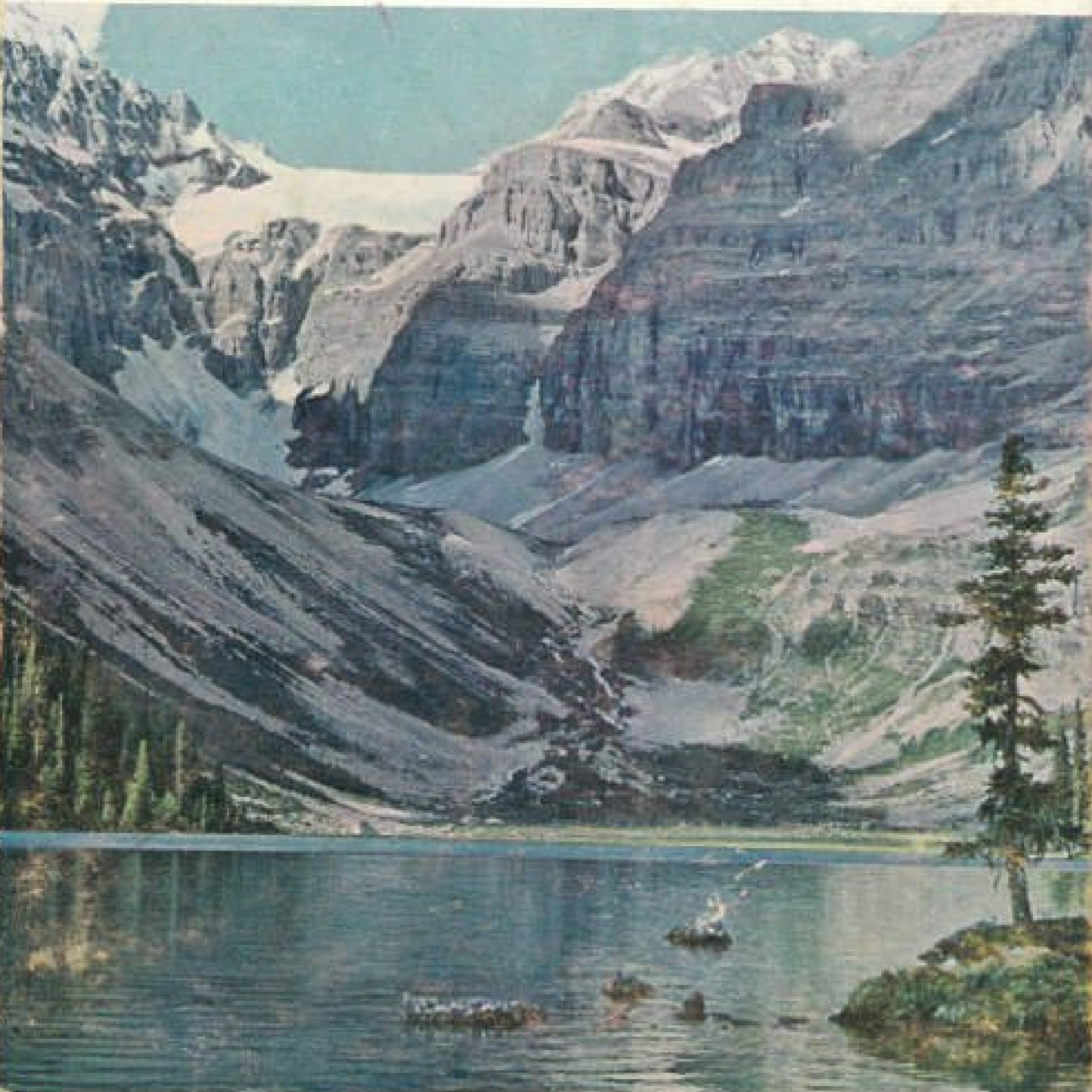
KOOTENAY NATIONAL PARK

wild mountains and great valleys



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David M. Baird

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All photographs are by the author. Pen sketches of mountains are by D. L. Dineley, University of Ottawa.

Map and other illustrations are by the Cartography Unit, Geological Survey of Canada.

How to Use this Book

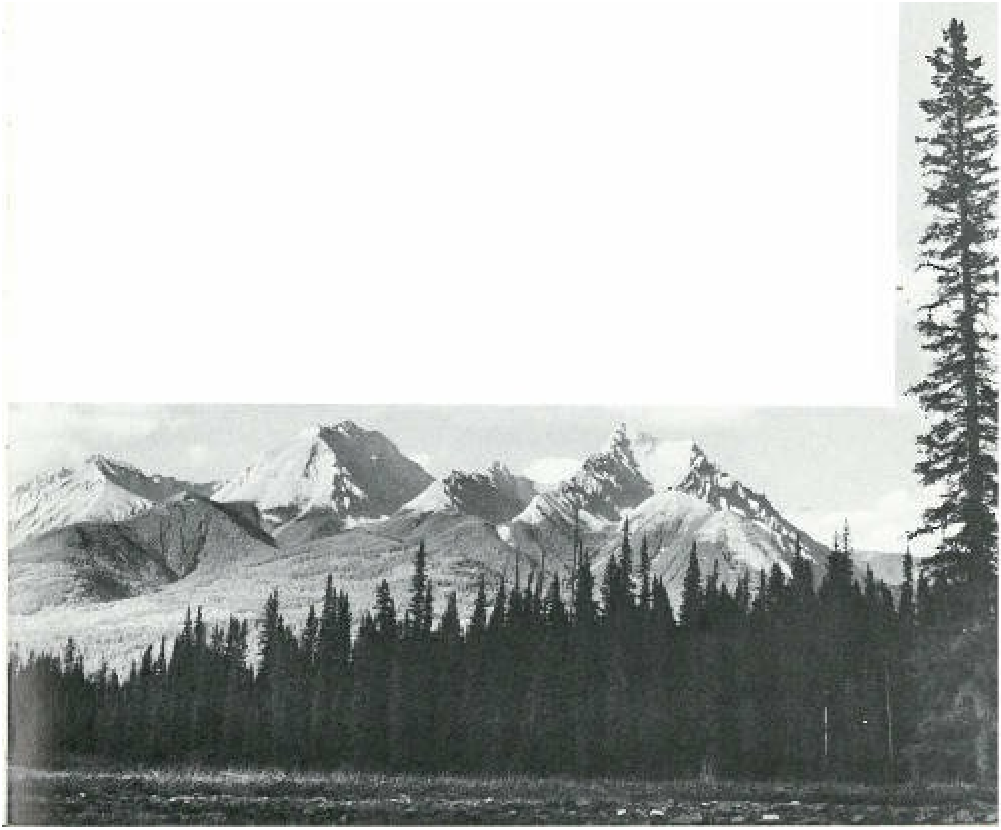
Read it from the beginning. If you haven't the time immediately, look at the illustrations and turn to the map at the back to find the numbers of the stops along the route you are travelling. Then turn to the roadlog (starting on page 45) and follow each stop carefully, for you will find that the beauty of the scene is increased for the traveller who knows something of what he is looking at and how it originated.

The first part of this guidebook describes in some detail the general aspects of the geology of Kootenay National Park . . . where it is, how the mountains there originated, what the rocks of the region are and where they came from, and the different shapes of individual mountains. Following this general background is a series of notes on what is to be seen at each of the lookouts and roadside stops along the main travel routes, with an index map to show where they are.

Most of the words used in a technical sense or which have an unusual meaning are explained carefully where they are first used. But if you don't immediately find the meaning of a word look in the index, for many of the unusual ones are listed there along with all localities and subjects.

Cover—

The still waters of Kaufman Lake reflect lofty mountains and glaciers on the continental divide on the northeast side of Tokumm Creek, about 7 miles northwest of Marble Canyon. The brooding cliffs are cut into limestones and other sedimentary rocks laid down in seas that covered this area in the Cambrian period, more than 500 million years ago.



Mount Selkirk, the second peak from the left, forms part of the jagged Mitchell Range. The lowland behind the tall tree at the right is the valley of Daer Creek. This view is from the valley bottom of Kootenay River, about 3 miles north of McLeod Meadow.

INTRODUCTION

Kootenay National Park is an area of superb mountain scenery with rows of mountains alternating with open valleys. Lengthwise it stretches for more than 60 miles parallel to the northwest-southeast trend of the Rocky Mountains, and along its width it crosses the mountains and valleys in a series of jogs, from the divide leading to the Bow River valley on the northeast to Columbia River on the southwest. The mountain ranges along its northeastern boundary are cut into a great thickness of nearly flat-lying rocks so that peaks there look like layer cakes or ancient castles. All the rest of its mountains are cut into rock masses that have been folded and faulted severely to produce peaks of a wide variety of shapes and rock structures.

Mountains along the eastern and central ridges are high enough to support numerous snowfields and glaciers. In summer these feed swift-flowing mountain streams that rush down steep valleys to join the principal rivers flowing in more leisurely fashion along the main valleys. A main highway with five 2
principal parts runs more or less the length of Kootenay National Park; its northeastern and southwestern ends cross the grain of the country via steep-sided valleys made by tributary streams of the major rivers. Two long stretches of the highway lie in the Kootenay River valley and the Vermilion River valley, which parallel the northwest-southeast grain of the country. The central part of the road crosses from Kootenay valley to Vermilion valley in a steep-walled narrow valley that cuts directly across the main trend of the country. Thus the scenery along the road is a succession of transcurrent, steep-walled, narrow valleys, and large open valleys, with major rivers that follow the main wind-rows of the Rocky Mountain System.

In the rocks themselves is written a history of ancient seas spreading over the land, and of thousands of feet of sand, silt, and gravel being deposited in the shallow marine waters that covered an area now occupied by snow-capped mountains. In the ancient seas, marine creatures lived and died; and their remains, in the form of imprints, or their shells and hard parts, are found as fossils in the rocks today.

Thus, for the visitor who has time to look around carefully, Kootenay National Park has a great array of wonderful scenery and many features of geological interest in the rocks into which the scenery is carved. The person interested only in the beauty of the scene will find it even more moving when he reflects on the intricately woven patterns of events that have, through the millions of years, produced the rocks and the mountains, the rivers and the glaciers.

It is the purpose of this book to tell you something of all these things—the beauty, the formation of the scenery, and the history written in the rocks. But first let's examine the boundaries of the park to see exactly where it is, and, because many of the boundaries are 'divides', we should find out what divides really are.

DIVIDES

Any stream, even the largest river, gradually gets smaller above the tributaries that pour water into it from the sides. Thus, even the largest rivers rise in a multitude of very small streams which make up the bulk of the main river by uniting their waters. If we travel farther and farther up a small stream we will eventually come to where it begins as a tiny trickle of water. Such a place is usually near the top of a hill, for as rain falls on the hill it will naturally flow down the slopes on all sides. Thus the crest of a ridge forms a natural divide between waters that flow down one side and waters that flow down the other. This is why, on the ground or on a map, a line drawn to separate two drainage systems is called ‘a divide’.

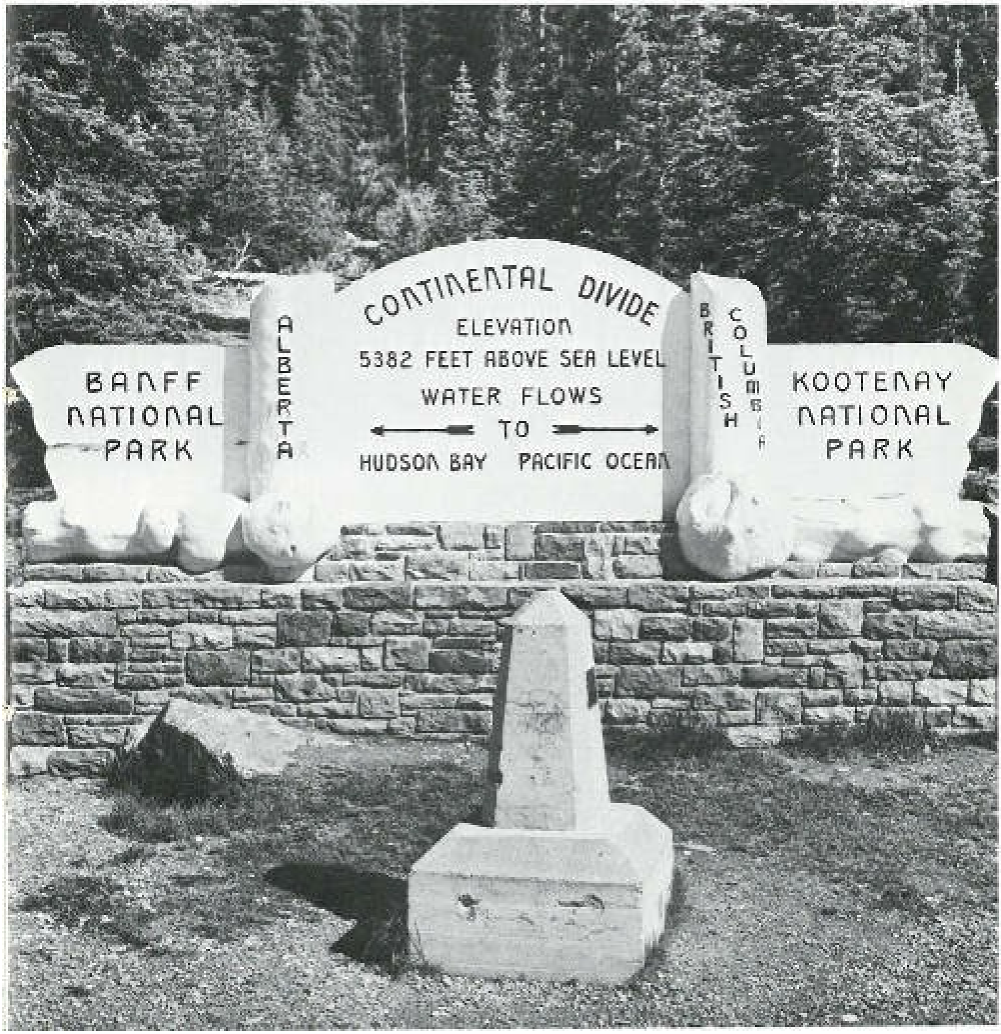
A look at a map of the whole of North America will quickly show us that some very large rivers flow into each of the oceans bordering this continent. If we were to follow these rivers to their very headwaters we should find a line separating the drainage to the Pacific Ocean from the drainage to the Atlantic Ocean, and other lines which divide Atlantic drainage from Arctic drainage and Arctic drainage from Pacific drainage. Thus we apply the term ‘continental divide’ to the imaginary line 4
that separates the drainage of a continent.

Ever since man first began to separate territories it has been convenient to divide them on the basis of drainage basins of rivers. Boundaries of countries, provinces, or even counties have commonly been defined as the divide between the water flowing to one side and water flowing to another. One such boundary is between the Province of Alberta and the Province of British Columbia. This divide, which runs right up the spine of the Rocky Mountains, separates waters that eventually end up in the rivers to the Pacific Ocean from those that will flow finally into the Atlantic Ocean. It is this same continental divide that forms the northeastern boundary of Kootenay National Park for nearly 40 miles.

In North America, where drainage is split among three oceans, there is one place—in the icefield where Banff National Park and Jasper National Park come together—from which the drainage flows in three directions. Here, a single drop of rain or a single crystal of snow may split into parts that end up in the Arctic, Atlantic, and Pacific Oceans after flowing for thousands of miles in completely different river systems.

BOUNDARIES OF THE PARK

Kootenay National Park lies wholly within the Province of British Columbia. It consists of four different segments: the northern end comprises the drainage basin at the head of Vermilion River; the middle section is a belt at right angles to the first, and it follows Vermilion River across the general trend of Vermilion Range and its extension in Mitchell Range to the southwest; the main southern part of the park is a strip along the Kootenay River valley; and a fourth part includes a jog to the westward, which takes in the valley of Sinclair Creek nearly to its junction with Columbia River. Kootenay Park with its irregular shape thus straddles several different mountain ranges.



This sign clearly marks the continental divide which is also the boundary between British Columbia and Alberta, and the boundary between Kootenay National Park to the west and Banff National Park to the east. The concrete marker in the foreground has a brass plate mounted on its top which shows exactly where the dividing line is. From this spot the boundary is visible as cleared lines leading up the mountains on both sides of the valley.

The northeastern boundary is the continental divide that separates British Columbia from Alberta and Kootenay

Park from Banff Park. The boundary leaves the continental divide near Simpson Pass and follows an irregular line through the Monarch, Mount Shanks, across Simpson River to an unnamed peak in a generally southerly direction, and then swings southwesterly to Split Peak. From here it runs nearly south along a series of divides, except where it crosses Daer Creek, to near the junction of Cross and Kootenay Rivers. A series of surveyed lines carries the boundary generally westward to a point about 4 miles southeast of Radium. From here northward to a point about 4 miles beyond Radium, the boundary consists of numerous right-angle bends and jogs which reflect the availability of land around rectangular privately owned areas. The boundary continues along a series of divides, first to the northeast then to the northwest to an unnamed peak about halfway between Kootenay Crossing in the park and the village of Spillimacheen. It then follows a number of surveyed lines to the peak of Mount Vérendrye. From here it extends along the divide or watershed between the upper Kootenay River to the southwest and the upper Vermilion River and its tributaries to the northeast for about 25 miles to a point near the peak of Mount Sharp. A curving, surveyed line then forms 7
the boundary between Kootenay National Park and Yoho National Park to the northwest. In all, the area of the park is 543 square miles.

ORIGIN OF THE MOUNTAINS

The surface of the earth has mountains of many different kinds: some stand as isolated masses whereas others occur in groups clearly related to one another; some tower thousands of feet above their surroundings whereas others (called 'mountains' by the people who live there) may be only a few hundred feet high. The wide variety of mountains points to a wide variety of origins.

In some parts of the world great masses of liquid lava and ash pour up from the depths of the earth to accumulate around volcanic vents. These are volcanic mountains. In other places, rivers and streams have cut deeply into high plateau areas over long periods of time to leave rough, mountainous terrain. In still other parts of the world, huge wrinklings in the earth's crust are made by tremendous compressive forces, in the same way that you can wrinkle the carpet on a floor by pushing against it with your foot. These make folded mountains. Another type of mountain results in places where the earth seems to have split along enormous faults or breaks and one of the sides may be uplifted several thousands of feet. These are fault-block mountains.

When, however, we come to the great ranges of mountains—groups of clearly related mountains that extend for hundreds or even thousands of miles over the surface of the earth—we find a much more complicated story. One of the most interesting parts of this story is that the major mountain systems all over the world seem to have the same kind of history, with at least several chapters in common. We call this type 'geosynclinal mountains' and it will help to know something about how they originate, for the mountains in the western Canadian National Parks are of this kind.

To begin the story of these mountains we must go back into geological time about 750 million years. North America then was very different from the land we know today. Where we now find the Rocky Mountain System from the Arctic Ocean to Mexico, there existed a great flat area which was very close to sea-level. Great forces in the interior of the earth caused the whole area to sink very slowly below sea-level. The rate of this depression was probably only a few inches in a thousand years but it continued over a long period. It meant that the sea eventually flooded the land over hundreds of thousands of square miles from the Arctic Ocean to the Gulf of Mexico. Into this vast shallow inland sea the rivers from the surrounding regions poured their loads of silt and mud, which spread evenly over the bottom. Waves along the shores of these ancient seas eroded the land, added more sediments, and made currents to distribute them over the bottom, far from land.

As the millions of years passed, the accumulation of sedimentary materials—the mud, silt and sand from the rivers and shorelines, and limy precipitates from the sea itself—gradually filled the shallow inland sea. At times, vast areas must have become filled up to near sea-level. But one of the strange things about these great depressions in the earth's surface is the way they seem to have continued to sink as the load of sedimentary material in their centres increased. By this gradual sinking and an almost equal rate of filling it was possible for thousands and thousands of feet of sand, silt and mud to accumulate, layer upon layer, and all show features of shallow-water origin.

