverse valleys are occupied by Vermilion River, and the southern transverse valley by Swede Creek, flowing east into Kootenay River, and Sinclair Creek flowing west into Columbia River (Rocky Mountain Trench). (See map.)

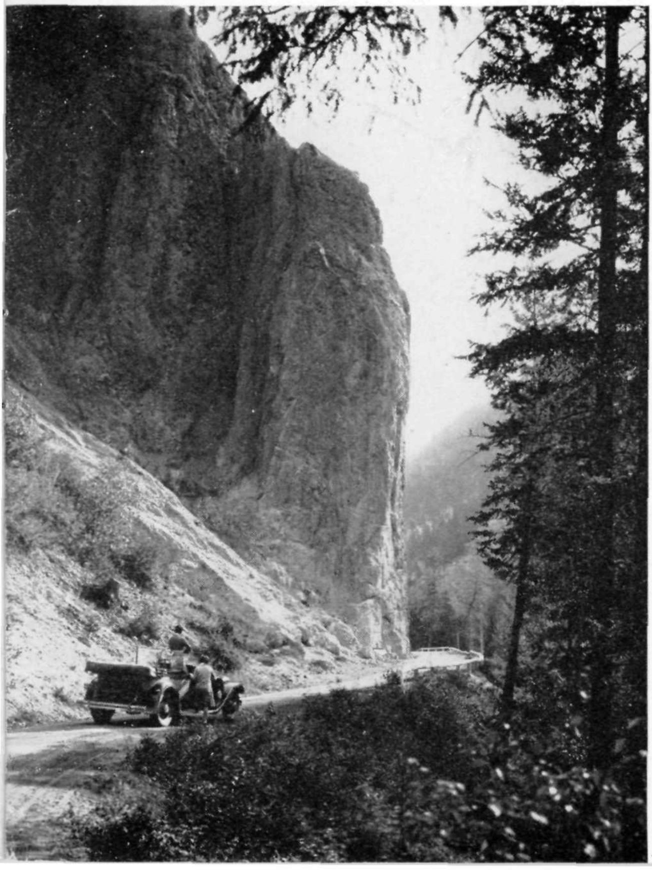
Along the highway may be observed a sequence of rock formations ranging from Lower Cambrian to Middle Devonian in age with folds and faults that trend in a northwesterly-southeasterly direction paralleling the ranges and master longitudinal valleys. One of the most pronounced faults is that which crosses Vermilion River and highway three and one-half miles southwest of Vermilion Pass, and which conforms to the valley of Tokumm and Haffner Creeks. This fault, which has a vertical displacement of several thousand feet, brings Lower Cambrian beds on the east in contact with Upper Cambrian beds on the west. Erosion along this fault has cut Marble Canyon, which is nearly 2,000 feet long, and in places over two hundred feet deep (photo 47).

In the three-and-one-half-mile area between this fault and Vermilion Pass to the east are to be observed flat-lying to gently folded Lower Cambrian shales and limestone occupying the valley bottom, Middle Cambrian limestone forming the mountain slopes, and hard Upper Cambrian limestone and shale capping the summits. The seven-and-one-half-mile-wide belt lying between the fault and Vermilion Range on the west is underlaid by Upper Cambrian rocks bowed into a broad syncline, the axis of which conforms closely with the longitudinal segment of Vermilion River. The western rim of this Upper Cambrian basin lies in faulted contact with more highly folded shales of Upper Cambrian and Ordovician ages that underlie the broad valley of Kootenay River and the east slope of Brisco Range. The crest of Brisco Range, and the belt, seven miles wide, lying between it and Columbia River, are characterized by tightly folded, crumpled and faulted rocks most of which are Ordovician and Silurian ages. One of these fault-blocks, however, cut by

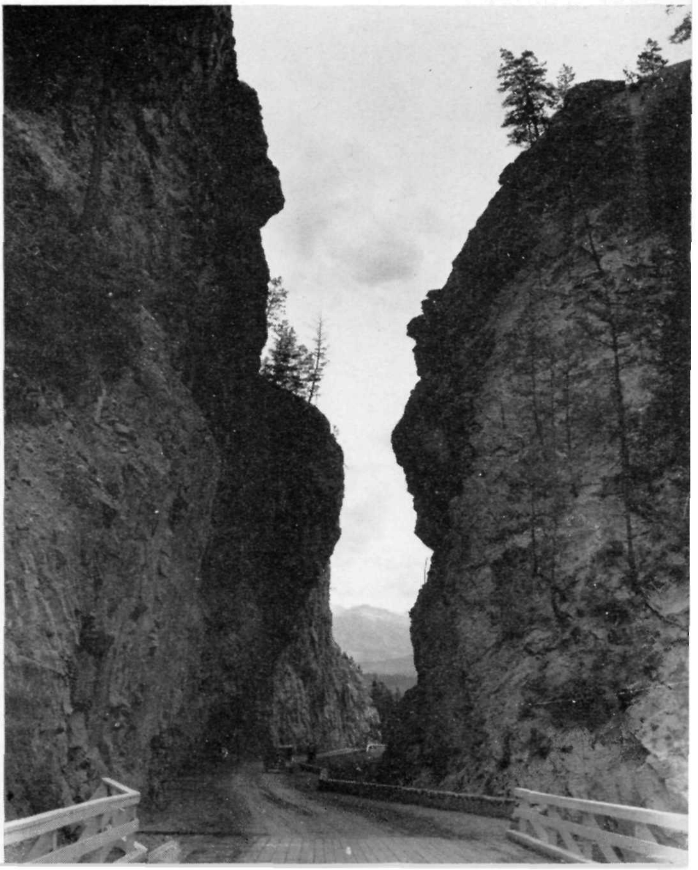
47. Marble Canyon on Tokumm Creek, a gorge 200 ft. or more deep, formed by stream erosion along joint planes and a fault that brings Lower Cambrian limestone at the east in contact with Upper Cambrian quartzite on the west (see page 30).