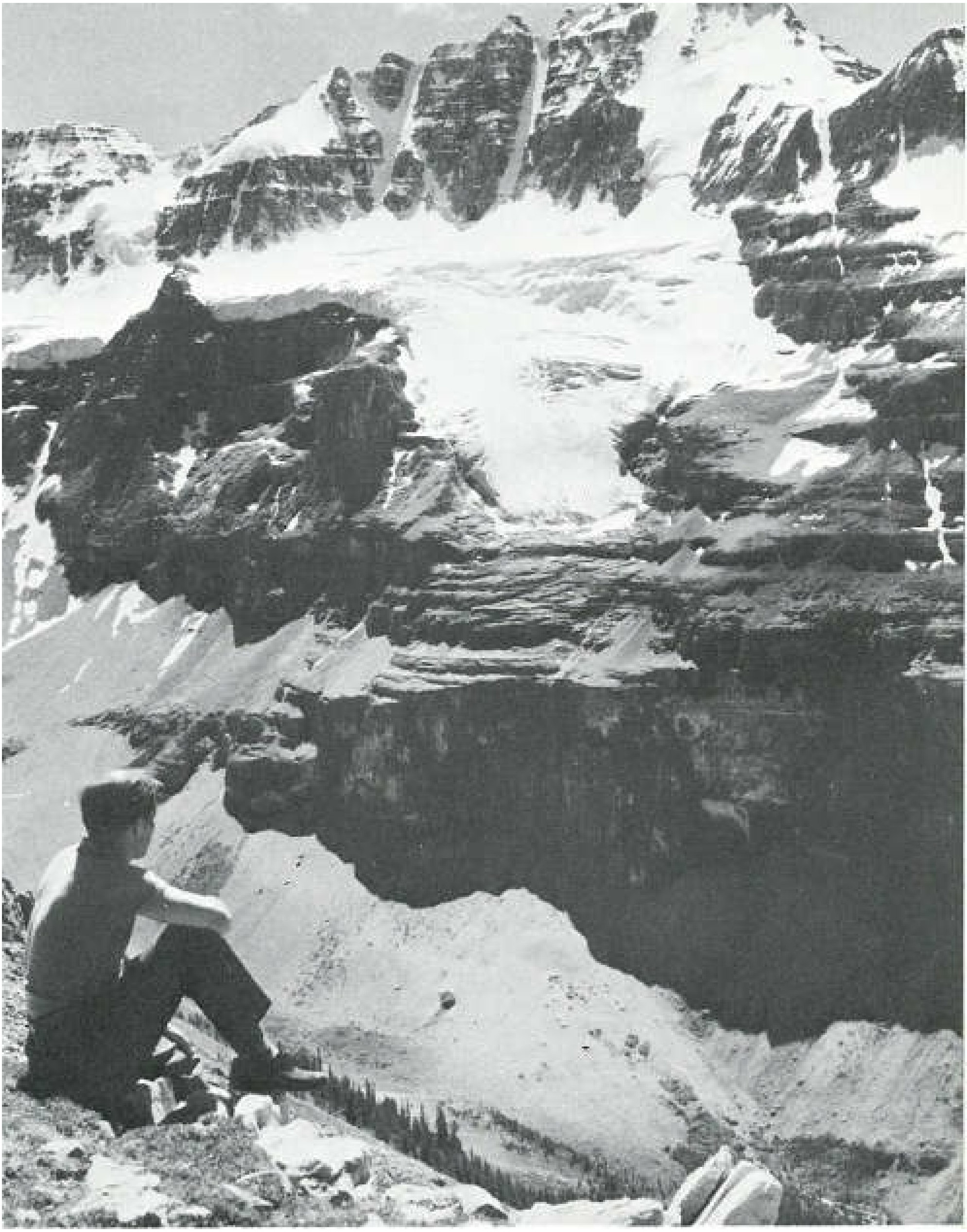
At a time in the earth's history which geologists place at between 600 million and 500 million years ago, living things began to populate some parts of the seas fairly thickly. Some of these creatures had hard skeletons or outer coverings, and when they died these hard parts fell to the bottom and were promptly buried by the accumulating muds and silts. In some places the hard parts of the dead animals made clear impressions on the sedimentary materials on the sea bottom. When the soft sedimentary materials hardened into solid rock (over a period of millions of years), the remains of the long-dead organisms became fossils.

How do we know these things took place where we now find the western mountains? We read it in the rocks where the story is fairly clearly written. The rocks of which the mountains are made are distinctly of sedimentary origin—that is, they are made of ancient gravels, sands, muds and various sediments that have become hardened into solid rock. They are layered or stratified as we would expect accumulating sediments to be, because from time to time there were changes in the composition of the material being laid down. These changes may have been due to storms, changes in wave patterns, changes in drainage systems, or the changes that would take place as the land supplying the sediment was gradually being eroded 10
away. On some of the rock surfaces we find ripple marks which are exactly like those found today in stream bottoms or in the shallow parts of the sea. By splitting open the rocks we can find the fossilized remains of ancient sea creatures, some of them with modern counterparts. Other fossilized skeletons are from creatures that have been extinct for millions of years; yet we can tell a great deal about them by comparing their structures with those of living creatures and noting carefully their

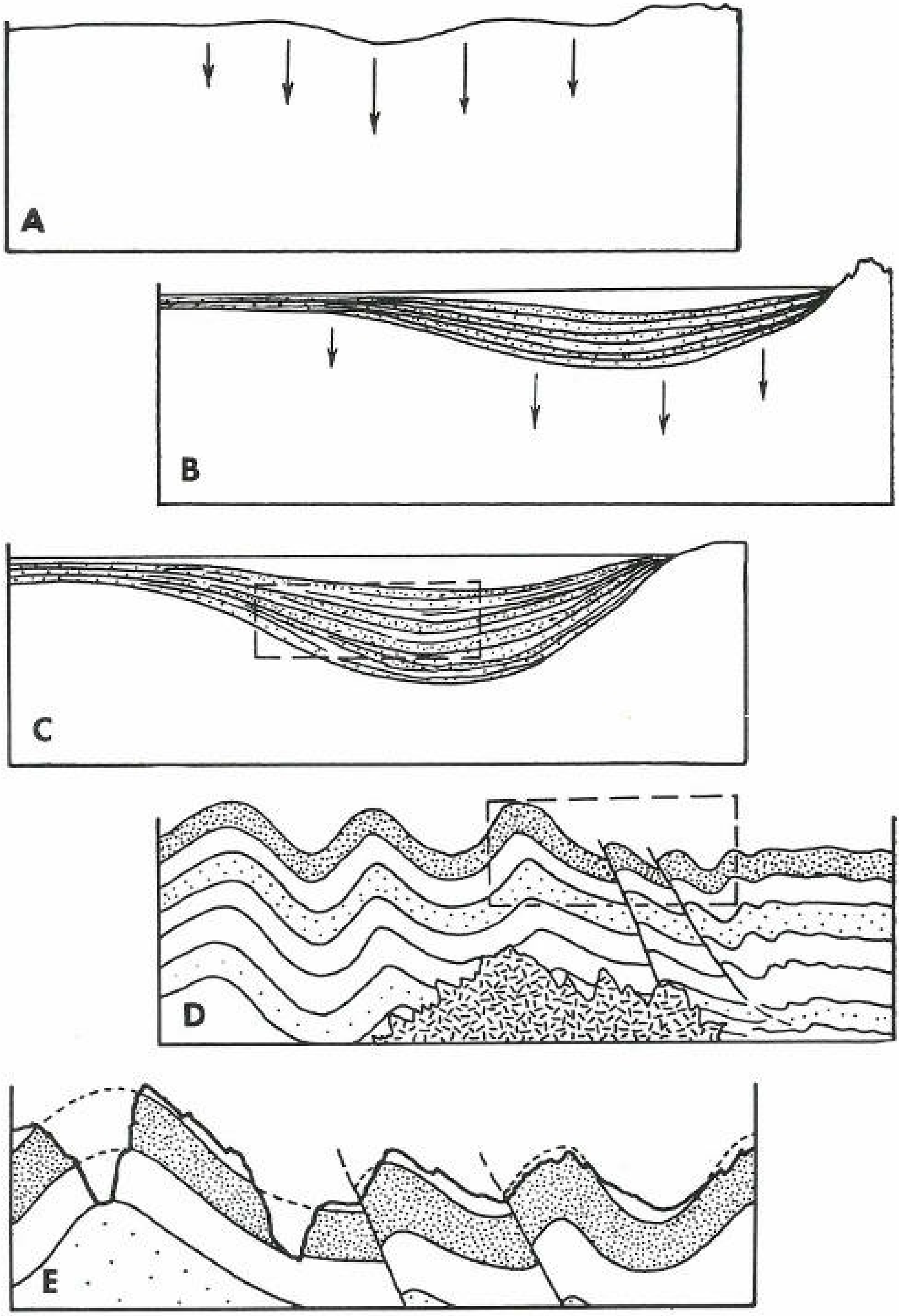
association with creatures we know something about.

The kinds of materials the rocks are made of and all the structures found in them can be observed today in different parts of the world in the actual process of formation. We can estimate the extent of the ancient seas by looking for the rocks that were deposited in them. We can tell something of the existence of former shorelines by looking for evidence of beach deposits in the rocks. We can tell whether rocks were laid down as sediments in deep water or in shallow water by comparing what we find in the rocks with what we see being deposited in those environments now.

As to the development of the Rocky Mountains we can conclude, by observing evidence of erosion still preserved in the rock record, that the seas withdrew temporarily from the region or that the sediments completely filled the shallow depression on the top of the continent. In short, by putting together and correlating hundreds of small pieces of scattered evidence we can unravel with some certainty the story of the rocks from which the mountains were later carved.



Stanley Peak, clothed in snow and ice on the upper slopes and in 'scree' and rock waste on the lower parts, is a vast thickness of Cambrian limestones and shales. Glaciers, now found only as small remnants in protected places, once occupied the whole valley. They have carved its steep-walled shape from the solid rock where before there existed but a shallow river valley.


A
B
C
D
E

13

Development of geosynclinal mountains:

The spectacular peaks and valleys of the Rocky Mountains as we know them today are made of rocks which record a story that began more than 600 million years ago. At that time part of western North America began to warp downward to form an elongated trough as in A.

Rivers poured sand, silt and gravel into the lowland area. Down-warping continued until the trough was filled with a shallow sea, into which poured a steady flow of sedimentary materials, as in B.

Downsinking continued, but it seems to have been at a rate that corresponded closely to the rate of filling, so that sedimentation was always into shallow marine waters. The mass of sedimentary materials slowly changed to sedimentary rock as the load on top increased until it had a form like that in C.

For reasons we do not yet understand the trough area was then severely compressed so that the rocks in it were folded and broken. At about this time in the history of such mountains great masses of molten materials commonly appear in the cores of the folded and broken rock, eventually solidifying into granite. D is what an enlarged section of C would look like.

Uplift accompanied the folding and faulting, and as soon as the rocks emerged from the sea they were subjected to erosion. Rivers and glaciers carved the valleys and formed the peaks as shown in E, an enlarged part of D. This is the stage of development of our Rocky Mountains now.

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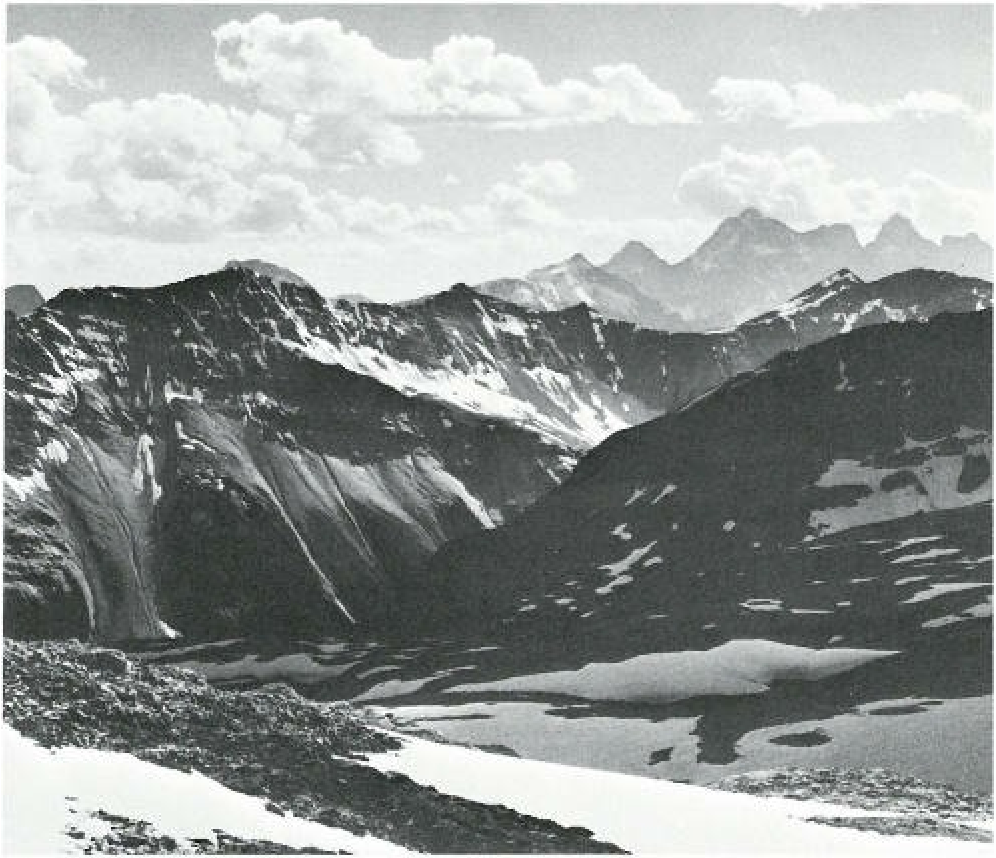
The next chapter in the history of the Rocky Mountains seems to have begun about 200 million years ago. The rock record tells us that a disturbance of the very shallow depression on the surface of western North America, which, as we have observed above, became filled with sedimentary materials, began to change the pattern of development. Some areas of the old trough were lifted up out of the sea and were themselves eroded to supply sediments that were poured back into the remaining sea.

As the tens of millions of years passed the crust of the earth apparently became more and more unstable in the region of what we now call the Rocky Mountains. This unrest culminated about 75 million years ago in a complete change. From the Arctic Ocean to the Gulf of Mexico the great thickness of rocks which had been accumulating as sediments on the old sea-bottom in the previous billion years, was lifted above sea-level, broken in many places along great fractures called ‘faults’, and, in some places, strongly compressed. The compression or squeezing caused the great blanket of rocks to fold and buckle, and, in places, to break so that one part slid up over another part. The forces within the earth that would cause this kind of uplift and breaking are so vast that it is difficult to comprehend them at all. Yet we can go to the mountains and once again clearly see proof of this chapter in the development of the Rocky Mountain System.

In very old mountain systems of the world, where long-continued erosion has cut into the very core of the mountains themselves, we can often observe in some detail a third chapter in the development of geosynclinal mountains. It seems that during or just after the folding and faulting, great masses of hot molten rock appear in the cores of mountain systems. These push rocks aside or melt their way into the interiors of the belts of folded and broken sedimentary rock, where they cool down and eventually solidify. Canada’s Rocky Mountains have not been deeply enough eroded so we know nothing of this part of their history.



The welter of mountain ridges in the northwest corner of Kootenay National Park gives way in the upper right corner to the peaks of the Goodsirs in Yoho National Park.

The next phase in the development of all geosynclinal mountain systems seems to be one of quiet stability, during which the agents of erosion, glaciers, rivers, and wind contrive to cut deeply into the uplifted, complicated mass of broken and folded rocks. For some 70 million years now this has been the history of the Rocky Mountains in Canada.

At the present time, as we drive through the river valleys and among the mountain peaks, we can observe erosion as it proceeds. We can actually watch the glaciers pushing and scraping over the country, tearing off rock and grinding it up, some of it as fine as flour. We can see the rivers cutting into their rocky courses, wearing away the land, and carrying their loads of debris towards the ocean. We can observe great masses of gravel, sand and silt—the result of erosion of mighty mountains through tens of thousands of years—now spread out below the foot of the mountains. Erosion has cut valleys deep into the complicated rock structures to reveal much of the story of folding, faulting and uplift.

THE ROCKS

We have already seen how the rocks in the area now occupied by the Rocky Mountains were almost all laid down as sediments in a succession of seas that covered this area in the distant geological past. Now let's examine these sediments and the rocks that resulted from their consolidation.

If we could find a place in the park where a drill could penetrate the entire rock section—from the very youngest rocks on the top to the very oldest ones deep below—we could study the whole history in one place. But because these rocks have been folded and broken along great splits or faults, this is not possible. We can, however, piece together the broken parts of the record from different areas and thus figure out almost exactly what the whole sequence of rocks looked like before it was broken.

Within the rock sequence, units of various sizes with different names occur. It is the custom of geologists to give names to rock units; they are named after the place where they were first discovered and described, or after the place where they are best exposed. Where there are masses of layered rocks geologists use different names to indicate the different layers and groups of layers. An individual layer may be called a 'bed' or 'stratum'; thus we might refer to a 'limestone bed', a 'limestone layer' or a 'limestone stratum'. A group of such beds, layers, or strata that have some distinctive character in common throughout, is called a 'formation'. An example in Kootenay National Park is the Cathedral Formation—named for its occurrence on Cathedral Mountain in Yoho National Park to the north and consisting of a number of beds or layers which have a generally similar age, composition and appearance. A still larger unit of rock layers is termed a ‘group’. Now, having looked at how geologists name rock units, let’s look at some of the rock types and the units into which they are grouped in Kootenay National Park.

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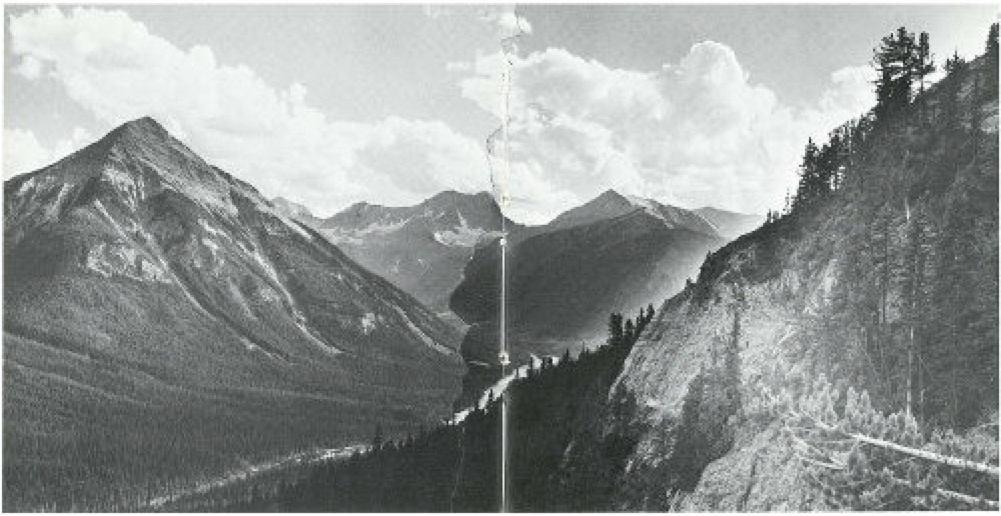
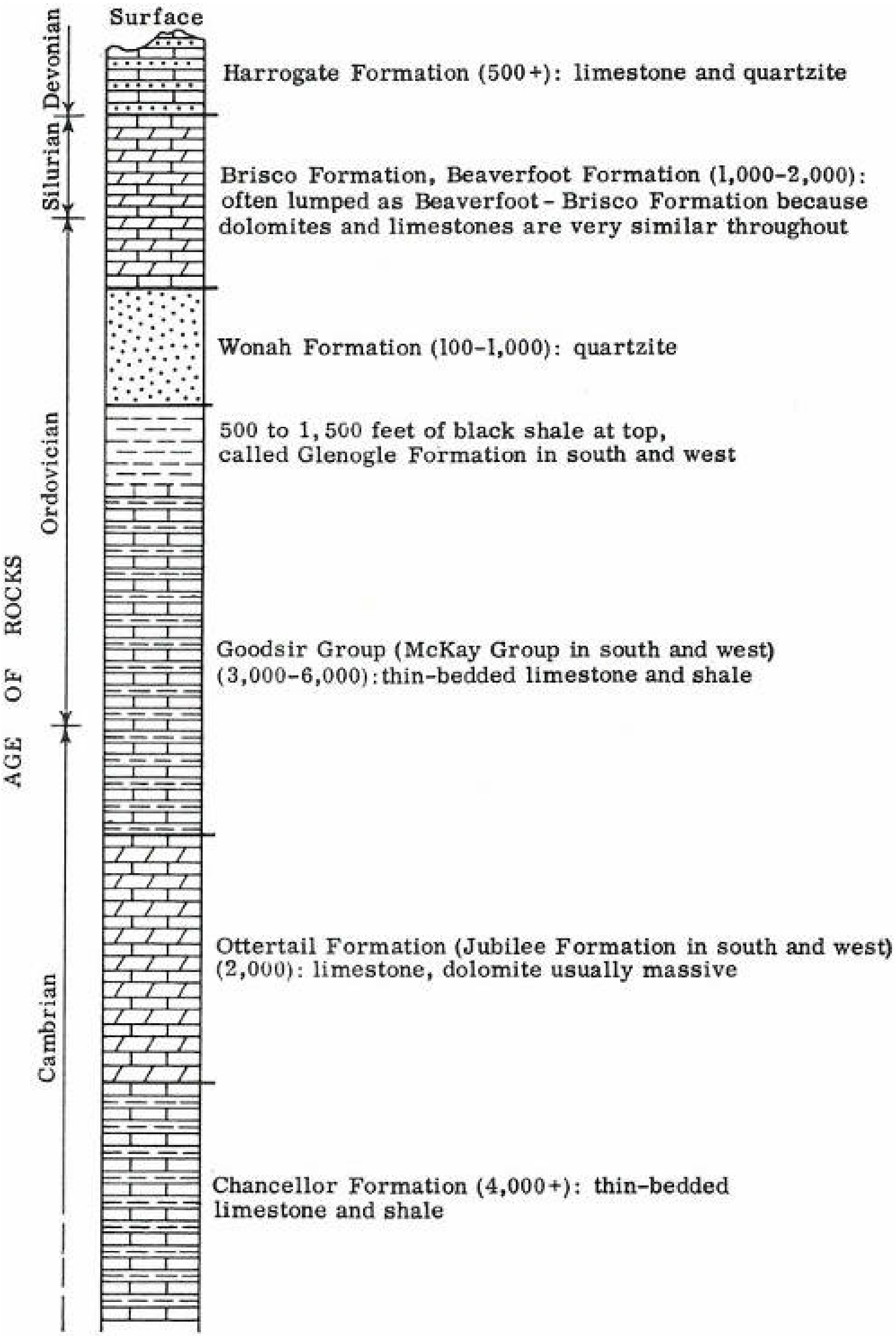


Hi-resolution Image

Mount Vermilion to the left is composed of drag-folded rocks of the Goodsir Group whereas the cliff in the right foreground is flat-lying Cathedral limestone. The valley in the left foreground is followed by the main highway to the Vermilion River valley in the centre distance. Beyond Vermilion Valley the lower and nearer mountains are cut into Chancellor rocks, with the high peaks behind cut into the Ottertail limestone of Ordovician age.

20


AGE OF ROCKS
Devonian
Silurian
Ordovician
Cambrian
Surface
Harrogate Formation (500+): limestone and quartzite
Brisco Formation, Beaverfoot Formation (1,000-2,000): often lumped as Beaverfoot - Brisco Formation because dolomites and limestones are very similar throughout
Wonah Formation (100-1,000): quartzite
500 to 1,500 feet of black shale at top, called Glenogle Formation in south and west
Goodsir Group (McKay Group in south and west) (3,000-6,000): thin-bedded limestone and shale
Ottertail Formation (Jubilee Formation in south and west) (2,000): limestone, dolomite usually massive
Chancellor Formation (4,000+): thin-bedded limestone and shale

AGE OF ROCKS

Cambrian

Chancellor Formation (4,000+): thin-bedded limestone and shale

Ottertail Formation (Jubilee Formation in south and west) (2,000): limestone, dolomite usually massive

Ordovician

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Brisco Formation, Beaverfoot Formation (1,000-2,000): often lumped as Beaverfoot-Brisco Formation because dolomites and limestones are very similar throughout

Devonian

Harrogate Formation (500+): limestone and quartzite

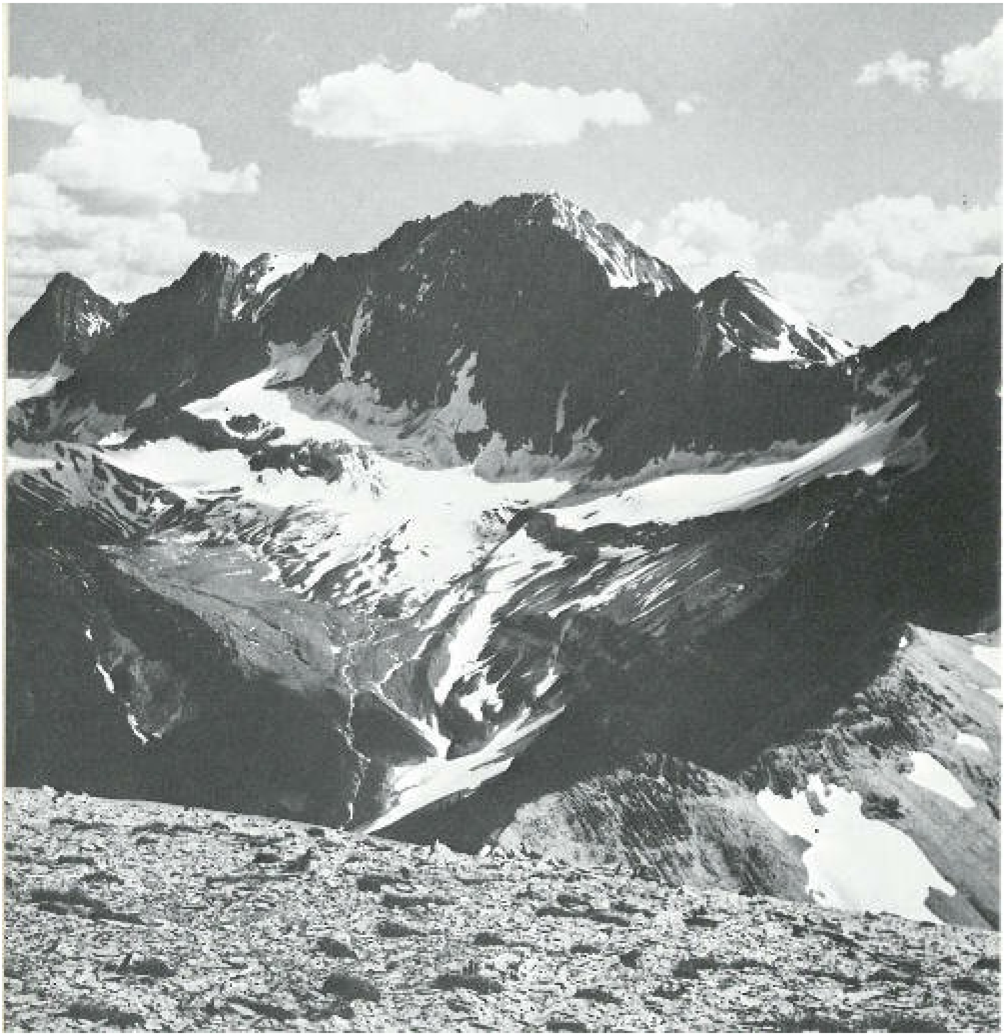
Surface

Note: numbers in parentheses refer to thickness in feet

GSC

The oldest exposed rocks in the park occur along the continental divide at its northeastern margin. Here, in the period of time known as the 'Precambrian', now more than 550 million years ago, great quantities of sand, with occasional muddy layers and pebbly layers, accumulated on the bottom of a shallow sea. These ancient sediments are now in the form of dense, hard, tough rocks known as the ‘St. Piran quartzite’. These sandy sediments were succeeded at the beginning of the next period in geological history, the Cambrian, by a few feet of sand and gravel and then a vast thickness of lime-rich sediments with occasional muddy layers. These accumulated on the bottom of the sea in much the same way that limy sediments are accumulating on the banks of the Bahamas at the present time. Thousands of feet of these materials accumulated layer upon layer as the million of years passed.

Now, when we come to look at these sediments in the form of rocks we find that they can be divided into a number of formations which differ from one another in composition and appearance. Their names and average thicknesses are given in the diagram. You will note that the names of the formations come largely from places outside Kootenay National Park. This is because they were first studied and named elsewhere and then traced laterally into this area. The thicknesses of the rock formations vary from place to place as one would expect in accumulations of mud, silt or sand in the bottom of the sea, thus the thickness figures given in the diagram are averages.



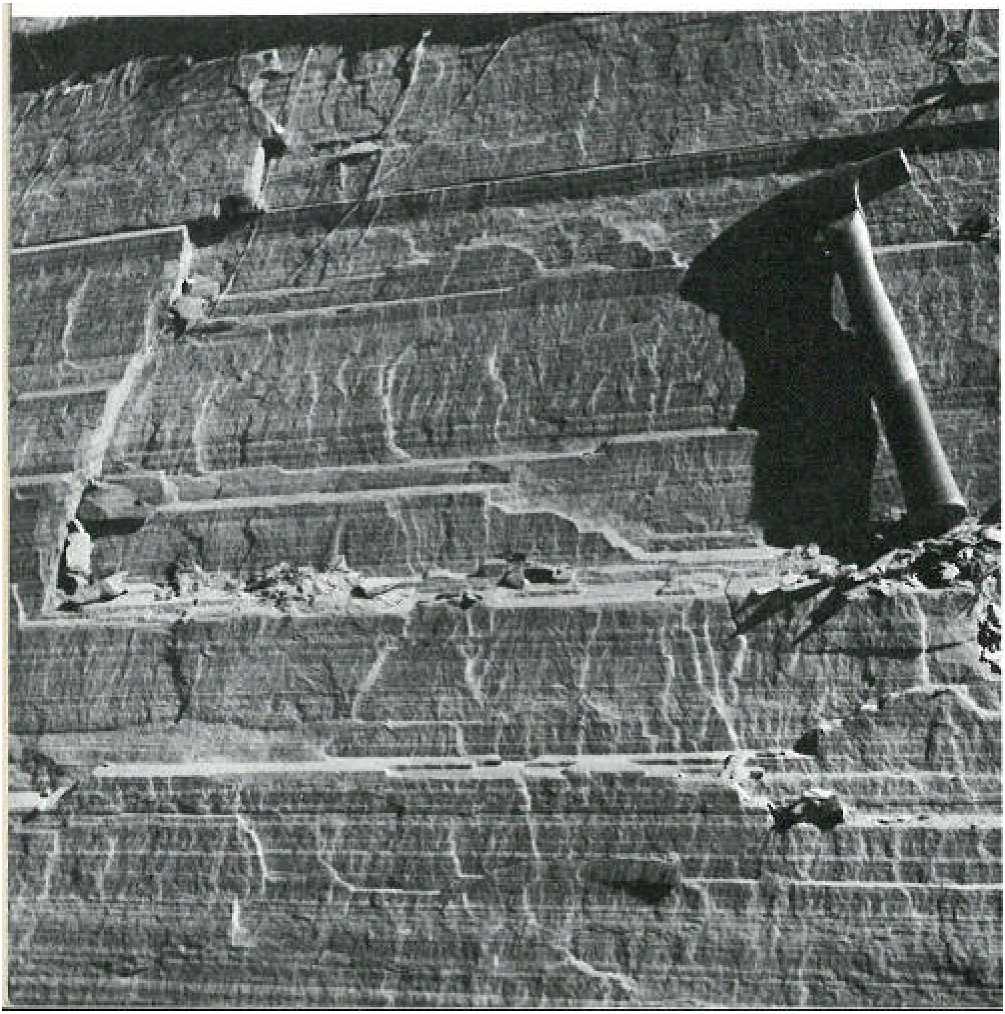
The mighty "Rockwall" of Ottertail limestone presents an east-facing line of cliffs and peaks for many miles along the western side of the Vermilion River valley. The foot of its steep east face is marked by glaciers and snowfields. The hills between it and the highway are made of sheared Chancellor Formation which commonly forms rounded surfaces strewn with chips and plates of rock as in the foreground.

Rocks in Kootenay National Park west of Marble Canyon are clearly different from those to the east. In some places the rocks are different because they are of different ages. But over a very large area of the park we find the rocks are of the same age but still are different. On second thought this is not really surprising when we think that the kinds of sedimentary materials being laid down in the ancient seas must have varied over the width of the many miles involved. Nowadays we go to places where sediments are being laid down in the sea and observe variations from place to place. Perhaps muds and silts are being deposited near the mouths of rivers whereas pure lime is being precipitated elsewhere at exactly the same time but under different conditions. Thus the rocks that are ultimately formed from these materials will be quite different in appearance from one another, even though they are of the same age.

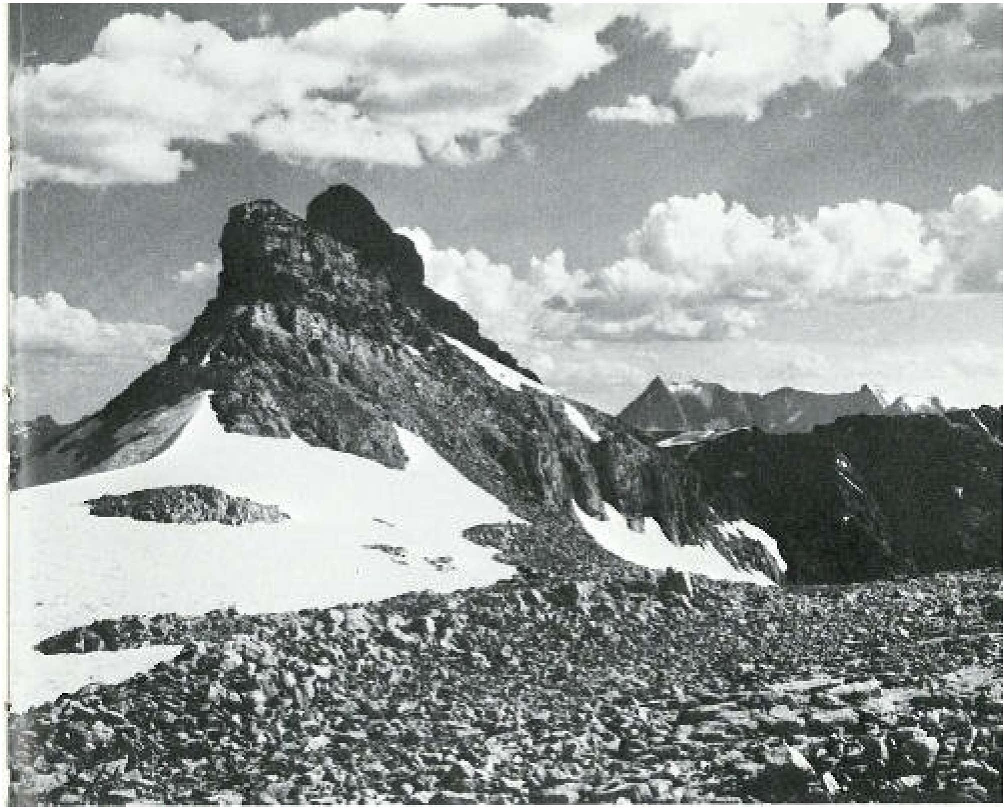
Something of this nature seems to have taken place during the Cambrian period in the region of mountains now straddled by Kootenay National Park. A mass of 4,000 to 5,000 feet of fine-grained sedimentary rocks which have been lumped together and called the ‘Chancellor Formation’ appears in several of the mountain ridges west of Vermilion River. These rocks are quite different from the limestones and shales of the mountains east of Marble Canyon, but they appear to be roughly the same age because in Yoho National Park the two rock groups are overlain by rocks which are known, from fossil evidence, to be equivalent.

Overlying the Chancellor Formation is the Ottertail Formation, which in most places is a mass of grey limestone or dolomite about 2,000 feet thick. The Ottertail Formation forms a series of great rock walls along the northeastern slope of Vermilion Range from Mount Sharp, near the boundary with Yoho National Park, southeastward to Mount Wardle and Split Peak. The same grey limestone unit is known to extend off to the south as far as Nevada. It must represent a time of long-continued precipitation of calcium carbonate under unusually stable conditions of land and sea.

The Ottertail Formation is succeeded by 4,000 to 6,000 feet of thin-bedded limestone and shale, called the 'Goodsir Group' from its exposure in The Towers of the Goodsirs in Yoho National Park near the Kootenay Park boundary. This great thickness of rocks was laid down over a long period of time which is known to include much of the later Cambrian and probably a good part of the succeeding 'Lower Ordovician' period. Southwest of Kootenay River this great rock formation is called the 'McKay Group' from exposures studied on John McKay Creek near Radium. In some places the upper part of the Goodsir Group becomes a black shale called the 'Glenogle Formation'.



Sheared slates of the Chancellor Formation can be seen along the roadside for much of the length of the Vermilion River valley. Here 'slaty cleavage' forms the steep face of the outcrop and 'bedding' makes the small ledge and the parallel banding.



The very high country in Kootenay National Park consists of boulder fields, rocky peaks and patches of lingering snow. Cambrian limestones are the rocks here at Chimney Peak and vicinity in the northeast corner of the park at more than 9,000 feet above sea-level.

The uppermost Goodsir Group, or its equivalent in the McKay Group, is succeeded by a white, massive quartzite called the 'Wonah Formation', of Ordovician age. In the southwestern corner of the park this formation is as much as 500 feet thick. This in turn is succeeded by a thickness of 1,000 to 2,000 feet of grey to pink dolomite, called 'Beaverfoot-Brisco Formation', which was laid down partly in Ordovician time and partly in the succeeding period—the 'Silurian'. Later Silurian or possibly 'Middle Devonian' (the next period) rocks of the

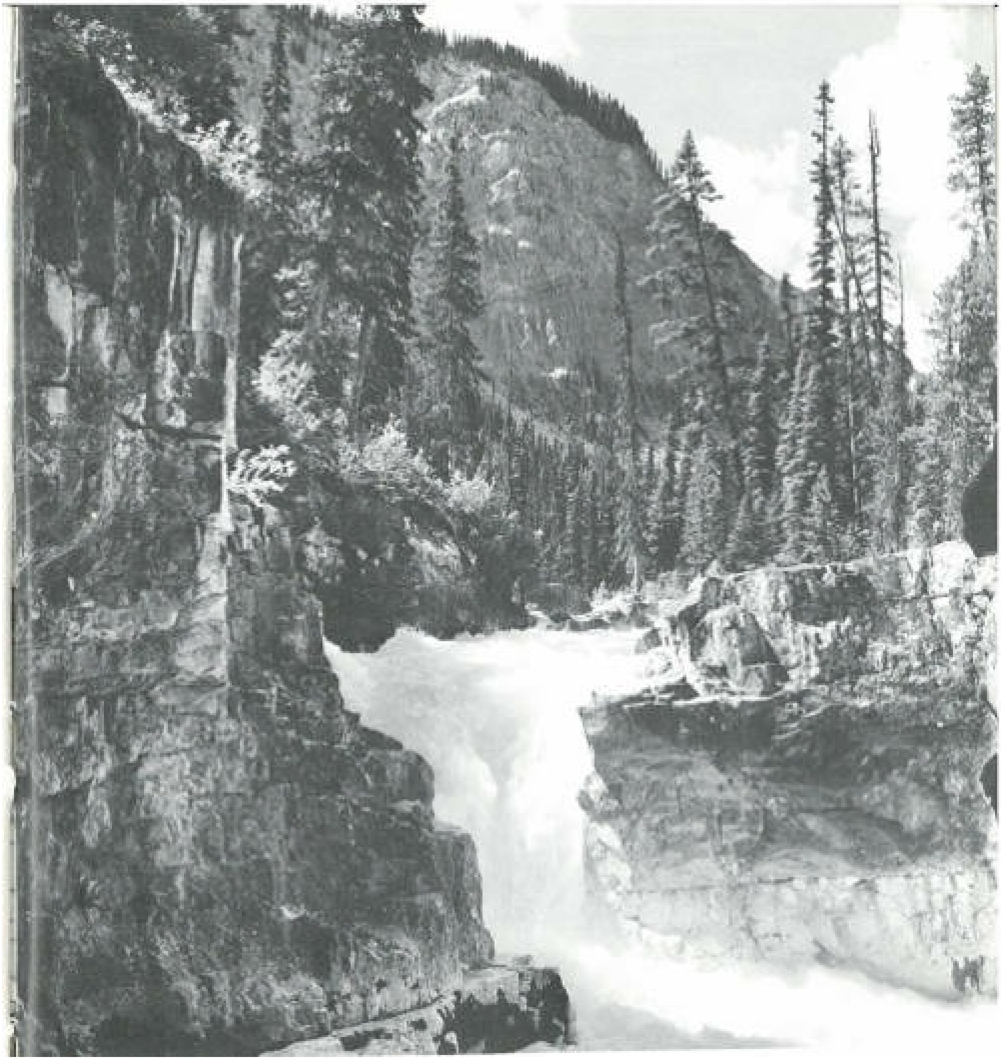
Harrogate Formation underlie a small area in the extreme southwestern part of Kootenay National Park. In some places the Beaverfoot-Brisco and the Harrogate Formations are extremely fossiliferous.

We have now seen what the rocks are made of, how most of them were laid down in the ancient seas that long ago covered this area, and the names which have been applied to them. But how were these rocks thrust up from the bottom of the sea and carved into the mountains we see today?

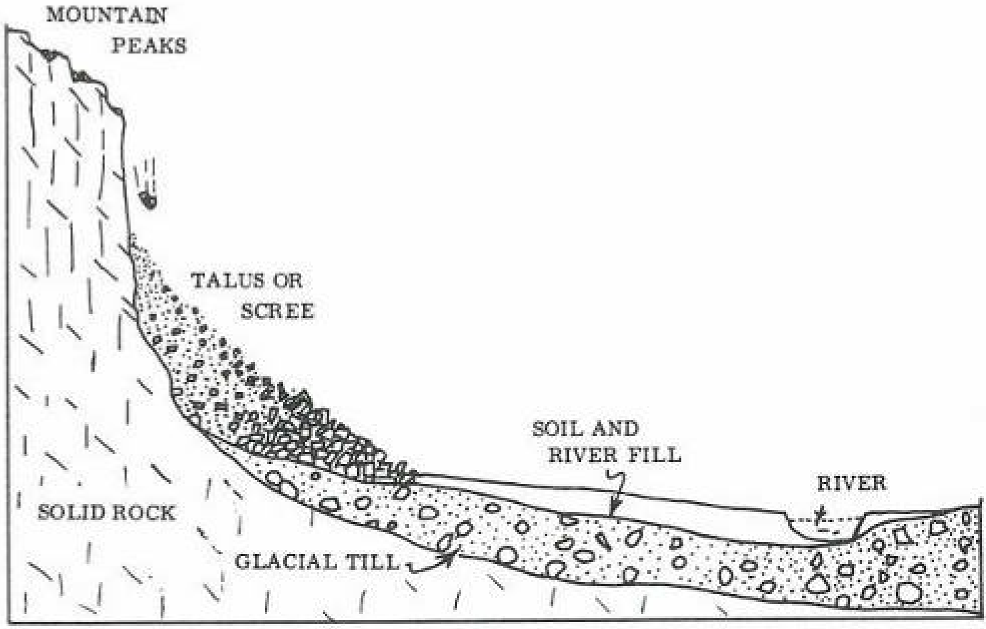
THE SCULPTURING OF THE MOUNTAINS

As soon as the rocks were laid bare by the retreat of the seas in which they were laid down they were subjected to the ever-present erosive action of rain, running water, falling snow, moving ice, frost, and chemical decay. Of all these agents of erosion, running water has been by far the most important in the carving of the mountains as we know them. For millions of years streams have carried away the debris of all the other agents of decay and erosion, and have themselves carved their valleys deep into the landscape.