Sinclair Creek, reveals at its eastern base, Cambrian limestone, and at its western end, a small outcrop of Middle Devonian limestone. It is on one of these faults that the famous Radium Hot Springs are located. The red-weathering bluffs and the deep canyon cut by Sinclair Creek along a transverse fault and joint planes in the steeply dipping rocks form one of the most scenic sections of the Banff-Windermere motor highway (photos 48 and 49).

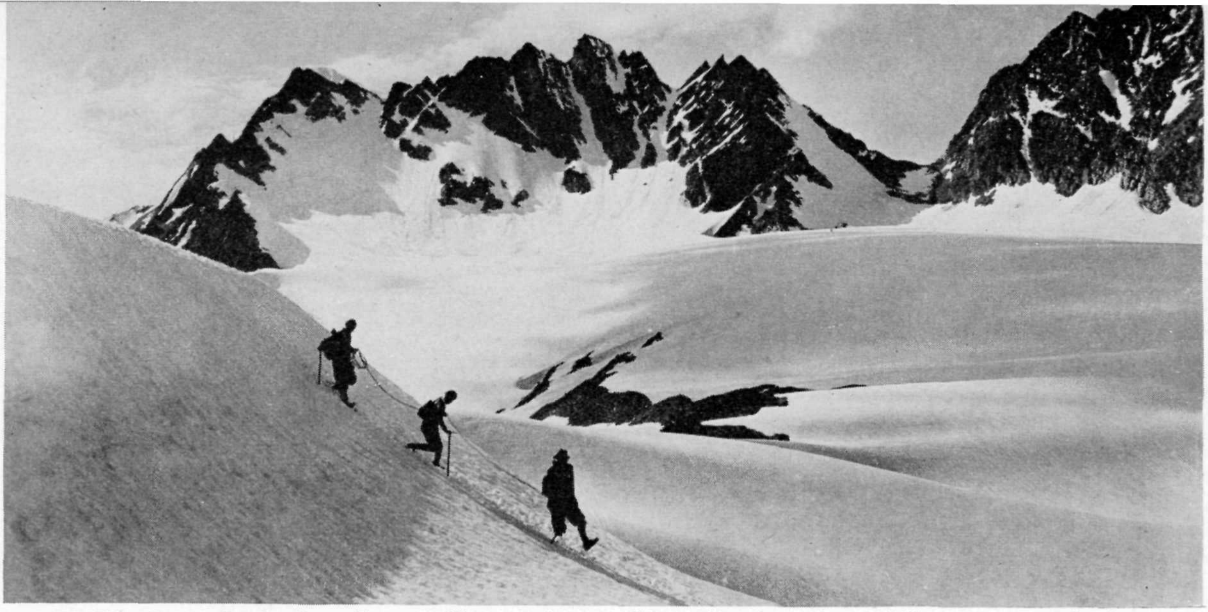
On the summit areas of the Continental Divide and of Vermilion Range, which form the eastern and western boundaries of the park in its northern part, are to be observed cliff glaciers and extensive snowfields, above which tower high pyramid-shaped peaks, and knife-edged ridges (photo 46). The motor highway with its tributary trails make it possible for the ordinary tourist as well as the alpine climber to find easy access to these delightful regions.



48. Looking northeast to Redrock Bluff, a high buttress of Cambrian red-weathering limestone at bend in the Banff-Windermere Highway about one-half mile east of Radium Hot Springs (see page 31).



49. View from bridge on Sinclair Creek, Banff-Windermere motor highway, one-half mile west of Radium Hot Springs, looking west through Sinclair Canyon to Columbia River valley. The canyon has been formed by erosion of Sinclair Creek along joint planes and a transverse fault, along which Upper Cambrian limestones on the north have been brought in contact with Silurian limestones on the south (see page 31).



50. Swiss Peaks from Tupper Glacier showing "horns", cols, arêtes, cliffs, cirques and other landforms sculptured by alpine glaciation, with non-glaciated cock's-comb crests (see page 32).