The story of water erosion may begin on the highest peak. The freezing of a thin film of water under a boulder may wedge it out and tumble it over the edge of a cliff. Heavy rains may loosen rocks and boulders or may lubricate others so that they too join the downward rush. Thus, bits and pieces of rocks are torn from the solid mountains and begin their long journey to the sea.



The waters of Tokumm Creek plunge into the upper end of Marble Canyon. The rock, which is weather-stained for the most part, can be seen to be dazzling white marble near the water level and in some other places along the rock walls where fresh slides have occurred.

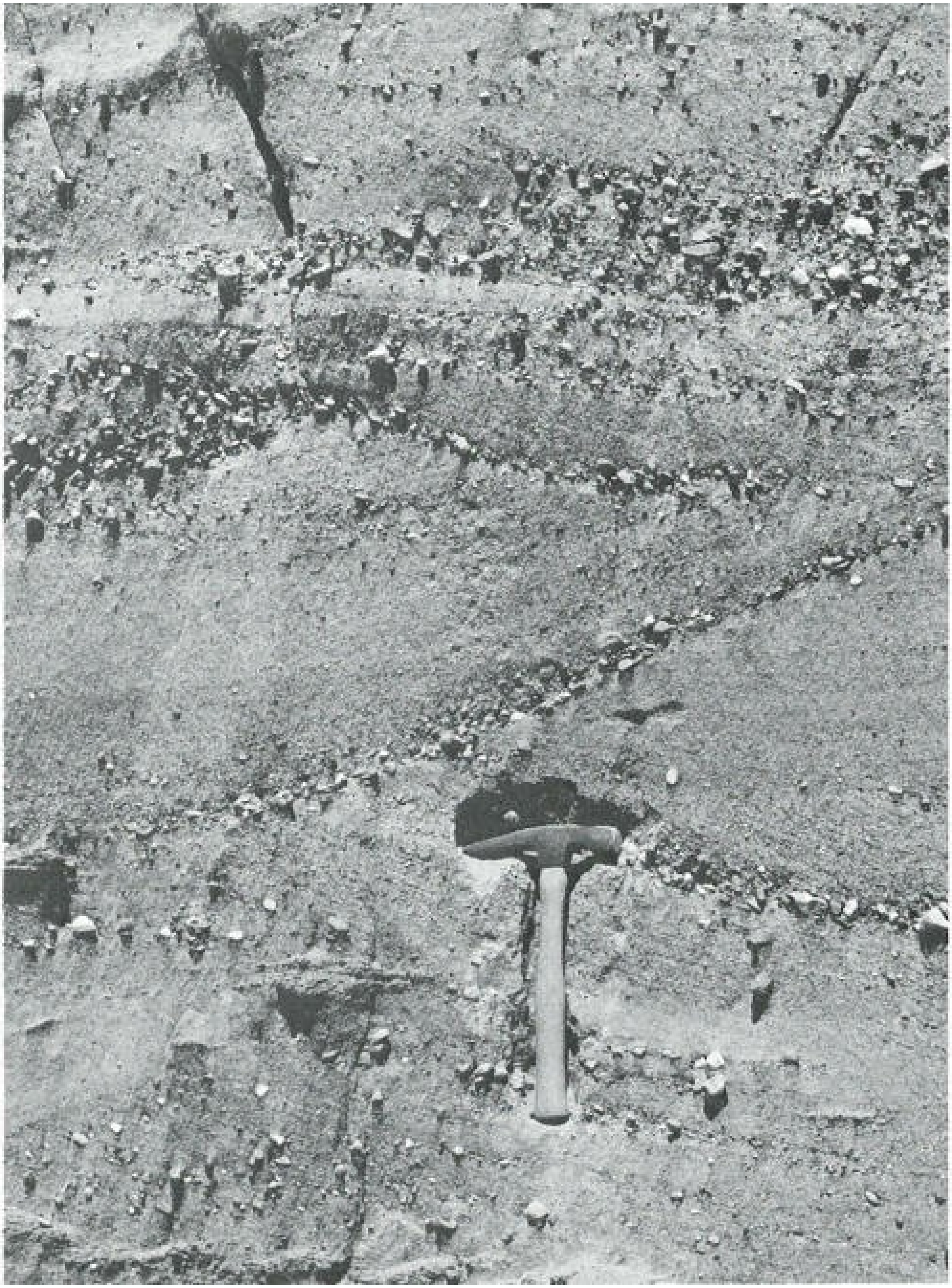


A common sequence of erosion in Rocky Mountain country begins when boulders and smaller particles of rock are wedged off the bare rocky peaks and fall to the talus or scree slopes below. Physical and chemical breakdown of the rocks in the talus produces fine-grained materials which move in the wash of rain and in streams, towards the river. A layer of glacial till made of a mixture of boulders, sand and clay commonly blankets the solid rock underneath the soil and river-fill in such valleys. In many places the glacial till is actively eroded by the river and thus contributes directly to the load of sediments on its way to the distant sea.

Their first resting place may be in one of the long fan-shaped accumulations of angular blocks and pieces of rock which we can see on the sides of every steep mountain. These are called ‘talus’ or ‘scree’ slopes, and their steepness is generally the maximum angle at which the loose rubble is stable. Climbing on them may be very difficult, particularly on the lower parts which consist of very large, angular boulders and chunks of rock lying in all attitudes where they have rolled or fallen. This means that not only will the surface of the talus or scree slope be very rough and irregular, but slight disturbances—even the passing weight of a man—may cause more sliding and adjustment of the blocks and particles in it.

Rivers may wash the bottoms of the talus slopes and carry off some of the boulders and rubble, so that angular pieces and fragments from the talus now become part of the mass of boulders, gravel and sand in the bottoms of stream valleys. Constant rubbing of boulders and pebbles against one another gradually wears them down and the fragments become very finely divided rock flour that looks like mud or silt in the water of the stream. Thus, over the ages, the mass of rocks in the mountains is gradually worn away by the forces of erosion and carried ultimately to the sea, where it rests on the bottom as mud, silt or sand.

After a very long period, during which great valleys were carved and the main outlines of the mountains as we know them were shaped by the action of running water, there came a period when the whole of northern North America was covered by a great ice-cap, rather like those on Antarctica and Greenland today. This period of glaciation began about a million years ago and lasted until quite recent times, perhaps 10,000 years ago.



Sand and gravel pits commonly have exposed in their walls a mass of evidence on how they got there. In this deposit of 'glacial outwash'—sand and gravel that come from the washing out of materials from the foot of a glacier—pebbles and small cobbles form lenses and thin layers at the

bottom of each of the lenses of sand made by shifting currents. Layering or bedding of one lens cutting across the layering or bedding of another is called ‘crossbedding’. The whole mass here is featured by crisscrossing bedding.

Glacier erosion is of two kinds. When an area is covered 31
by an ice-cap, more or less evenly, the movement of ice outward from the centre of accumulation of snow tends to round off the bumps and smooth out the hollows. High in the mountains, however, the action of the glaciers is generally much more localized and accentuated. Around the margins of snowfields or icefields, tongues of ice push down the valleys, steepening them and deepening them as they go. In the areas of accumulation, great bowl-shaped depressions—called ‘cirques’—are sometimes carved deep into the mountainsides. These commonly have almost vertical back walls and rounded bottoms. The cutting action caused by the movement of ice and snow toward the centres of cirques and the outlets of snowfields tends to steepen the scenery in the mountains and make it much more sharp and angular. If, for example, cirques are being cut into two opposite sides of a mountain, the two vertical back walls may happen to intersect one another, leaving a razor-sharp rock ridge. It sometimes happens that a rounded mountain-peak of considerable elevation is cut into by cirques from several sides. This process may leave semi-pyramidal towers of rock, like the world-famous Matterhorn, or Mount Assiniboine in the Canadian Rockies.

Long tongues of ice extending from snowfields down the valleys as valley glaciers commonly steepen the valley walls, pushing great piles of rock rubble and debris ahead of them. The position of maximum penetration of such alpine glaciers is commonly marked by great heaps of the debris they have left behind. Long ‘finger lakes’ are sometimes found in such dammed-up valleys, but in others the river was able to cut through the dam and drain the upper valley.

Farther back, where the valley walls were much steepened, a characteristic U-shape is impressed on the valley and the bottom is covered with a blanket of glacial debris. Small streams, 32
occupying shallow valleys on the shoulders of the main valleys, may now tumble over the edge in very high waterfalls. The high valleys that the streams run in are called ‘hanging valleys’.

Thus we can see how glaciers tend to sharpen up the profiles of the mountains and the scenery. Bowl-shaped depressions with vertical walls (cirques), sharp ridges with nearly vertical sides, sharp angular mountain peaks, U-shaped and hanging valleys—all of these are characteristic of areas of upland glaciation. Nowadays in Canada’s western mountains we can even see a few remnants of the ice that covered the whole area in the not very distant geological past; these are the glaciers and snowfields still left on the heights and in protected places.

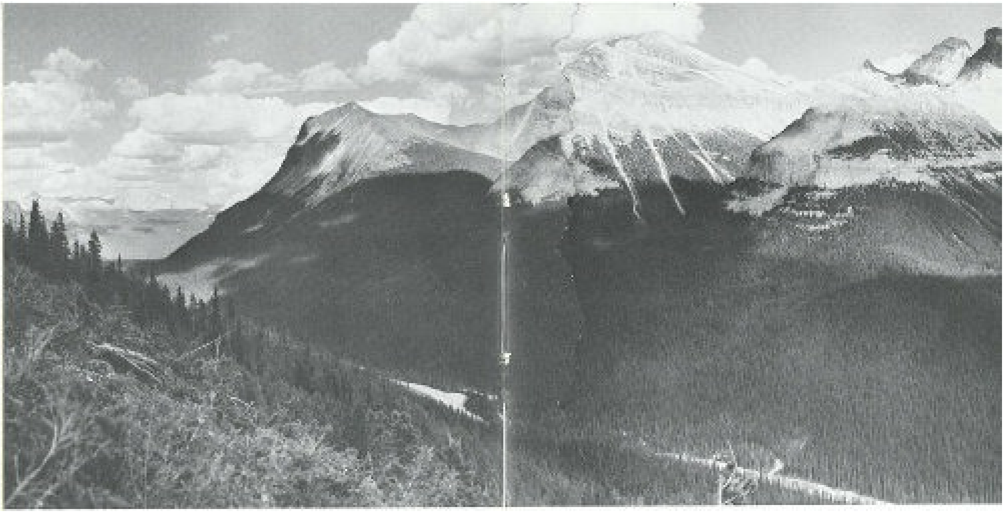
In the few thousands of years since the glaciers modified the shape of Canada’s western mountains, rivers have resumed the carving and cutting of the great mass of uplifted rock. Now, however, their valleys are choked with glacial debris brought from higher places by the moving ice. In some places the cirques or bowl-shaped depressions carved by the glaciers are occupied by small lakes called ‘tarns’, and in other places the long valleys have filled with water and are now long finger lakes.

The glacial litter—the vast quantity of sand, gravel and ground-up rock—is in some places distributed and redistributed by flowing rivers over flat valley floors to make ‘braided streams’. Steep rock walls and cliffs abound. In summer, when meltwaters from the glaciers and the snowfields make the rivers high 33
and turbid, you can imagine what an enormous load of rock debris must be carried to the sea each year from the wasting mountains.

REGIONAL DIFFERENCES IN THE MOUNTAINS

The western mountains of Canada show a distinct zoning from east to west at many different places along their length. Undisturbed flat-lying rocks underlie the western plains from Manitoba to near the western boundary of Alberta. To the west this area is succeeded by the Foothills, a region of folded and faulted rocks which have not been greatly uplifted. Still farther west, the Front Ranges of the Rocky Mountains succeed the Foothills along a very sharply marked boundary line. The Front Ranges are made of a series of fault slices of folded and broken rocks thrust together so that they overlap like the shingles on a roof.

The region of the Front Ranges is separated fairly clearly from another zone of mountains to the west—the Main Ranges of the Rocky Mountains. Here the rocks at the surface are relatively undisturbed although very much uplifted and deeply eroded. This we can tell because they include some of the oldest rocks exposed in the Rocky Mountain System. Farther west again are the Western Ranges of the Rocky Mountain System, built along a belt of severe disturbance in which the rocks are broken, faulted and severely folded.



Hi-resolution Image

Massively bedded, Middle and Lower Cambrian sedimentary rocks form the bulk of Storm Mountain (far back and right) and adjacent peaks. This view is from half way up the north side of the valley followed by the main highway from Bow River across the mountains to the Vermilion River valley. A small segment of Mount Eisenhower on the far side of the Bow River valley is just visible along the left margin. The white streak in the valley bottom is partly the stream bottom and partly the road.

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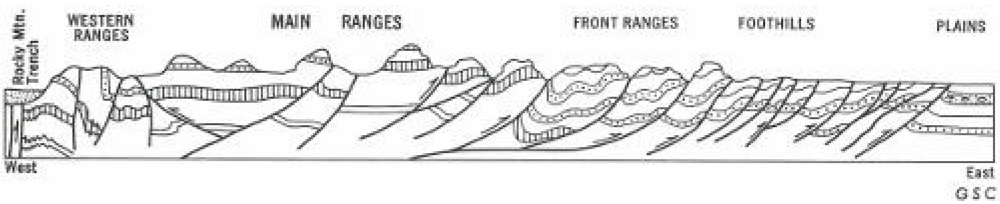


This cross-section through the Rocky Mountains, from the Plains to their western boundary, is greatly simplified to show the main features of their structural framework. In the east (the right in the diagram) flat-lying sedimentary rocks lie under the Plains layer upon layer, thousands of feet thick. In the Foothills the rocks are broken into steeply dipping slices, tilted so that each layer dips to the west, and uplifted so that rocks are brought from the depths up to or close to the surface.

The Front Ranges are made of slices of severely folded and faulted rocks which are uplifted and eroded so that layers that once were deep beneath the Plains are now at the surface, and in the valleys older rocks may be seen lying on top of younger rocks along each of the fault planes.

The simpler Main Ranges of the Rocky Mountains lie to the west of the complicated structures of the Front Ranges. They are cut into masses of sedimentary rocks which have not been severely folded but have been uplifted high into the air. Erosion has stripped off younger rocks and today we can see the flat-lying older rocks high in the peaks.

The Western Ranges are cut into fractured and folded younger rocks. The western boundary of the Rocky Mountains is the 'Rocky Mountain Trench', indicated by the dotted pattern. It is filled with thick deposits of sands and gravels and is occupied by major rivers like the Kootenay, the Columbia and the Fraser.

The Rocky Mountain Trench, a great valley system that extends for hundreds of miles in a northwest-southeast direction, marks the western boundary of the Rocky Mountain System. Kootenay National Park straddles several of the subdivisions of the Rocky Mountain System. That part of the northern end of the park that lies northeast of a line extending through the valley of Tokumm Creek, Marble Canyon, Haffner Creek and southeastward to and beyond Mount Shanks, is characterized by peaks cut into massive flat-lying rocks. These mountains look very much the same as those in adjacent parts of Banff National Park and Yoho National Park, and are considered to be a part of the eastern sector of the Main Ranges. The rocks in these mountains are generally of Cambrian and Precambrian age and the peaks are all 'castellate' or 'layer-cake' peaks (see below). 37

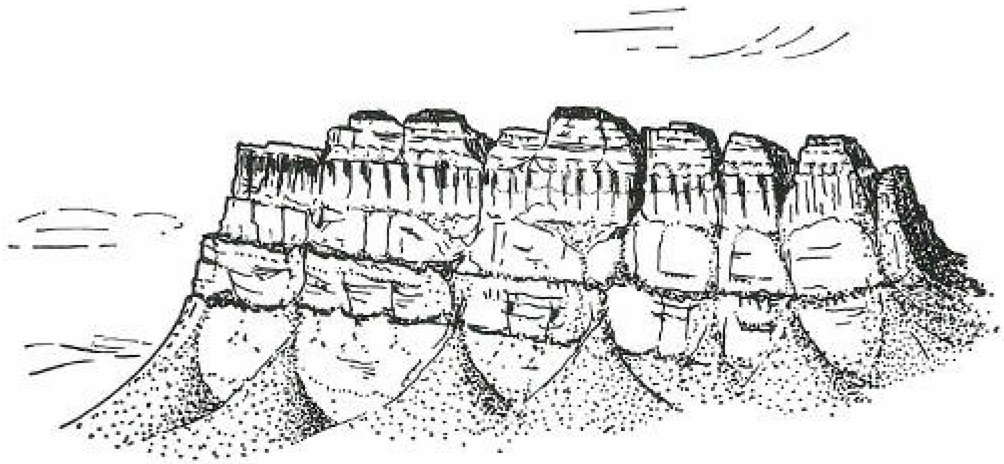
To the southwest, the Hawk Ridge-Vermilion Peak mountains, Vermilion Range, and Mitchell Range, all show rock sections and structures that allow their classification in the western sector of the Main Ranges. The western ranges of the Rocky Mountain System are represented in Kootenay National Park by part of Brisco Range, by Stanford Range, and by the mountains that extend westward from these, all the way to Radium. Differences in the appearance of the mountains from sector to sector are visible even to the casual traveller. What look like superficial differences in shape and surface reflect differences in structure and stratigraphy.

SHAPES OF MOUNTAINS

Travellers in the mountains have long noted the distinctive shapes of individual mountains. These are due to a combination of three things: the kinds of rocks that go to make up the mountain, the structure of the rocks within the mountain, and the particular tools or agents of erosion which have carved the mountain (in the case of the mountains in Canada's western parks, the rivers and glaciers). An assortment of rock types which vary from flat-lying to vertical and from parallel-layered to crumpled and folded, has contributed to the many different shapes of the mountains we see in Kootenay Park. The hundreds of peaks and mountain masses, however, belong to only about eight kinds—the ones you see sketched here.

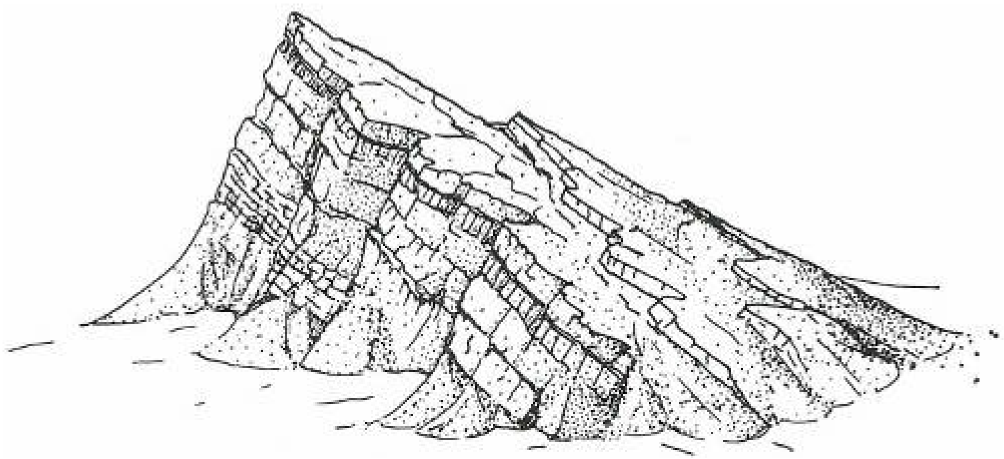
38

Castellate, castle, or 'layer-cake' mountains



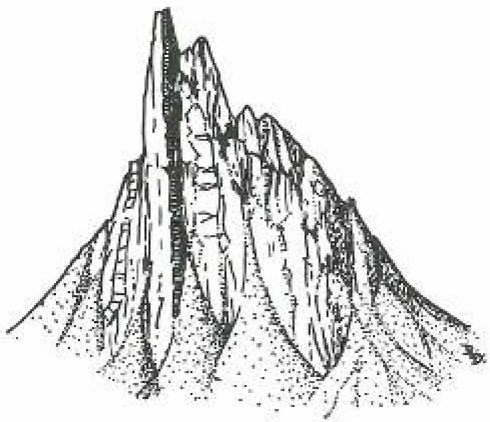
Mountains that are cut into more or less flat-lying sedimentary rocks commonly have profiles in which vertical steps alternate with flat or sloping terraces. Some such mountains look very much like ancient castles and are thus said to be 'castellate' or 'castle' mountains. Mountains of this kind are best developed in regions underlain by great thicknesses of rocks in which beds of massive limestone and sandstone or quartzite alternate with less-resistant shale or slate beds. The softer beds are eroded more rapidly, so that the harder beds are undermined and tend to break off at right angles, forming steep slopes and cliffs. Steep-sided needles and pinnacles are sometimes left on the tops of such mountains as the uppermost massive layers are cut away. Mount Eisenhower, Pilot Mountain, the Cathedral Peaks and Mount Stephen are examples in other parks. Stanley Peak and Mount Ball are castellate mountains in Kootenay Park.

Mountains cut in dipping layered rocks



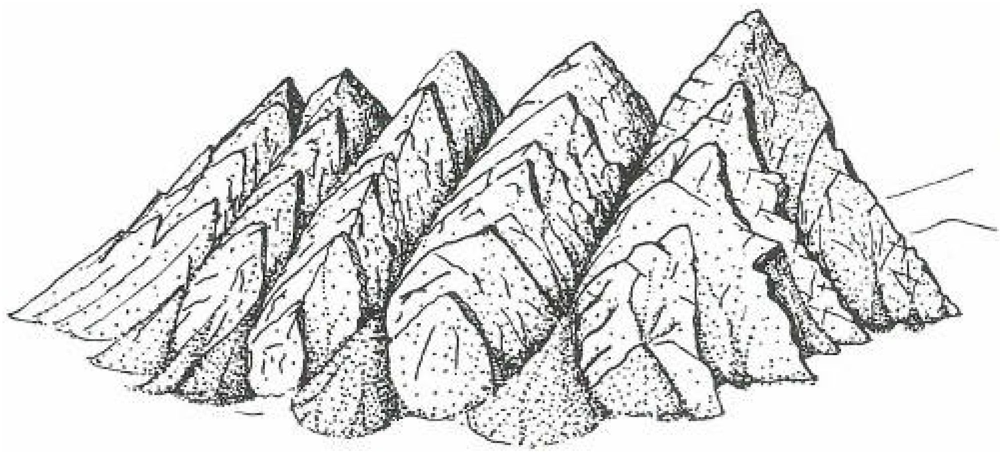
Some mountain peaks are cut into masses of layered sedimentary rocks which ‘dip’ or slope from nearly horizontal to 50 or 60 degrees. Some of these, like Mount Rundle near Banff, have one smooth slope which follows the dip of a particular rock layer from its peak almost to its base, and, on the other side, a less-regular slope which breaks across the upturned edges of the layered rock units. Other mountains, like Mount Edith Cavell, are cut into dipping sedimentary rocks in such a way that neither side follows the dipping rock layers, and thus both sides are irregular.

Dogtooth mountains



Sharp jagged mountains sometimes result from the erosion of masses of vertical or nearly vertical rock. The peaks may be centred on a particularly resistant bed, in which case a tall spine or rock wall may result. Some of the peaks in the Amiskwi area of Yoho Park are of this kind.

Sawtooth mountains

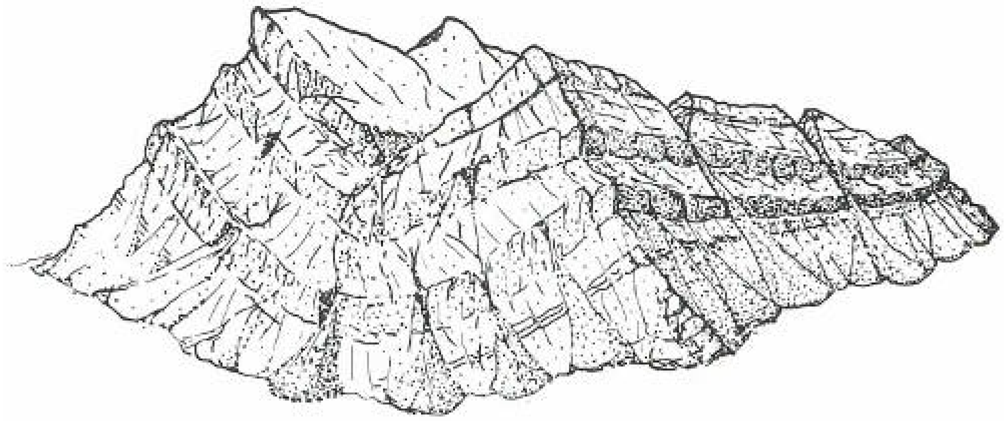


If the rocks in a long ridge are vertical, erosion may produce
rows of angular mountains that look like the teeth in a saw. 41
This type can be seen in the Sawback Range near Mount
Eisenhower in Banff National Park, and in the Colin Range east
of Jasper.

Irregular mountains

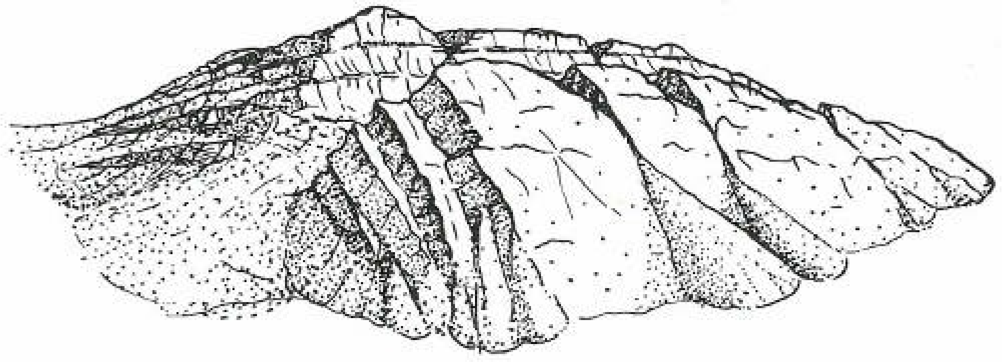
Many mountains are cut into more or less homogeneous masses of rock and, as a result, have no particularly characteristic shapes. These we may call 'irregular mountains', although individual peaks may be round, conical, pyramidal, or quite shapeless, depending on how they were cut.

Synclinal mountains



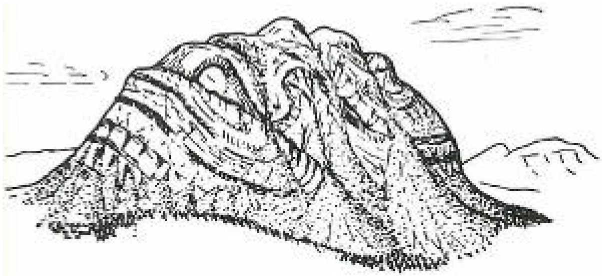
Mountains are very commonly cut by erosion into masses of rocks that have been folded into great arches and troughs. Erosion over long periods may cut away all the surrounding rocks to leave a mountain with a trough or bowl structure within it. This probably comes about because the folded rocks in the centre of the trough, which is called a ‘syncline’, are more 42
resistant to erosion than those in the surrounding parts, which tend to split and break during folding. Mount Kerkeslin in Jasper National Park is an excellent example of a synclinal mountain.

Anticlinal mountains



In some regions of folded rocks, mountains are underlain by great upbowed or arched masses of rock. Such upfolds are ‘anticlines’ and the mountains are called ‘anticlinal mountains’. Stretching of the rocks on the outside or upper layers results in numerous fractures which in turn make the rocks very susceptible to erosion, so that true anticlinal mountains are rare.

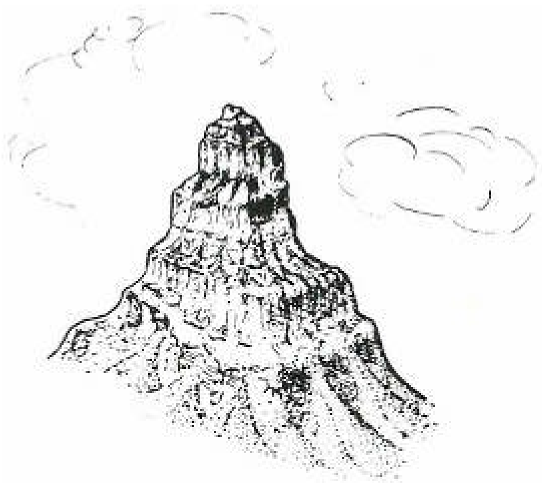
Mountains of complex structure



Anticlines and synclines, that is upfolds and downfolds, may be seen in the flanks of some mountains that have been developed on tightly folded rocks. These we may call ‘complex mountains’ because of the complex structures of the rocks within them.

Magnificent examples can be seen all along the eastern 43
edge of Jasper National Park. Vermilion Peak is a mountain of complex structure in the northeastern part of Kootenay National Park.

Matterhorn mountains



When glaciers cut deeply into rocks that are more or less homogeneous they carve bowl-shaped depressions called ‘cirques’. When several cirques cut into a mountain mass but are stopped by a warming of the climate and consequent melting, they sometimes leave sharp, semi-pyramidal towers of rock to which the general term ‘matterhorn’ is given. Mount Assiniboine is an outstanding example in the Canadian Rockies.

44

The spectacular gash of Sinclair Canyon is cut into Ordovician limestones. This small footbridge marks the end of the path leading from the viewpoint on the main highway just east of the Radium entrance.

ROADLOG AND POINTS OF SPECIAL GEOLOGICAL INTEREST

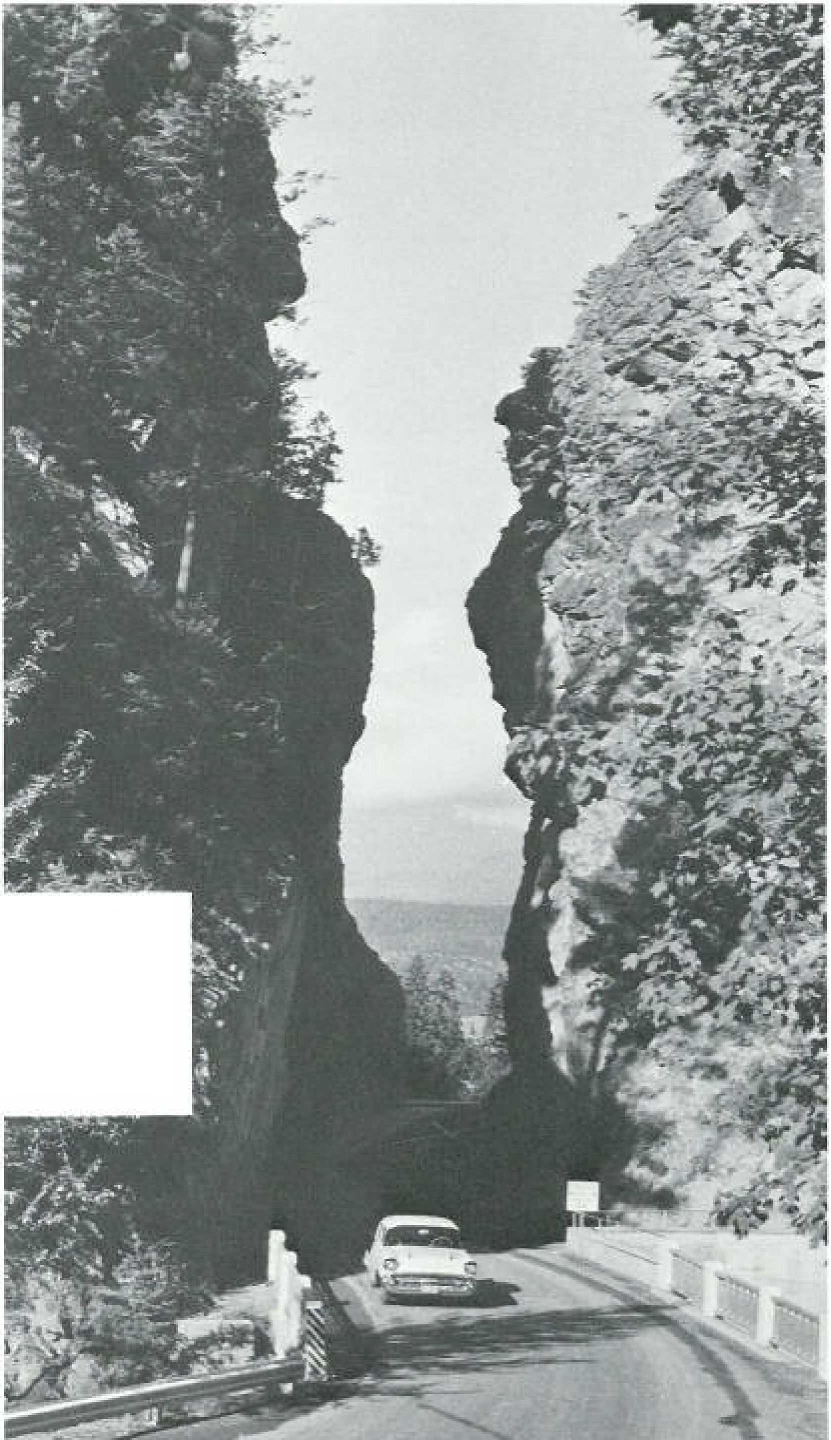
(1) Southwest Gate and Information Centre at Radium

The southwest gate and information centre are on the south bank of Sinclair Creek, a very small tributary that cuts across the general trend of the mountains on the east side of Columbia River. To the west lies the Rocky Mountain Trench, a great gash in the surface of the earth that extends for more than a thousand miles northwestward from the United States border. It is occupied by sections of the Kootenay, the Columbia, the Fraser, and Parsnip and Finley Rivers, and extends on up into Yukon Territory. The rocks and the structures in them on the opposite sides of the trench are different, so that it appears that a system of faults underlies the Rocky Mountain Trench. Opposite Radium, Columbia River wanders around on the sand and gravel deposits which make a flat bottom in the trench here.

Southwest Gate to Sinclair Canyon—0.3 mile

(2) Sinclair Canyon

From the west end of the canyon a view westward shows the distant mountains on the other side of the Rocky Mountain Trench, with wide terraces and former river banks in the valley below. Sinclair Canyon itself is a deep narrow gash, cut into heavy limestone beds that trend across its course. Over long periods of time the small brook has gradually worn and dissolved its way through these limestone barriers. In the walls at the narrow part of the canyon can be seen several faults or breaks in the rock, and in some places quite different kinds of limestone are brought into juxtaposition by the movement along these faults. The rock at the western end of the canyon belongs to the Beaverfoot-Brisco dolomite, of Ordovician and Silurian age. The rocks of these formations are stained pink by small quantities of iron oxide. On the upstream or eastern side of the separating faults the rocks belong to the McKay Group, of Lower Ordovician age. One of the faults which dips or slopes at 60 degrees to the west is conspicuous on both sides of the canyon and you can actually go up to it and put your hand on the fault surface.



Sinclair Creek cuts abruptly across the strike or trend of limestone units of Ordovician age in this steep-walled canyon. The southwestern entrance to Kootenay National Park is through this narrow gorge.

This unusual view of Sinclair Canyon, with the road clinging to one side and partly obscured by the cliffs, is from the nature trail between the

canyon and the hotsprings pool area.

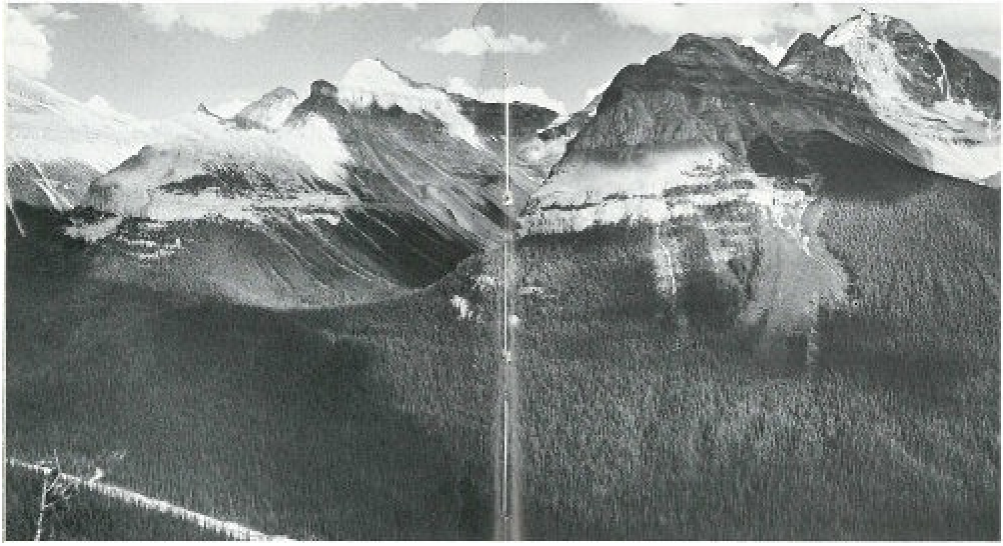
The gorge itself has been generally cut by the abrasive action of the stream and the sand and gravel which it carries in its headlong plunge to the valley flat below. In some parts of the gorge, round ‘pothole’ shapes show where individual boulders and groups of boulders have been whirled round and round in the currents so that they drilled holes into the limestone.

Sinclair Canyon to Radium Hot Springs—0.8 mile

(3) Radium Hot Springs

Radium Hot Springs, with the houses, hotels, motels and stores, is in a slightly expanded part of the valley of Sinclair Creek. Banks of glacial till, some of it roughly layered, and a bouldery accumulation from the cliffs above, make the flat bottom and some of the banks into which the road and house foundations are cut. To the east a strut of broken limestone, stained bright orange with iron oxide, is visible as it comes down on one side of the valley, crosses and goes up the other. This is a ‘breccia’ zone and has been made by breakage of the rocks along a fault system. By following it along the mountains, a vertical relief of nearly 4,000 feet can be seen on the surface.

Surface waters travel deeply into the interior of the earth where they are heated and then emerge at Radium Hot Springs at a temperature of about 116 degrees Fahrenheit. The water issues from the base of the rocks in the photograph and flows over a low retaining wall into the upper or hot pool. It is interesting to note that the water is a nondescript grey colour beyond the retaining wall but where light is reflected through it from the bottom of the pool it takes on more of a turquoise colour.



Hi-resolution Image

Mountains between Stanley Peak (upper right) and Storm Mountain (far back and left) are cut into a great mass of horizontal, Middle and Lower Cambrian sedimentary rocks. The open U-shaped valley in the centre is typical of glaciated regions and seems to be 'hanging' above the main valley below.

The hotsprings themselves emanate from shatter zones within the Jubilee limestone on the left bank of Sinclair Creek. The waters of hotsprings the world over are known to be mostly surface waters which have travelled deep under the earth, been heated on contact with hot rocks, and have risen again to appear at the surface. It may be that the fault zone so clearly marked by the shattered and brightly stained zone is the controlling feature in the underground travels of the waters of the Radium Hotsprings. In their underground journey the waters have become heated to a temperature of about 125 degrees Fahrenheit and have picked up numerous mineral compounds in solution. These are principally calcium (Ca), bicarbonate (HCO_3) and sulphate (SO_4). The amount of dissolved materials 52 in the Radium Hotsprings water is not high in relation to that of other hotsprings in the Rocky Mountains; for example it is only about half that of the nearby Fairmount Hotsprings. It is interesting to note that the light-coloured bottom of the lower swimming pool and the upper, hotter pool make the water appear a delicate green, whereas outside the pool, just under the rocks where the water issues, it appears to be much darker and murkier. The average temperature of the water in the upper or warmer of the two pools is about 113 degrees Fahrenheit, while the larger swimming pool is cooled to about 90 degrees,

For a short distance Sinclair Creek is deprived of the addition of the water from the Radium Hotsprings because it now goes through the swimming pools and various outlets to join Sinclair Creek considerably lower downstream than it originally did. The quantity of hot water coming into the creek undoubtedly warms it considerably.

Radium Hot Springs to Iron Gates viewpoint—0.5 mile

(4) Iron Gates Viewpoint

The 'Iron Gates' is a very narrow gorge cut through a strut of limestone which constricts the valley here. Silty sand and pale yellow-brown boulder rubble beneath the limestone cliffs have accumulated partly as a result of outwash from former glaciers in the valley, from stream deposits, and as 'talus' from the crumbling cliffs above.

It is worthwhile to walk back along the road a few feet to where the ‘Redwall breccia’ comes out. This bright orange-brown breccia is made up of broken fragments of limestone of all sizes, from dust to great boulders 6 to 10 feet long, and stained by iron oxide. It marks the trace of a fault or break in the earth’s crust which is traceable along the mountains for many miles and is clearly visible everywhere it crops out because of the bright colour.