GLACIER NATIONAL PARK

BRITISH COLUMBIA

Glacier National Park, so named from the profusion of icefields and glaciers in it, is an area of unrivalled alpine beauty. It spans the summit of the Selkirks, crosses the Purcell Trench, and overlays the western slope of the Purcell Range. The park, embracing 521 square miles, is roughly rectangular in outline, measuring twenty-five miles in a north-south direction, and from eighteen to twenty-five miles in an east-west direction. Glacier, the main railway station, is located near the centre of the park, close to the summit of the Selkirks. The Canadian Pacific Railway traverses the park area for a distance of twenty-five miles, entering it by the valley of Beaver River at a point two miles south of Rogers station and leaving its western border by the Illecillewaet River valley two miles northeast of the station of that name. The railway formerly climbed over the summit of the Selkirks in Rogers Pass, elevation 4,341 feet, but the ascent has been reduced by 480 feet by driving the five-mile, double-tracked Connaught Tunnel through Mount Macdonald at an elevation of 3,860 feet; the summit of the mountain (9,492 feet) is 5,632 feet vertically above the tunnel (photo 52). As the elevations at the north and west entrances of the park are less than 2,900 feet above sea-level, and the highest summit in the park, Hasler Peak, is 11,123 feet, there is a vertical relief in it of over 8,200 feet.

Although the average height of the peaks in the Selkirks and Purcell Ranges is considerably less than that of the Rockies, the profusion of extensive coalescing icefields and large bordering glaciers, the sharp mountain peaks and serrated ridges rising far above the snow, and the dark green luxuriant forest of the lower mountain slopes, combine in giving to Glacier National Park an exceptional charm and beauty (photos 50 to 55). In the eastern part of the park, for a distance of twenty-five miles, is the valley, four miles in width, occupied by Beaver River, and known as the Purcell Trench. This trench runs with remarkable straightness in a southerly direction into the United States and is one of the major topographic features of the Cordilleran Belt (photo 51).

Rocks of Glacier National Park are quartzites, sandstones and slates of Lower Cambrian age and Precambrian age and have a total exposed thickness of more than eight miles. They are folded into a series of northerly trending anticlines and synclines roughly paralleling the course of Beaver River. In fact, Beaver River runs along the faulted crest of one of these anticlines in the Precambrian rocks. Between the river and the eastern boundary of the park are several minor folds, and to the west of the river there

51. *View from the west slope of Bald Mountain on Purcell Range looking southwest across Beaver River Valley (Purcell Trench) to Mt. Topham (9,488 ft.), Selkirk Mountains, and showing landforms developed by alpine glacial sculpturing and valley-glacier erosion on Precambrian and early Palaeozoic strata. At the right is Deville Névé and Deville Glacier with its several cascades, and farther south are to be seen cliff and valley glaciers ornamenting the western slope of the Purcell Mountains (see pages 5, 32).*

52. *Mt. Macdonald (9,492 ft.) consisting of Lower Cambrian Sir Donald quartzite. This mountain is penetrated by the 5-mile double-track Connaught Tunnel that passes directly beneath the peak at an elevation of 3,860 ft. (see pages 32, 34).*

53. *View from near summit of Mt. Tupper (9,239 ft.) looking east across Beaver River Valley (Purcell Trench) to Purcell Range and Rocky Mountains showing cliffs of vertically-jointed Lower Cambrian quartzites (Sir Donald formation) on its north side (see pages 32, 34).*

54. Looking south along Asulkan Brook Trail to Asulkan Pass (7,720 ft.) and Asulkan Glacier (see pages 3, 39).

is a broad syncline, the axis of which crosses the valley a little east of Glacier station. The centre of this trough for a width of three and a half miles is underlain by Sir Donald quartzites of Lower Cambrian age. On its eastern limit is a minor synclinal fold in Lower Cambrian quartzites on which are located Mt. Sir Donald, Mt. MacDonald and Mt. Tupper (photos 52, 53, 55).

A feature of scenic wonder in Glacier National Park is the large caves that have been formed by solution and mechanical erosion of Cougar Creek in a 350- to 600-foot-thick crystalline limestone formation known as the Nakimu formation. These caves, designated the "Caves of Cheops", occur at three different levels and comprise nearly 10,000 feet of mapped subterranean galleries.

55. View from Illecillewaet Glacier on the north slope of Lookout Mountain, looking northeast and showing a variety of landforms sculptured by alpine glaciation along Sir Donald Range, including the sharp pyramid-shaped peaks or "horns" of Mt. Sir Donald (10,818 ft.) on the right; Uto Peak (9,620 ft.) in centre, and Eagle Peak (9,363 ft.) on left, with their intervening passes or cols, and knife-edge ridges or arêtes (see page 32).

56. View from Mount Revelstoke motor road looking southwest across Revelstoke townsite and Columbia River valley to Monashee Mountains of the Columbia Range; Mt. Begbie (8,956 ft.) on left, and Mt. McPherson on right (see page 35).