Iron Gates to Mount Sinclair viewpoint—1.0 mile

(5) Roadside View of Mount Sinclair to the East 54

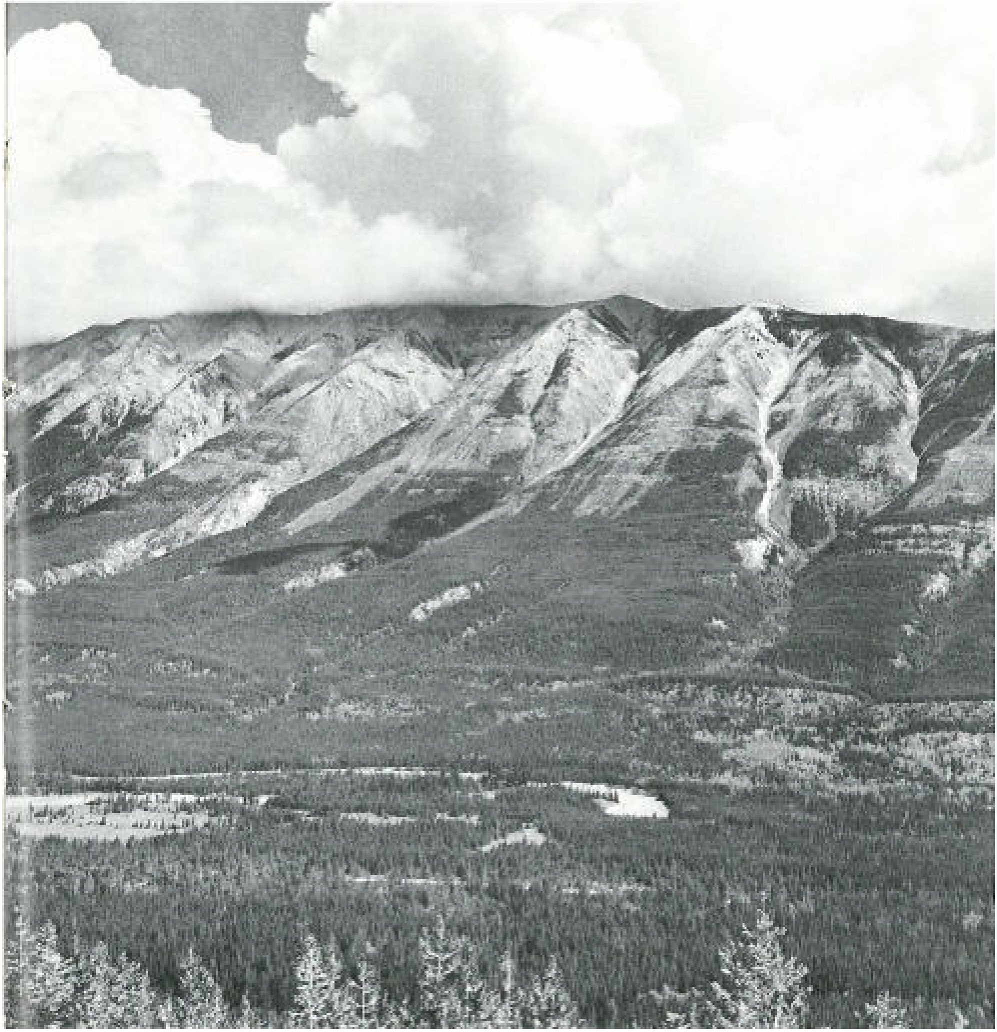
The valley of Sinclair Creek separates Brisco Range to the north from Stanford Range to the south. From this position there is an excellent view of Mount Sinclair, the northernmost major peak of Stanford Range. The rocks in Mount Sinclair dip generally toward the west. The upper part of the mountain is made of Beaverfoot-Brisco rocks, of Ordovician and Silurian age. The white band close to tree-line is the Wonah quartzite. Below that in the tree-covered slopes the dark Glenogle shale and McKay limestone make up the bulk of the mountain. The rocks along the road, both east and west of the stop, are mostly of the McKay Group.

Mount Sinclair viewpoint to roadside stop—4.5 miles

(6) Roadside Stop in Black Shales

Black shales along the road in this section belong to the Glenogle Formation. Geologists almost always look in shales of this kind for remnants of fossil ‘graptolites’—tiny creatures of animal organization which apparently floated in ancient seas, rather like seaweeds of today—and although no graptolites may be found in this section, they are abundant in some outcrops of the Glenogle. Beds of limestone up to 18 inches thick occur interbedded with the dark shales.

Roadside stop in black shale, to divide—0.2 mile



This view from the Kootenay valley viewpoint, about 8 miles east of Radium, shows the western slope of Mitchell Range north of Cross River. Features to note are the more or less even gullying, the banding of the forests from left to right, which probably represents the trend of the bedrocks underneath, the terraces along the banks of Kootenay River, and the river itself in the bottom of the valley.

(7) Divide and Lake Olive

To the west of this point the waters of Sinclair Creek drain westward. Lake Olive and waters east of here drain eastward via Swede Creek. This position, then, marks the divide or ‘height of land’ between the drainage of Columbia River to the west and that of Kootenay River to the east. The highest point on the road lies a little to the east of Lake Olive at an elevation of 4,875 feet above sea-level. The area is known as Sinclair Pass.

Divide to Kootenay valley viewpoint—2.4 miles

(8) Kootenay Valley Viewpoint

The Kootenay valley viewpoint provides a magnificent view out over the expansive valley of Kootenay River toward Mitchell Range opposite. The conspicuous gap to the right, 2 or 3 miles down Kootenay River, is the valley of Cross River which cuts through the mountain mass of Mitchell Range. Mitchell Range gradually increases in elevation to the left or northward as far as the conspicuous break made by Pitts Creek. The rocks of this great block consist principally of the Ottertail limestone with some of the overlying Goodsir Group. The conspicuous horizontal striping of the vegetation on the flanks of Mitchell Range opposite this viewpoint is due to the parallel layering of the rock, with some layers providing better growing conditions than others. Beyond the break in Mitchell Range, marking the course of Pitts Creek, Mount Harkin stands at some 9,788 feet above sea-level. Beyond that, Mount Daer, Mount Selkirk and Split Peak form parts of the skyline in the distance.

Mountains of Mitchell Range are cut into folded and faulted rocks of the Ottertail Formation and the Goodsir Group. In this view from the fire tower on the northeastern side of Kootenay River the steep valley of Daer Creek is visible in the right foreground with the mountain behind it cut into a series of faulted slices. Mount Selkirk looms farther back to the left.

Far below on the valley flat, Kootenay River wanders against banks of sand and gravel which are probably largely made of outwash from glaciers that once occupied the whole of this area.

A splitting known as 'slaty cleavage' develops when rooks are severely folded under great compression. Slaty cleavage is formed at right angles to the compression which produces the folds, so the folds themselves must be symmetrical about a plane that is parallel to the slaty cleavage. In any outcrop the geologist can thus tell his position on a fold even though he can see only a very small part of it. In this rock-cut, about 2 miles west of the Kootenay valley viewpoint, the geologist is holding his arm parallel to the slaty cleavage, while the beds, which must be overturned, are the steeper white bands.

Westward and southwestward the jagged peaks of Stanford Range include nearby Mount Sinclair, at an elevation of 8,734 feet above sea-level. The rocks in the road-cut opposite the viewpoint are highly sheared and altered rocks of the McKay Group. In many of the road-cuts just to the west of this viewpoint it can be shown from the relationship of the bedding planes and the slaty cleavage that the rocks are actually upside down relative to the positions in which they were laid down. In the ditch at this viewpoint you can see the highly sheared and broken condition of the rocks and how very soft they are. White masses of quartz (very hard and sometimes glassy), and calcite (white or yellowish and much softer), are common in these altered rocks as veins and irregular masses.

Kootenay valley viewpoint to valley bottom stop—10.7 miles

(9) Bottom of Kootenay River Valley

This stopping place provides a wonderful view of the skyline of Mitchell Range to the east and a view of an unusual structure to the northwest. The spur that sticks out of Brisco Range to the northwest can be seen to be a downfold or ‘syncline’. The light grey to white Wonah Formation, at the timber-line and in the steep-sided slab to the left of the peak there, is distinctly synclinal. Above the white Wonah Formation the Beaverfoot-Brisco Formation extends to the top of the peak and the darker Glenogle shale below it is visible in the spurs.

A view due north from the Kootenay Valley viewpoint shows the ragged skyline of Mitchell Range which is cut into folded rocks of the Ottertail Formation (upper Cambrian) with some of the overlying Goodsir Group which straddles the Cambrian-Ordovician boundary. The sharp gully in the centre of the picture is the valley of Pitts Creek. Kootenay River may be seen wandering along in the terraced valley bottom.

On the far side of the valley is a magnificent display of sharp angular peaks along the crest of Mitchell Range, beginning with Mount Harkin to the right. Mount Daer, directly opposite, is in Ottertail limestone. The minor peaks on its left show the pattern of rocks made when gullies cut across rock layers that dip more gently than the gullies themselves. Mount Daer and the slightly lower subsidiary peaks to the right show the ruggedness that comes from differential erosion of multilayered rocks dipping steeply west and cut by a series of faults which dip generally to the east. The timber-line all along the western slope of Mitchell Range is well marked, being higher on the spurs that are protected from snow and rockfalls and much lower in the gullies. Beautiful examples of steep-sided gullies occur along this slope, with fairly active movement of rock waste going far down the flanks.

On clear days The Towers of the Goodsirs are visible some 40 miles to the northwest. The conspicuous gap almost directly north of here is made by Vermilion River as it cuts across the trend of the mountains and separates Vermilion Range to the northwest from Mitchell Range to southeast.

Valley bottom viewpoint to Kootenay Pond—7.7 miles

(10) Kootenay Pond (Uphill End)

The hill you are now on provides a westward view to the peaks of Brisco Range. The gap more or less opposite and to the west is Luxor Pass. The very sharply marked round pond below is probably a glacial 'kettle'. If it is a kettle it was formed when a large block of glacial ice was isolated and then completely surrounded by sand and gravel at a time when the glaciers were melting fairly rapidly and supplying a great spew of sedimentary debris. At a later time the block of ice melted, with consequent slumping in the gravel and sand, to produce the steep-sided, round depression.

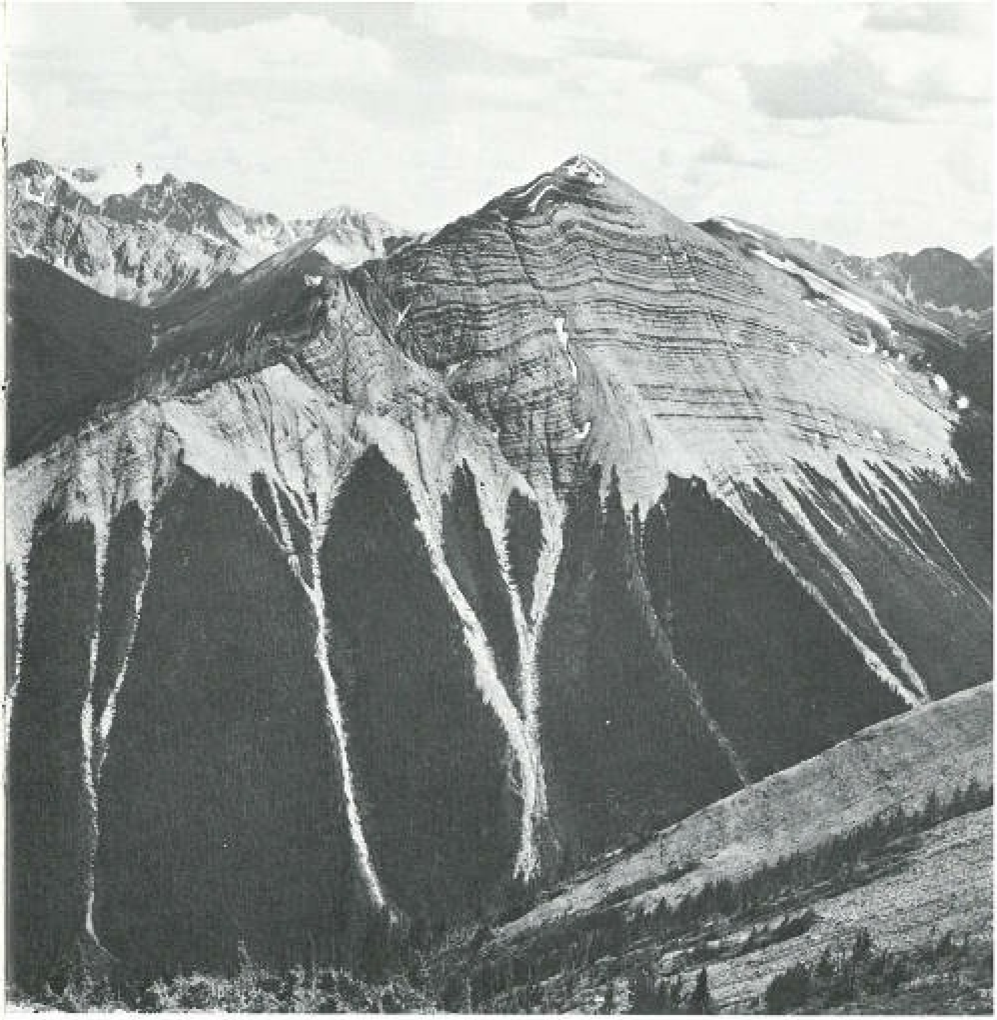
To the northeast of this point the bulk of Mount Wardle, the southernmost peak of Vermilion Range, is cut into the limestone and shaly limestone of the Ottertail Formation and the Goodsir Group. A glimpse of Hawk Ridge may be had to the northeast through the gap made by Vermilion River.

Kootenay Pond to Hector Gorge viewpoint—1.7 miles

(11) Hector Gorge Viewpoint

This viewpoint overlooking a sharp bend in what is called 'Vermilion River' is a good place to see that the river systems here have really been misnamed, because the main waters clearly come from Vermilion River into the Kootenay River valley. A tributary brook called 'Kootenay River' comes in from the northeast to join the main thread of water (called 'Vermilion River') which comes in from the northeast.

The gap made by Vermilion River separates Vermilion Range to the northwest from Mitchell Range to the southeast. The gullied flanks of Hawk Ridge are visible to the northeast through the gap made by Vermilion River. Below this point Vermilion River makes a series of hairpin turns in banks of loose, unconsolidated, water-washed glacial debris. It is easy to see here how Vermilion River swings out against the outside of the bend, cutting sharply into its bank, with a flat left on the inside of the bend. At times of low water the river spills into a variety of channels on the flat. Hector Gorge is cut deeply into the terraced land for a couple of miles below this point.



Conspicuously layered slaty rocks of the Chancellor Formation mark this unusual peak 6 miles southwest of the Simpson Monument. A steady trickle of rock fragments makes the white scars on the lower slopes where snowslides clear out broader paths in the dark woods.

The rocks in the river below and in highway-cuts between this point and the Kootenay River viewpoint (No. 8) are sheared and altered rocks of the Goodsir Group. They have been profoundly affected by movements along a great fault system, called the 'White River Break', that extends for many tens of miles along the Kootenay River valley; it can be traced northeastward through the valleys of Beaverfoot River and Kicking Horse River in Yoho National Park.

Hector Gorge viewpoint to Simpson Monument—6.2 miles

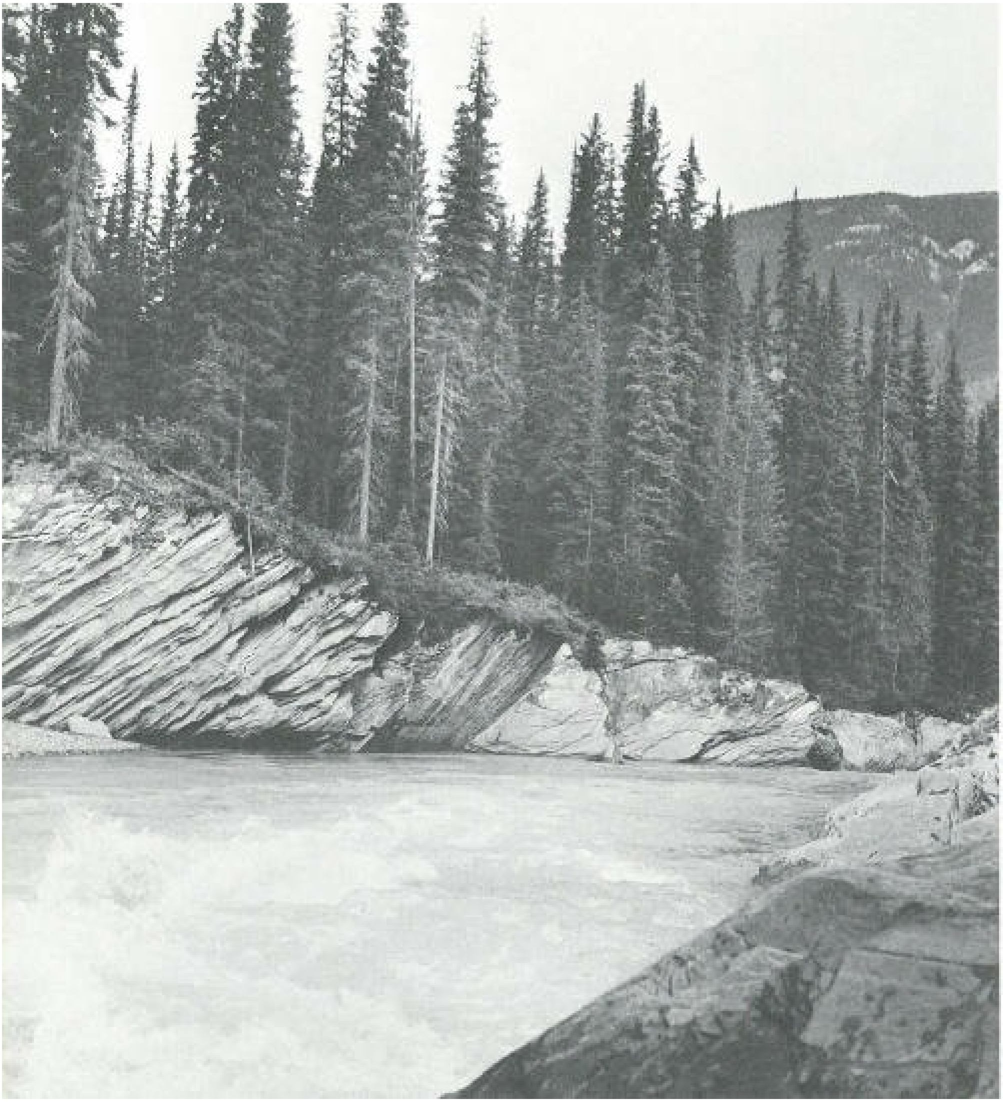
(12) Simpson Monument

An old travel route through the mountains via Simpson Pass and Simpson River joins the valley of the Vermilion-Kootenay system at this point. As you look southeastward from here your back is to the southern end of Vermilion Range and you are facing the valley of Simpson River which makes a tremendous gash across the general northwest-southeast-trending mountain ridges in this neighborhood. To the south the great wall of Ottertail limestone in Split Peak and its flanks to the north is clearly different from Spar Mountain (nearer and slightly to the left) which is largely cut into rocks of the Chancellor Formation. Far to the right or southwest a peak of Brisco Range on the west side the Kootenay River valley is visible through the gap cut by the Vermilion River valley. At a distance up the Simpson River valley and slightly to the right, the reddish rocks of Indian Peak dip generally to the west. Northeastward across Vermilion River the mass of Hawk Ridge extends off to the northeast. The rocks in Hawk Ridge, belonging to the Goodsir Group, have been tightly folded. The two long, parallel, nearly horizontal, light-coloured ribs represent a single limestone bed of the Goodsir Group that has been tightly folded so that it appears in two different places. The two light bands visibly converge toward the northwest or left. Opposite this stop, dark grey slaty ‘phyllites’ along the road belong to the Chancellor Formation. All along here the rocks show an excellent slaty cleavage and are commonly of silky appearance on the slaty surfaces.

Simpson Monument to Mount Assiniboine viewpoint—2.7 miles

(13) Mount Assiniboine Viewpoint

On very clear days the tip of Mount Assiniboine, Canada’s most spectacular Matterhorn-type mountain, some 40 miles to the southeast, is visible from here through the valleys and slight breaks in the mountain profiles. Complicated folds show strongly in the north end of Octopus Mountain, more or less straight down the valley to the southeast. These seem to be a continuation of the same folding in Hawk Ridge directly across the valley to the east and northeast. In Hawk Ridge, beds of the Goodsir Group are tightly folded into an overturned ‘anticline’, so that the two light-coloured, parallel and nearly horizontal stripes along the mountainside are actually two different parts of the same limestone bed, and they visibly converge and join to the northwest. From the road in this section, Split Peak, a mass of Ottertail limestone, looks very different from Spar Mountain, largely cut in Chancellor beds to the left or east of it.



The waters of Vermilion River rush through this narrow gorge just below the highway bridge at Vermilion Crossing. The rocks, which belong to the Chancellor Formation, show a strong cleavage which dips at approximately 45 degrees to the west. The trace of bedding planes is commonly visible on the cleavage surfaces here and in nearby road-cuts.

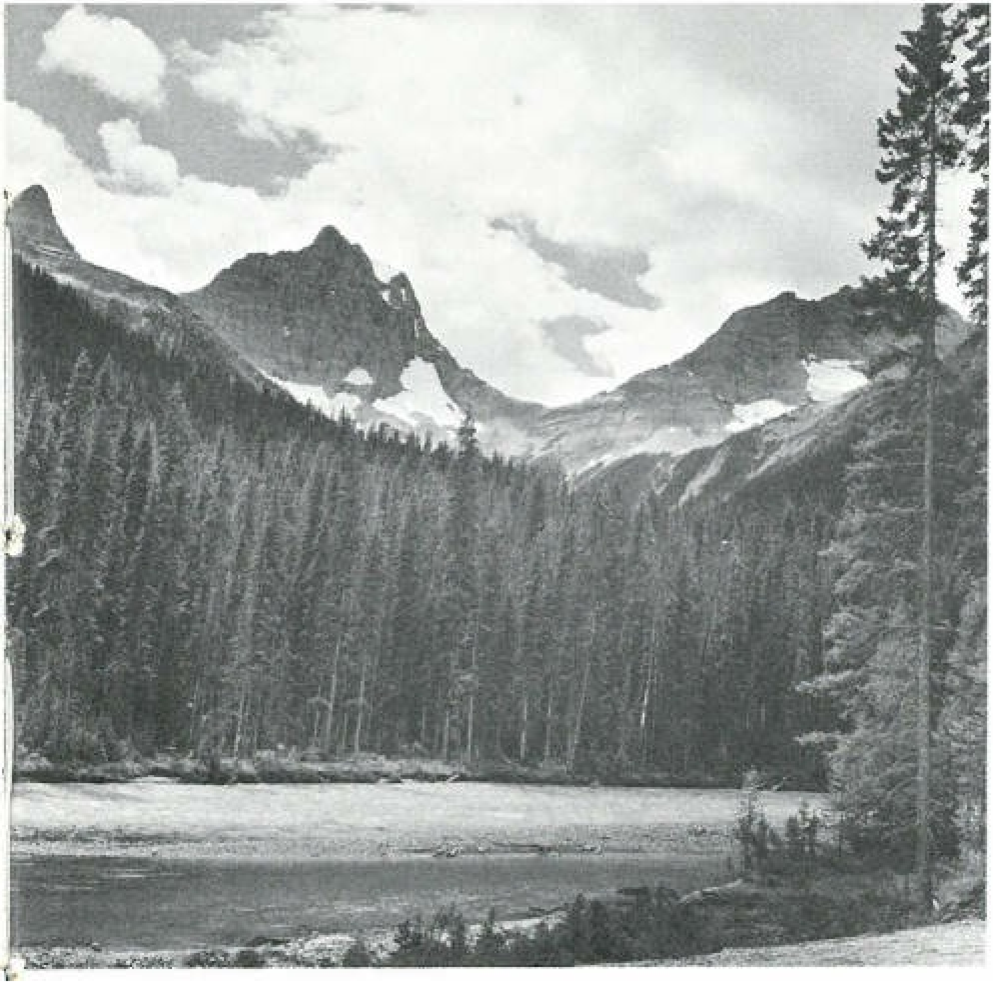
Steep-sided peaks of Ottertail limestone along the “Rockwall” form a dramatic backdrop for this darkly wooded valley southwest of the highway near Vermilion Crossing. Patches of ice and lingering snow, white ribbons of brooks and light snowslide scars feature this scene which is not visible from the highway because of intervening slopes as shown in the photo on page 69.

Mount Assiniboine viewpoint to Vermilion Crossing—1.5 miles

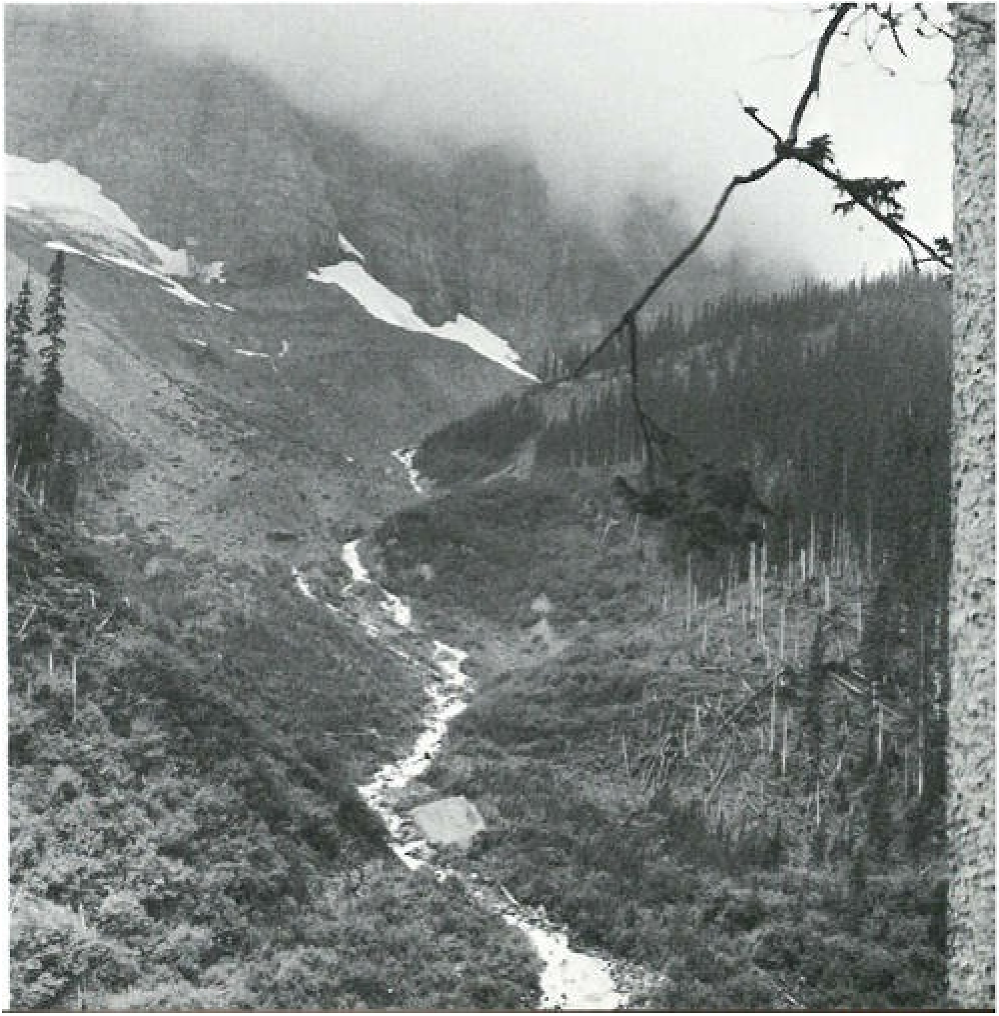
(14) Vermilion Crossing

Vermilion River crosses the road in a narrow, rock-lined gorge, cut into rocks of the Chancellor Formation. The trace of the original bedding can be seen in outcrops to be very nearly horizontal, but the slaty cleavage dips generally about 45 degrees to the west in this neighborhood. Darker rocks of the Chancellor Formation outcrop in the near ridges to the west. Far to the southeast the folded structure in the spur of Octopus Mountain is visible. To the west, parts of the great “Rockwall”, formed of rocks of the Ottertail limestone formation, are visible here and there up the river valley. The main peak nearby is Mount Vérendrye, which reaches an elevation of 10,125 feet above sea-level. Small glaciers and snowfields are visible on its lower flanks. To the east, the Goodsir Group forms all of the visible part of Hawk Ridge. Beyond the crest, however, the rock formations change abruptly into nearly horizontal Cambrian rock formations of the group that form the spectacular scenery between Marble Canyon and the northeast gate of Kootenay National Park.

Vermilion Crossing to Hawk Creek and Floe Lake trails—5.5 miles



The great “Rockwall” of Ottertail limestone with Mount Vérendrye to the left looms above the lower slopes across Vermilion River from the main highway, just north of Vermilion Crossing. Note that the main channel is cloudy grey with sediment while the quiet water in the foreground is clear.



Floe Creek tumbles down the steep mountainside in foaming white water. In the background is the great “Rockwall”, its head in the clouds. The piles of rock waste just below the snow are a combination of ‘scree’ or ‘talus’, and moraine from the moving glaciers that once occupied this area far more extensively than now.

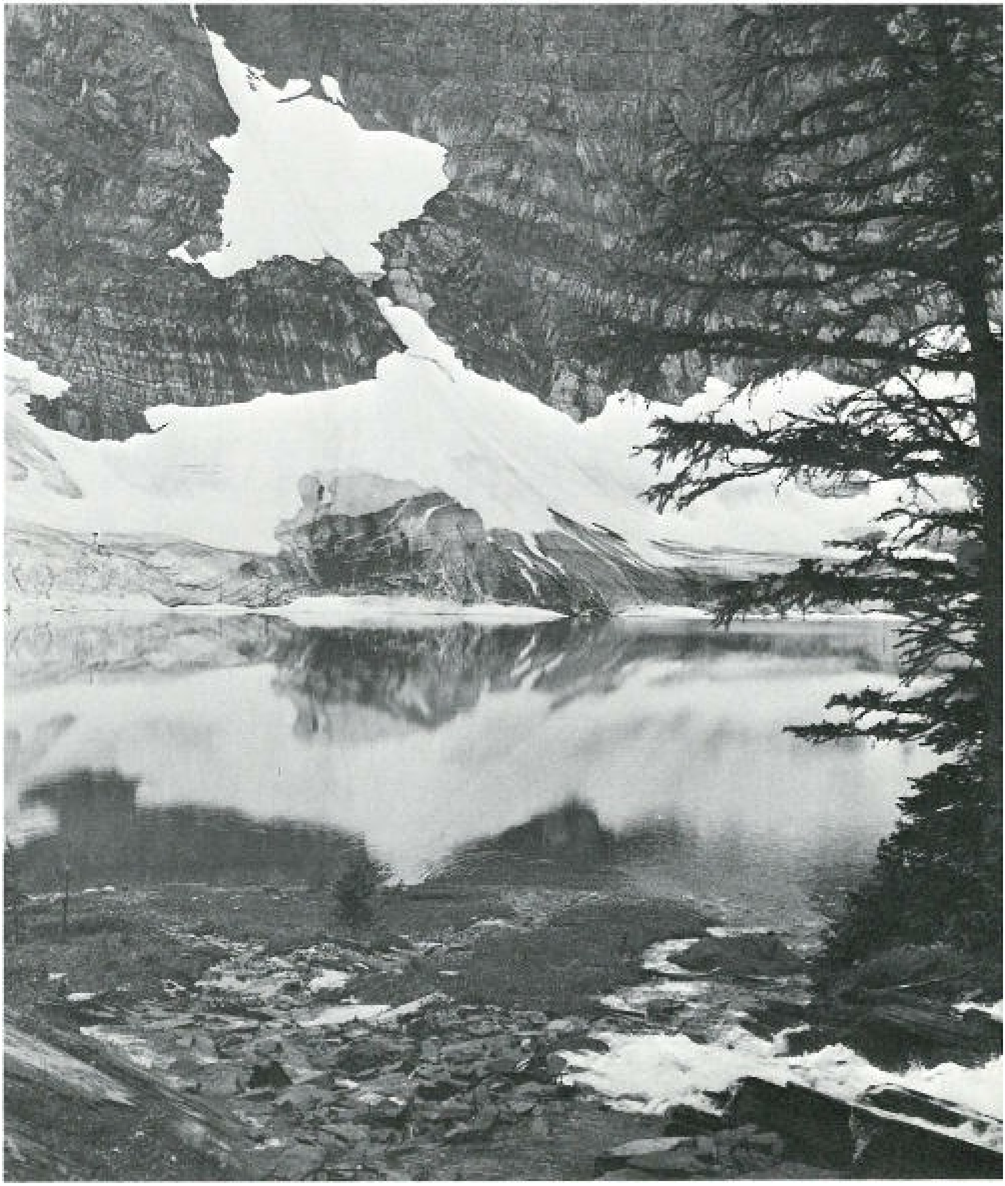
(15) Hawk Creek and Floe Lake Trails

Hawk Creek drains off the Ball Mountain Group and through Hawk Ridge to the northeast, and Floe Creek joins Vermilion

River from the height of land along Vermilion Range to the southwest. Along the road in this section of the Vermilion River valley, you get glimpses of the great cliffs of the “Rockwall”, which marks the eastern slope of the top of Vermilion Range. At many places it is visible in the gaps in the lower hills formed by the valleys of tributary creeks to Vermilion River. On the other hand the valley of Hawk Creek shows the horizontal limestones of the high peaks of the Ball Mountain Group to the northeast in a view through the works area on the north side of the road.

The massive vertical cliffs cut in the grey Cambrian limestones and dolomites of the Ball Mountain Group contrast sharply with the brownish and brownish-grey ‘scree’ slopes of the foreground mountains that are made of folded and sheared slaty rocks of the Goodsir Group. A short walk from the highway here along the Floe Creek trail takes you to Vermilion River at a place where it has cut a low gorge in sheared slates of the Chancellor Group. A walk of about 5 miles along Floe Creek will take you to Floe Lake which lies in a magnificent setting below massive cliffs of Ottertail limestone in the Rockwall, the spine of Vermilion Range. With its glacial-green colour and masses of glacial ice and snow at the foot of the enormous cliffs, Floe Lake is one of the beauty spots of Kootenay National Park.

Floe Lake trail to Floe Creek valley viewpoint—0.5 mile



Part of the great "Rockwall", with its skirt of glacial ice and newer snow, forms a background for the waters of Floe Lake. The rushing brook in the right foreground is building a small delta into the near side of the lake.

(16) Floe Creek Valley Viewpoint

This viewpoint provides a good view of the Rockwall at the head of Floe Creek valley. The Rockwall is a series of great cliffs, as much as 2,000 feet high, that occur all along the eastern spine of Vermilion Range. The bedding in the Ottertail limestone in the Rockwall dips gently westward and its trace can be seen looping gently in and out around the spurs. Vermilion River cuts into gravelly terraces on the outsides of bends just below the viewpoint and again downstream just opposite. A small brook tumbles in a series of lacy falls on a spur on the right side of the valley.

Floe Creek valley viewpoint to Numa Creek view—5.8 miles

(17) Numa Creek View

A view northeastward at this stop looks up the valley of Ochre Creek; the view southwestward is up the valley of Numa Creek toward the great Rockwall, which marks the spine of Vermilion Range on the east slope. From this point a section of Tumbling Glacier is visible at the foot of the Rockwall. Between Numa Creek and Floe Creek the flanks of the nearby hills provide unusual displays of snowslide meadows. In winter great snow cornices form along the edges of the nearby cliffs. When these cornices break off they start snowslides down the slight gullies and clean out all trees and boulders in their way. This process leaves dark coniferous woods in protected places and along the shoulders, and these contrast with the much lighter green of the low bushes that grow quickly in the snowslide paths in summertime. The spacing of gullies at the top of the ridge along here is probably due to joints or minor faults. At the foot of some of the snowslide meadows, masses of woody debris show clearly what the snowslides have done. To the northwest, long scree slopes of brownish Chancellor rocks are characteristic.

Numa Creek view to ochre pit stop—1.6 miles

(18) Ochre Pit Stop

From here we have an excellent view into Numa Creek, with Tumbling Glacier showing clearly along the foot of the great Rockwall of Ottertail limestone. The nearer slopes in the flanks of Numa Creek valley are clearly of a different rock—the brownish-weathering Chancellor Formation. The peak immediately east of here is Vermilion Peak, made up of strongly folded rocks of the Goodsir Group. Northward across the valley the same kind of rock formation is clearly visible. Northward and northeastward across the intervening Tokumn Creek valley, the massive grey cliffs cut in flat-lying Cambrian rocks of the Mount Whymper complex are clearly different from the mountains cut in folded rocks in the foreground and to the west. Away to the east the ramparts of Mount Eisenhower just show through the gap made by the valley of the uppermost part of Vermilion River.

Iron-rich waters come to the surface a few hundred yards from Vermilion River, about 2 miles southwest of the Marble Canyon stop. The iron is precipitated as limonite ($Fe_2O_3.2H_2O$) or common rust, and accumulates in these mound-shaped masses with pools of yellow-green water. The limonite is carried downstream into a bog and some of it even reaches the main river where it stains the gravels a conspicuous yellow-brown.

Across the river from this viewpoint the gravels on the right bank are heavily rust-stained. This is due to large quantities of iron oxide which issue from a series of springs a few hundred feet inside the woods on the north side of the river. These ochre springs may be reached by trail from Marble Canyon or across the footbridge from the sign. A short trip into the woods will take you into a very large, bright yellow-brown ochre bog. A little farther up the ochre-laden stream which runs through the bog are large springs which issue from the earth and precipitate iron oxide in the form of various hydrous compounds such as limonite. The water of the springs evidently rises under pressure, for it builds up pools rimmed with the iron oxide and spills out through small gaps to form the unusual limonite-laden streams below. At one time an effort was made to use the ochre commercially, and old machinery and tiles can still be seen in the vicinity.

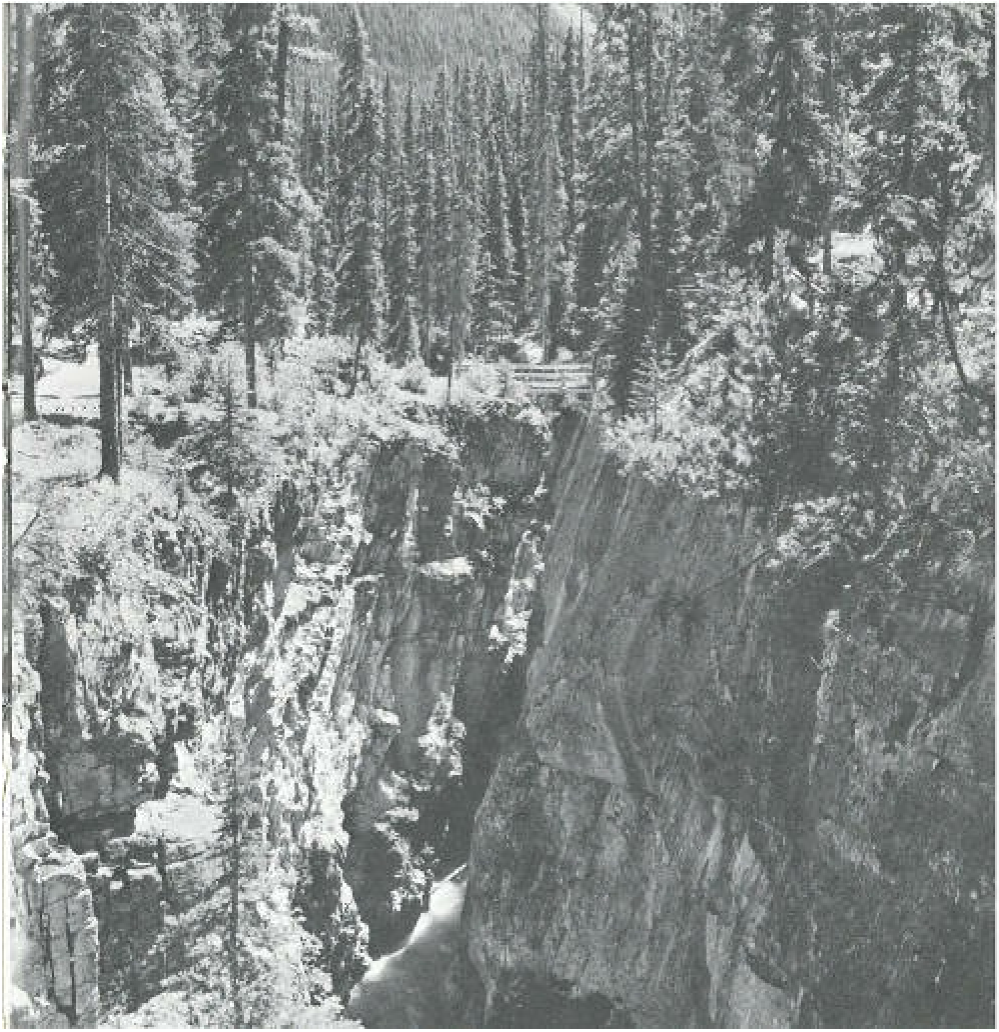
The highly rounded gravels in the river bottom opposite this viewpoint show that they have been transported a long way by water. It seems likely that it is largely glacial debris which has been carried and bumped along in stream bottoms for long distances to produce the high degree of rounding.

Ochre pit stop to Marble Canyon stop—2.0 miles

(19) Marble Canyon Stop

From the parking place a view all around will show several different kinds of mountains. To the west, down the valley of Vermilion River, the peaks of Vermilion Range form the skyline along the great Rockwall, cut in Ottertail limestone. Part of Tumbling Glacier is visible up the valley of Numa Creek. Due south, or to the left as you face down the stream, the more or less symmetrical mass of Vermilion Peak shows a complicated rock structure within and scree slopes made of rock fragments of the Goodsir Group. Its complicated internal structure, colour and shape contrast strongly with the mountains to the northeast of Haffner Creek valley, directly opposite this stop. From Stanley Peak nearby, to Storm Mountain far to the left or east, massive limestones of Cambrian age, including the Cathedral and Eldon Formations, make distinctive mountain peaks characterized by huge vertical cliffs alternating with terrace-like gentler slopes. The same rock formations and the same structures produce similar-looking mountains to the northwest of the headwaters of Vermilion Creek in the Mount Whymper area.