57. Looking northwest from Heather Lodge (6,350 ft.) to Clachnacudainn Range and Snowfield capping the summit in Mount Revelstoke Park, lying above 7,000 feet elevation (see page 35).

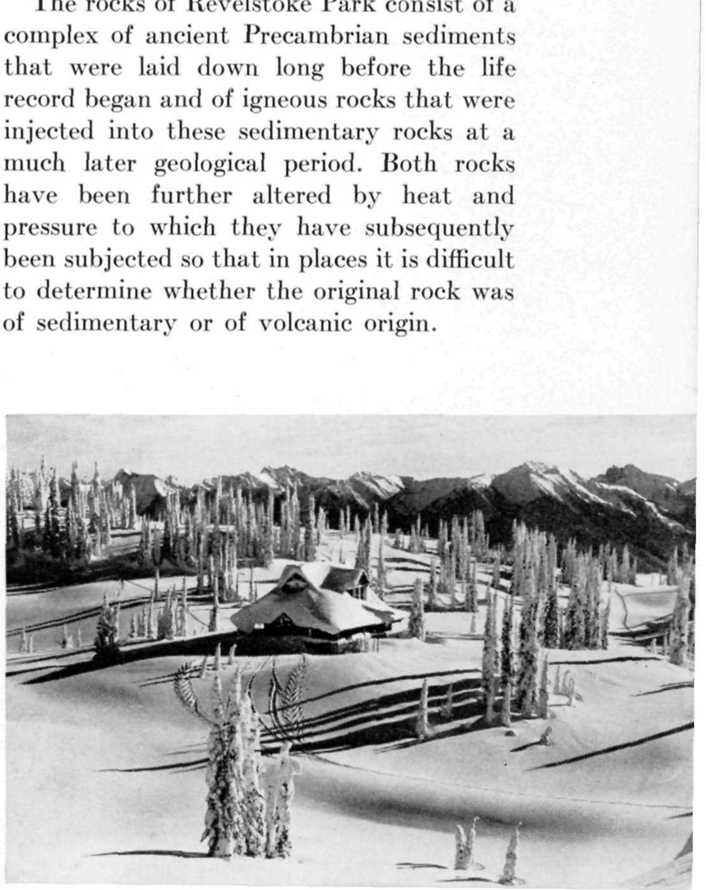
MOUNT REVELSTOKE NATIONAL PARK,

BRITISH COLUMBIA

Mount Revelstoke National Park, which forms the last link westward in Canada's chain of national parks in the Rockies and Selkirks, covers an area of 100 square miles in the northeast angle between the Illecillewaet and Columbia River Valleys. The town of Revelstoke is built on the alluvial flat bordering the park at an elevation of 1,500 feet, and from the valley bottom the mountains rise rapidly to rear their snow-capped heads high into the clouds, some reaching elevations of over 8,000 feet. On the summit of Mount Revelstoke is the large Clachnacudainn Snowfield which is bordered by cirques, some of which contain beautiful rock-basin lakes, such as Millar Lake, Jade Lake, and Eva Lake (photo 57). From the townsite, an eighteen-mile scenic motor road ascends the mountain slope to an elevation of over 6,000 feet by a series of switchbacks, passing through a virgin forest of cedar, balsam, and spruce, and ending in a beautiful alpine park near Balsam Lake camping grounds (photo 58).

The view from the uplands is awe-inspiring. North and south, as far as the eye can see, extends the broad, flat-bottomed Selkirk Trench occupied by Columbia River and Upper Arrow and Lower Arrow Lakes; on the west rise the snow-capped peaks of Monashee Mountains with Mount Begbie ten miles to the southwest rising to an elevation of 8,956 feet (photo 56). The park is bounded on the south by the long, deeply entrenched gorge of Illecillewaet River, and on its southern side rise the snow-capped peaks of the Selkirk Range, the nearest of which, Mount Albert, has an elevation of 10,008 feet.

The rocks of Revelstoke Park consist of a complex of ancient Precambrian sediments that were laid down long before the life record began and of igneous rocks that were injected into these sedimentary rocks at a much later geological period. Both rocks have been further altered by heat and pressure to which they have subsequently been subjected so that in places it is difficult to determine whether the original rock was of sedimentary or of volcanic origin.



58. Winter at Heather Lodge, a popular summer resort located on Mount Revelstoke at 6,350 elevation (see page 35).

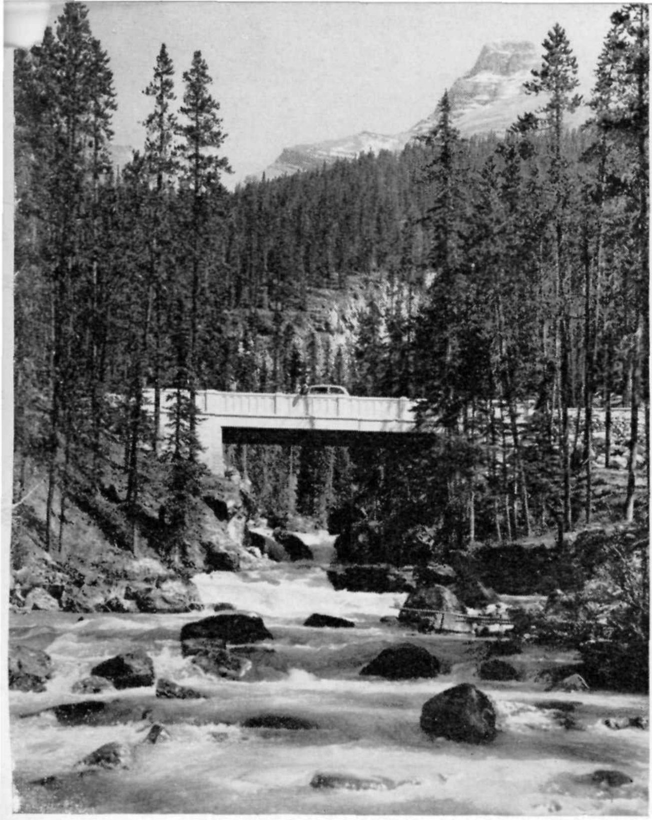
EPILOGUE

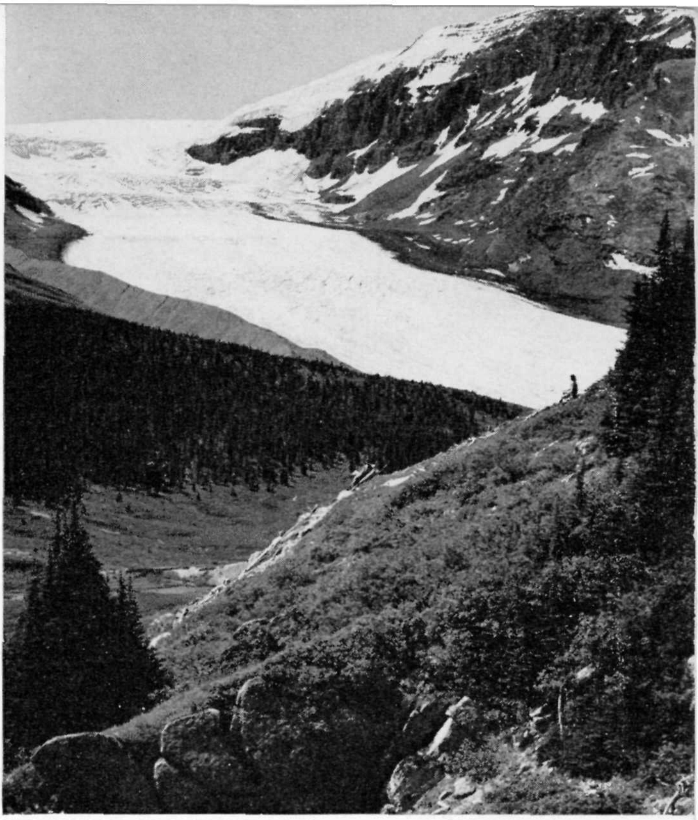
Canadians and foreign visitors are demonstrating their appreciation of the splendid mountain scenery and the unsurpassed recreational advantages for relaxation, sport, and nature study offered by Canada's national mountain parks, coming as they do annually in their hundreds of thousands to enjoy a delightful holiday in these glorious alpine regions and to gain new health and vigour. It is not accidental, moreover, that much of the early mountain climbing in the Canadian Rockies and Selkirks was done by British and Continental Europeans who received their training as mountaineers in the Alps. It is significant, also, that the membership of the Alpine Club of Canada includes, in addition to Europeans, many residents of the Eastern United States who prefer climbing in the Canadian Rockies and Selkirks, notwithstanding the fact that the Rocky Mountains in the United States rise to higher elevations. The reason for this is that the Canadian mountains offer not only the lure and adventure which a vast unexplored wilderness with numerous unscaled summits affords, but through a combination of forest-covered mountain slopes, lake scenery, canyons, waterfalls, extensive icefields, glistening glaciers and snow-clad peaks, possess a charm the like of which can be experienced neither in Switzerland nor in the United States. Moreover, they offer opportunities for climbing with a wide range in difficulty and diversity rarely obtainable elsewhere.

A most important factor in increasing the popularity and use of these national playgrounds by the general public has been the construction of numerous trails and the linking up of the parks by motor highways as shown on the accompanying map. The latest of these highways to be completed is the 186-mile motor highway joining the administrative centres Banff and Jasper. Traversing as it does the very heart of the Rocky Mountains and skirting the great Columbia Icefield that caps the "Roof of the Continent", it offers an added inducement to view, under enjoyable conditions, the scenic splendour of Canada's alpine wonderland (photos 2, 5, 59, 60, 61, 62).

In the foregoing pages are to be found brief descriptions of the geological formations and illustrations of representatives of the great variety of landforms developed by mountain uplift, faulting and folding and fashioned by subsequent weathering and stream and glacial agencies. The alpine grandeur of the Rocky and Selkirk Mountains with their lower slopes covered with forests of spruce, balsam and Douglas fir, and their towering peaks ornamented with extensive snowfields, cascading glaciers and associated cirques, rock-basin lakes, waterfalls and canyons make this vast wonderland the alpine paradise of the Western Hemisphere. As has been enthusiactically said, "a month spent amid these surroundings is worth a thousand doctors and psychoanalysts".

59. View looking northward from the glacial-moraine-dammed lake at headwaters of the North Saskatchewan River towards Mt. Athabasca (11,452 ft.) showing crevasses and stratification on the nose of Saskatchewan Glacier that issues from the Columbia Icefield. Banff National Park (see pages 13, 17).

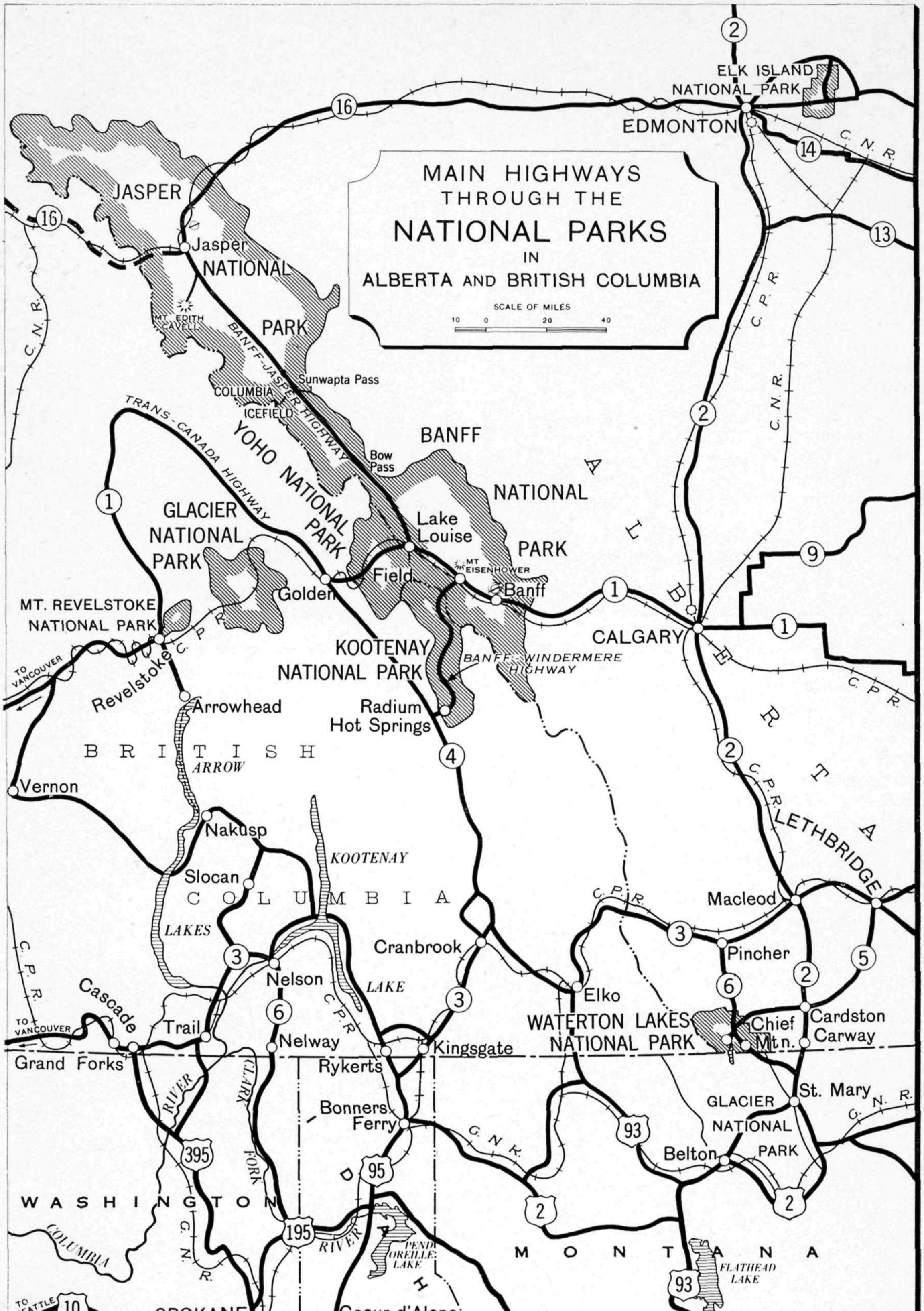




60. View from near Nigel Creek bridge in Banff National Park, near Sunwapta Pass (6,675 ft.) looking northwest to Nigel Peak (10,533 ft.) that forms the boundary between Banff and Jasper National Parks (see page 33).

61. Steps and crevasses on Athabasca Glacier that cascades from Columbia Icefield between Mt. Athabasca (11,452 ft.) on east, and Snow Dome (11,340 ft.) on west. Jasper National Park (see pages 17, 22, 36).

62. View from Columbia Icefield chalet, Jasper National Park, near Sunwapta Pass (6,675 ft.) looking south across tongue of Athabasca Glacier with Mt. Athabasca (11,452 ft.) at extreme left, showing recessional moraines left by the retreat of valley glaciers, and cliff glaciers (see pages 17, 22, 36).



MAIN HIGHWAYS THROUGH THE NATIONAL PARKS IN ALBERTA AND BRITISH COLUMBIA

SCALE OF MILES
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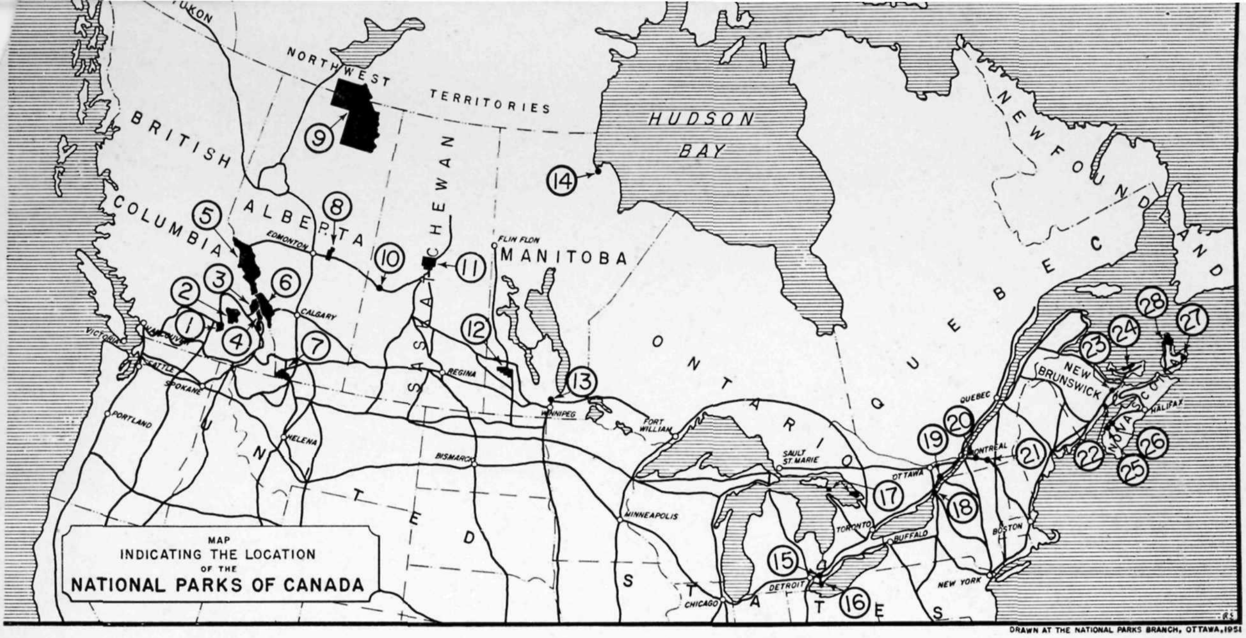
PREPARED AT THE SURVEYS AND MAPPING BRANCH 1950



DRAWN AT THE NATIONAL PARKS BRANCH, OTTAWA, 1951

THE NATIONAL PARKS OF CANADA

1. MOUNT REVELSTOKE, British Columbia. Rolling mountain-top plateau on west slope of Selkirk Mountains. Colorful alpine meadows. Accessible by rail and highway. Summer accommodation in park. All-year accommodation in nearby town of Revelstoke. Equipped camp-grounds. Championship ski runs and ski jump. Established 1914; area, 100 square miles.

2. GLACIER, British Columbia. Superb alpine region in Selkirk Mountains. Towering peaks, glaciers and forests. Accessible by railway only. Climbing, skiing, camping. Established 1886; area, 521 square miles.

3. YOHO, British Columbia. On west slope of Rockies. Lofty peaks, magnificent waterfalls, colorful lakes. Yoho and Kicking Horse valleys. Accessible by rail and highway. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1886; area, 507 square miles.

4. KOOTENAY, British Columbia. Encloses Vermilion-Sinclair section of the Banff-Windermere Highway in Rockies. Broad valleys, deep canyons, hot mineral springs. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1920; area, 543 square miles.

5. JASPER, Alberta. Mountain playground and noted wildlife sanctuary. Contains majestic peaks, ice-fields, beautiful lakes and famous resort, Jasper. Hot mineral springs, summer and winter sports. Accessible by rail, highway and air. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1907; area, 4,200 square miles.

6. BANFF, Alberta. Magnificent scenic playground in central Rockies. Contains noted resorts, Banff and Lake Louise. Hot mineral springs; summer and winter sports. Accessible by rail, highway and air. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1885; area, 2,564 square miles.

7. WATERTON LAKES, Alberts. Canadian section, Waterton-Glacier International Peace Park. Mountain playground with colorful peaks and charming lakes. Accessible by highway. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1895; area, 204 square miles.

8. ELK ISLAND, Alberta. Fenced preserve near Edmonton containing a large herd of buffalo; also deer, elk and moose. Popular recreational area; bungalow cabin accommodation and equipped camp-grounds. Accessible by highway. Established 1913; area, 75 square miles.

9. WOOD BUFFALO, Northwest Territories and Alberta. Immense region of forests and open plains between Athabasca and Great Slave Lakes. Home of the largest remaining herd of bison on the continent. Other wildlife species abundant. Established 1922; area, 17,300 square miles.

10. FORT BATTLEFORD, Saskatchewan. North West Mounted Police Post built in 1876 in the territory of the Cree Indians. Original buildings house interesting museum collection and are surrounded by a log stockade. Established 1951; area 36.7 acres.

11. PRINCE ALBERT, Saskatchewan. Forested region dotted with lakes and interlaced with streams. Summer playground and recreational area. Accessible by highway. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1927; area, 1,496 square miles.

12. RIDING MOUNTAIN, Manitoba. Playground and wildlife sanctuary on summit of Manitoba escarpment. Fine lakes; summer playgrounds and recreational area. Accessible by highway. Hotel and bungalow cabin accommodation. Equipped camp-grounds. Established 1929; area, 1,148 square miles.

13. LOWER FORT GARRY, Manitoba. Stone fort built by the Hudson's Bay Company between 1831-39. Located on west bank of Red River about 20 miles north of Winnipeg. Established 1951; area, 12¾ acres.

14. FORT PRINCE OF WALES, Manitoba. National Historic Park at Churchill on the shores of Hudson Bay. Ruins of fort built 1733-71. Established 1941; area, 50 acres.

15. FORT MALDEN, Ontario. National Historic Park with museums at Amherstburg. Site of defence post built in 1779-99. Established 1941; area, 5 acres.

16. POINT PELEE, Ontario. Recreational area on Lake Erie. Remarkable beaches, southern flora. Resting place for migratory birds. Accessible by highway. Hotel and bungalow cabin accommodation in park area and vicinity. Equipped camp-grounds. Established 1918; area, 6.04 square miles.

17. GEORGIAN BAY ISLANDS, Ontario. Recreational and camping areas. Unique pillars on Flowerpot Island. Accessible by boat from nearby mainland points. Equipped camp-grounds and annual youth camps on Beausoleil Island. Established 1920; area, 5.40 square miles.

18. ST. LAWRENCE ISLANDS, Ontario. Mainland area and 13 islands among the "Thousand Islands". Recreational and camping area. Mainland accessible by highway; islands reached by boat from nearby mainland points. Established 1914; area, 189.4 acres.

19. FORT WELLINGTON, Ontario. National Historic Park with museum at Prescott. Defence post built 1812-13. Established 1941; area, 8.5 acres.

20. FORT CHAMBLY, Quebec. National Historic Park with museum at Chambly. First built by the French, 1665. Established 1941; area, 2.5 acres.

21. FORT LENNOX, Quebec. National Historic Park on Ile-aux-Noix in Richelieu River, near St. Johns. Built by French in 1759. Established 1941; area, 210 acres.

22. FUNDY, New Brunswick. Delightful recreational area on the Bay of Fundy between the cities of Saint John and Moncton. Forested region, wildlife sanctuary, rugged terrain. Bungalow cabin accommodation and equipped camp-grounds. Established 1950; area, 79.5 square miles.

23. FORT BEAUSEJOUR, New Brunswick. National Historic Park with museum near Sackville. Site of early French fort. Established 1926; area, 81 acres.

24. PRINCE EDWARD ISLAND. *Coastal strip 25 miles long on* shores of the Gulf of St. Lawrence. Recreational area; fine bathing beaches. Accessible by highway. Hotel and bungalow cabin accommodation within and adjacent to park. Equipped camp-grounds. Established in 1937; area, 7 square miles.

25. PORT ROYAL, Nova Scotia. National Historic Park at Lower Granville. Restoration of "Habitation" or first fort built in 1605 by Champlain, DeMonts and Poutrincourt. Established 1941; area, 17 acres.

26. FORT ANNE, Nova Scotia. National Historic Park with museum at Annapolis Royal. Well preserved earthworks. Established 1917; area, 31 acres.

27. FORTRESS OF LOUISBOURG, Nova Scotia. National Historic Park with museum near Louisbourg. Ruins of walled city erected by the French 1720-40. Interesting excavations. Established 1941; area, 340 acres.

28. CAPE BRETON HIGHLANDS, Nova Scotia. Rugged Atlantic coast-line with mountain background. Fine seascapes from park highway. Recreational opportunities. Hotel and bungalow cabin accommodation, within park area. Hotel and boarding-house accommodation adjacent to park. Equipped camp-grounds. Established 1936; area, 390 square miles.

For additional information on the National Parks of Canada, write to:

Canadian Government Travel Bureau
DEPARTMENT OF RESOURCES AND DEVELOPMENT
Ottawa, Canada