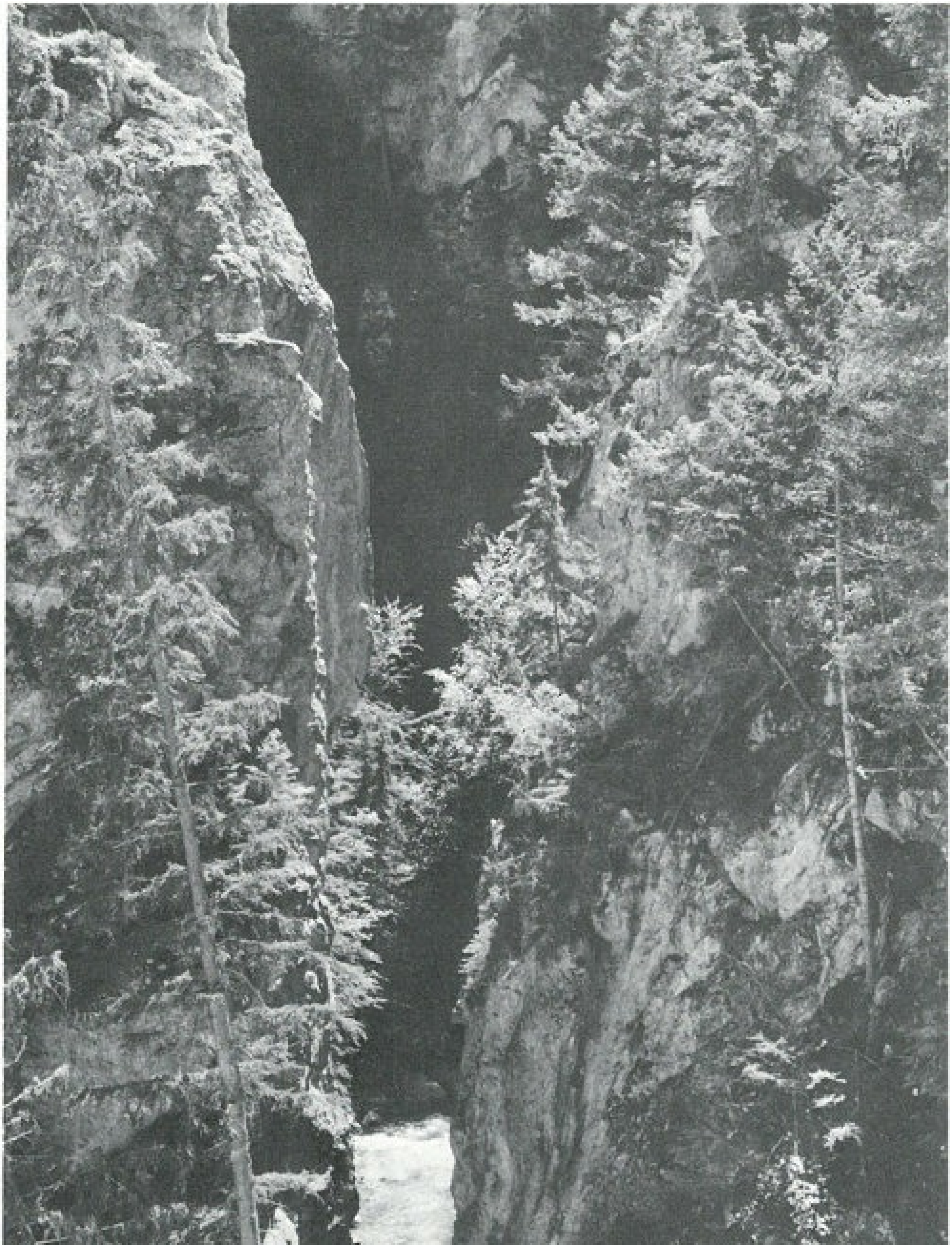
Near the parking lot the rocks are white marbles which have come from the recrystallization of limestone. In many places along Tokumm Creek, coming in from the northwest, and along the main thread of Vermilion River, coming in from the northeast, the marble has been eroded into unusual patterns. In some places single boulders or groups of boulders have been whirled round and round in currents to wear very round 'potholes' into the solid rock. Quite an unusual display of these potholes may be seen in the main stream a few hundred feet below the parking spot.


The rushing waters of Tokumm Creek have carved a steep-walled canyon in marbleized limestones of Cambrian age. At this point a few hundred feet above the Marble Canyon stop it can be clearly seen that the shape and course of the gorge are controlled by the jointing which dips diagonally down to the left.

A lovely walk up the valley of Tokumm Creek along Marble Canyon to the upper waterfalls takes in many features of geological interest. Tokumm Creek flows in a typical mountain valley along much of its length. Then, at the head of

Marble Canyon, it tumbles over a lip of very white marble which may be one of the Cambrian limestone formations that has been recrystallized and altered because of its nearness to a large fault. A 10- to 15-foot drop into a large pothole with violent water currents clearly visible in it is followed by a much higher waterfall into the main part of the canyon itself. It is interesting to note here that most of the water bypasses what used to be the main stream and now plunges into a deep hole, forming a more or less natural arch. There are several similar arches and partial arches lower in the canyon. It is probable that these begin by water leaking down cracks and joints in the rock, gradually dissolving and wearing away alternate channels. Once most of the water starts flowing through a shortcut, the speed of abrasion is greatly increased and in the space of a very few years the stream changes course. In many places in the canyon, rounded potholes and parts of potholes are visible. The strong influence of joints and splits along the canyon is visible in several places.

This perfect example of a 'pothole', formed where eddying currents whirl boulders round and round and gradually wear away the limestone, is found just a few hundred feet downstream from the Marble Canyon stop.



Tokumm Creek cuts deeply into marbleized limestones at Marble

Canyon near the northeast end of Kootenay National Park. The shape and position of the canyon are governed by joints, bedding, and other slight differences in the rocks.

A few hundred feet below the Marble Canyon stop the waters of

Vermilion River, here very low, have carved the limestone into this series of irregular passages and round holes. It has done this partly by solution, partly by abrasion by fine particles, and partly by boulders being spun around in eddying currents.

A horse and walking trail leads northwestward from 81
Marble Canyon along Tokumm Creek into some very beautiful mountain country. To the northeast of Tokumm valley, very high mountains support extensive icefields and several glaciers. Kaufman Lake, a turquoise gem among the mountains, lies in an elongated basin cut into the wall of grey rock several hundred feet above the waters of Tokumm Creek, some 7 miles northwest of Marble Canyon. It drains over the steep side of the valley in a ribbon of white water that is visible for miles.

The mountains on the northwest side of Tokumm Creek are cut into gently dipping, grey, Cambrian limestone and shaly limestone whereas those on the southeast side are composed of folded and faulted brownish shale with minor limestone beds of the Chancellor Formation and the Goodsir Group. The very different appearance on the two sides make Tokumm valley an unusual one, in addition to its being beautiful.

Marble Canyon to roadside stop—2.7 miles

(20) Roadside Stop Opposite Stream Valley coming in from Southeast

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Cloud shadows dapple the rocky peaks and wooded lower slopes of the valley that cradles Kaufman Lake (lower right) and part of the upper Tokumm Creek valley (middle foreground). The high mountains along the back belong to the Wenkchemna Peaks.

This stop is in the middle of a belt of great mountains formed in more or less flat-lying Cambrian limestones. Marbleized, white limestone is clearly visible all along the road between the Marble Canyon stop and this point. In the stream beside the road the same white rock is also very obvious. Straight south, a little to the left as you look downstream in the valley, are the regular slopes of Vermilion Peak with the complicated structures within its mass and the numerous scree slopes on its flanks. These contrast with the nearer mountains whose huge vertical cliffs are made of massive limestone. The upper cliffs of the mountains are cut in Eldon dolomite and the massive lower grey band is the Cathedral limestone. Travellers who have been into Yoho National Park will undoubtedly be struck with the great similarity of the mountains in the two places. The reason for the similarity is the occurrence in both places of the same rock formations and the fact that in both areas they are nearly flat-lying. Quartzites of the St. Piran Formation lie below the Eldon and Cathedral Formations and are exposed in the main road at and just east of the entrance to Kootenay National Park.

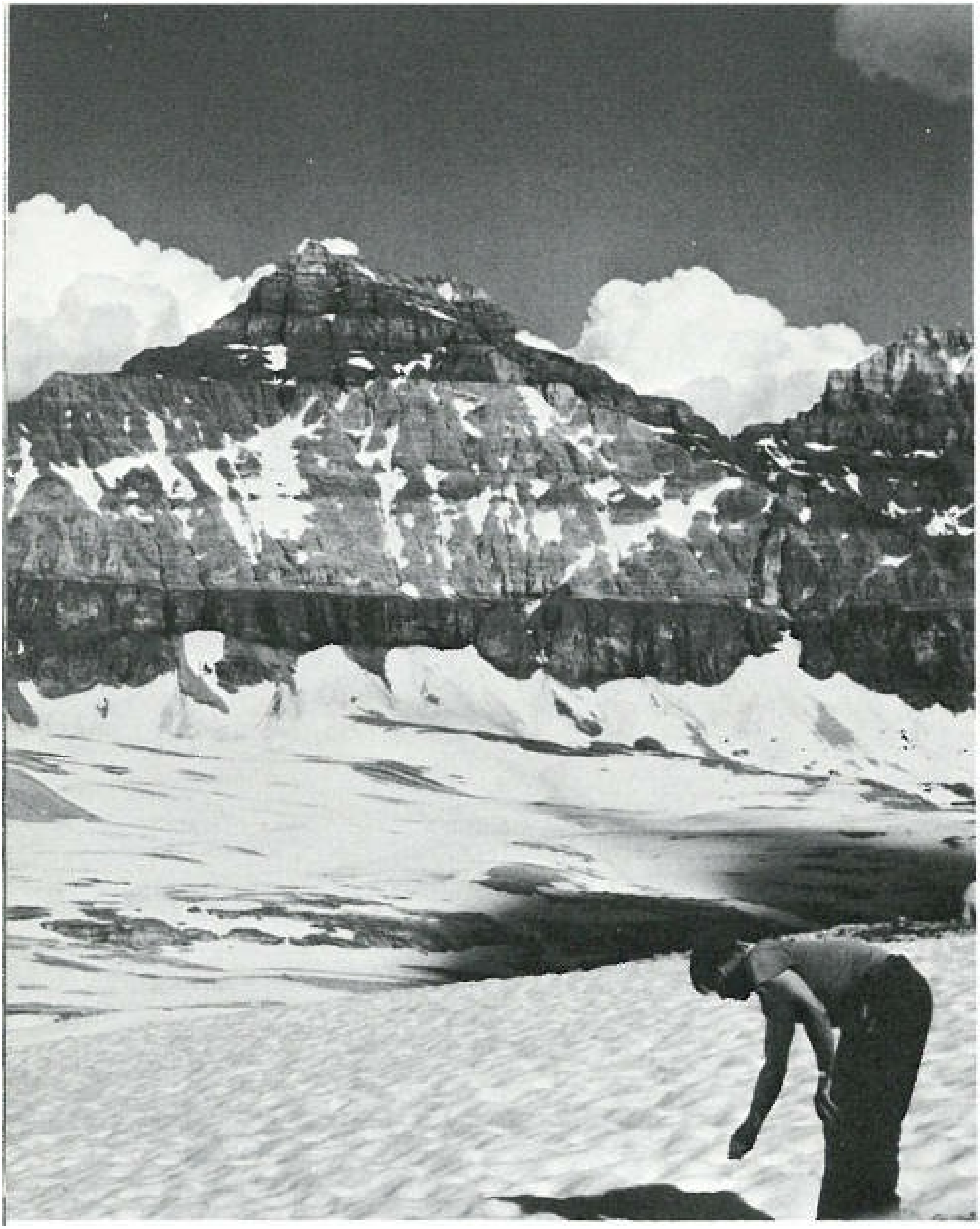
Road-cuts in this vicinity expose stratified sands and gravelly glacial till with little evidence of layering. Glaciers on Stanley Peak and surrounding peaks of the Ball Mountain Group are visible up the valley to the southeast.

Roadside stop to northeast entrance—1.7 miles

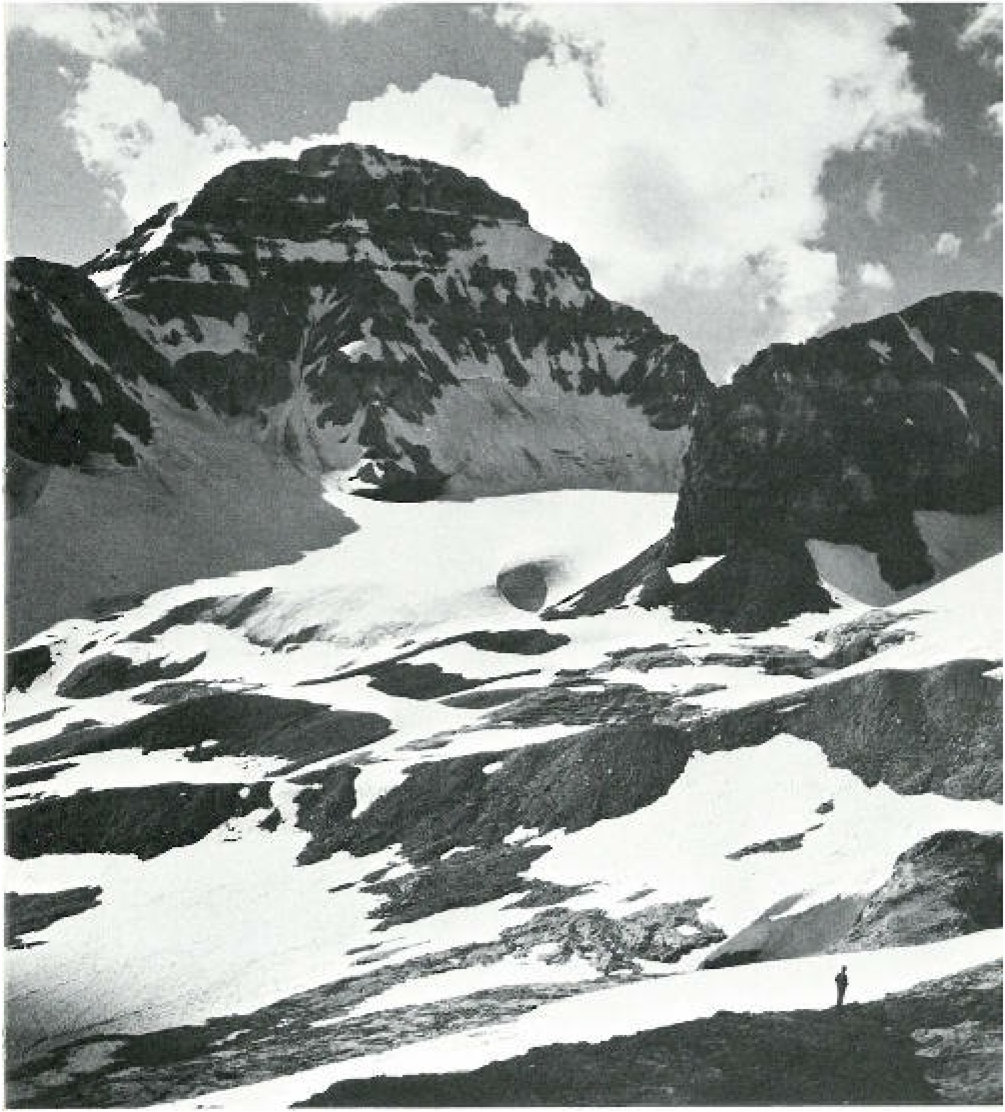
(21) Northeast Entrance

The boundary between Kootenay National Park and Banff National Park to the northeast is the continental divide. If you stop at the sign you will be able to look up the hillsides on both sides of the road and see the boundary as cleared lines through the woods going up the flanks of Boom Mountain northwestward and a subsidiary peak of Storm Mountain to the southeastward. The outcrops along the road in this vicinity and just to the northeast in Banff Park are of grey quartzites of the St. Piran

Formation. By following the sloping rocks one would conclude that much of the mountain to the southeast is the same quartzite formation, as is the front of Boom Mountain to the northwest. From the spot, precipitation is split into two drainage systems with very different routes. The water on the east side of the continental divide flows eastward through Altrude Creek to join Bow River and ultimately the Saskatchewan River system, which carries it into Hudson Bay. Water to the west of this divide on the other hand joins the headwaters of Vermilion River which meets the Kootenay, then the Columbia and finally flows into the Pacific Ocean near Portland, Oregon.



East of the valley of Tokumm Creek the mountains of Kootenay Park are cut into nearly horizontal layers of limestone and shaly limestone. Fresh snow on old ice on Quadra Glacier contrasts with the layered rocks in the background and the wind-dimpled snow in the foreground.



Man seems to count for little in the vast displays of rock, snow and ice of the high mountains. This area, west of Quadra Mountain, lies high above the east bank of Tokumm Creek, about 8 miles northwest of the Marble Canyon stop.

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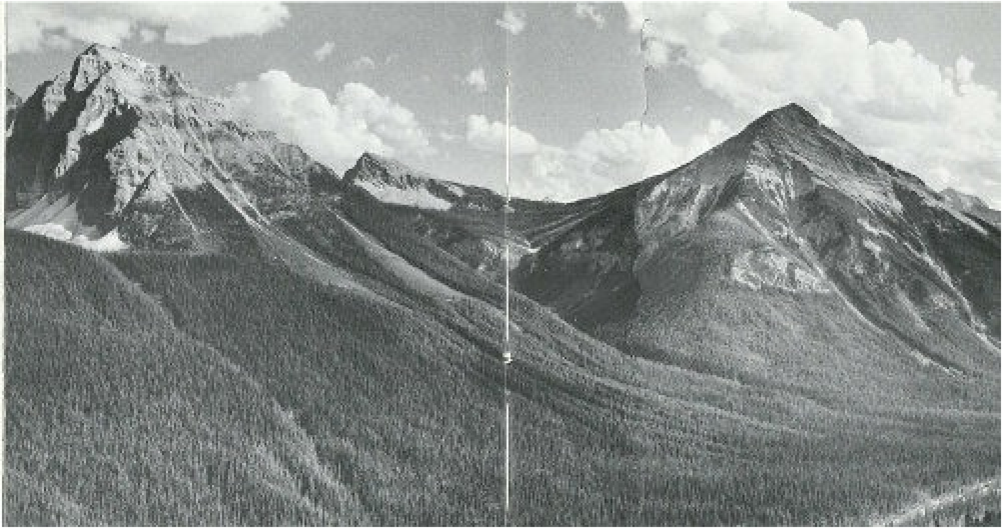

Hi-resolution Image

The symmetrical peak of Mount Vermilion, on the right, is formed of highly folded rocks of the Goodsir Group, of Upper Cambrian and Lower Ordovician age. These rocks have been pushed against the contrasting flat-lying, massive beds of Middle Cambrian age in the peaks to the left. The fault separating the two is thought by some to be the same fault seen on the flanks of Mount Stephen above Field in Yoho National Park.

Eastward across the valley of Bow River the ramparts of Mount Eisenhower dominate the near mountains, with various ridges of the Sawback Range farther distant to the right. 88

EPILOGUE

No matter where one travels in Canada's western mountains, the knowledge of the geological history spanning hundreds of millions of years can only increase the awe that is felt in these magnificent surroundings. Rows of parallel mountains that alternate with great open valleys reflect millions of years of erosion in complicated masses of rocks thrust up thousands of feet by enormous stresses inside the earth's outer framework. Rivers and brooks rise in remnants of glaciers and gush down the mountains in ribbons of white water, eroding the slopes and digging out valleys as rivers have done for millions of years. Ancient rocks that once were soft muds stirring to the wash of waves on the bottom of shallow warm seas now reflect the sun greyly from mountain peaks. Living creatures of the time, 500 million years closer to the beginning of life on this planet than we are, left their shells and imprints in the soft muds and 89
now we find them weathering out of the solid rocks, even on the highest ridges. People camp happily where mighty glaciers once spread their icy tongues, and in their long drawn-out dying, spewed forth sand and gravel in their meltwaters to floor the valleys with the waste of mountains. Everywhere we look we see nature seeking to redress imbalance—steep river banks slide away, rocks slowly weather, and muddy streams and silt-laden rivers carry debris to the sea as the mountains are being planed and the valleys filled.

For more information on the geology of Kootenay National Park see the following publications.

A Guide to Geology for Visitors in Canada's National

Parks, by D. M. Baird. Published by the National Parks Branch, Department of Northern Affairs and National Resources. Available from the Queen's Printer, Ottawa, or from any of the National Parks. This pocket-size book describes the general principles of geology with special references to the National Parks of Canada, written in layman's language (about 160 pages, 50 illustrations).

Alberta Society of Petroleum Geologists—Guidebook for the Fourth Annual Field Conference; Banff-Golden-Radium, 1954. A professional approach to the geology of a large area of country, including Kootenay National Park. This book includes general articles on the history of the area, the general geology, and roadlogs for certain highways. Available from the Alberta Society of Petroleum Geologists, 631 8th Ave. W., Calgary, Alberta.

Geology and Economic Minerals of Canada. Economic Geology Series No. 1 (1957) of the Geological Survey of Canada. This compilation of the geology of all of Canada contains a great deal of information on the western mountains. Available from the Queen's Printer, Ottawa, or from the Geological Survey of Canada, Ottawa.

Brisco-Dogtooth Map-area, British Columbia, by C. S. Evans, Geological Survey of Canada, Summary Report 1932, Part AII, pages 106-176. This is a report on the geology of an area along the eastern side of Columbia River Valley and includes some of the southwestern part of Kootenay National Park.

Geology of the Stanford Range of the Rocky Mountains, *Kootenay District, British Columbia*, by G. G. L. Henderson. Bulletin No. 35 of the British Columbia Department of Mines, 1954. This technical report covers an area that includes the southernmost part of Kootenay National Park.

Particular questions of a geological nature concerning Kootenay National Park should be addressed to the Director, Geological Survey of Canada, Ottawa, or to the office of the Geological Survey in Calgary or Vancouver.

For information on all other matters concerning the park, write to the Director, National Parks Branch, Department of Northern Affairs and National Resources, Ottawa.

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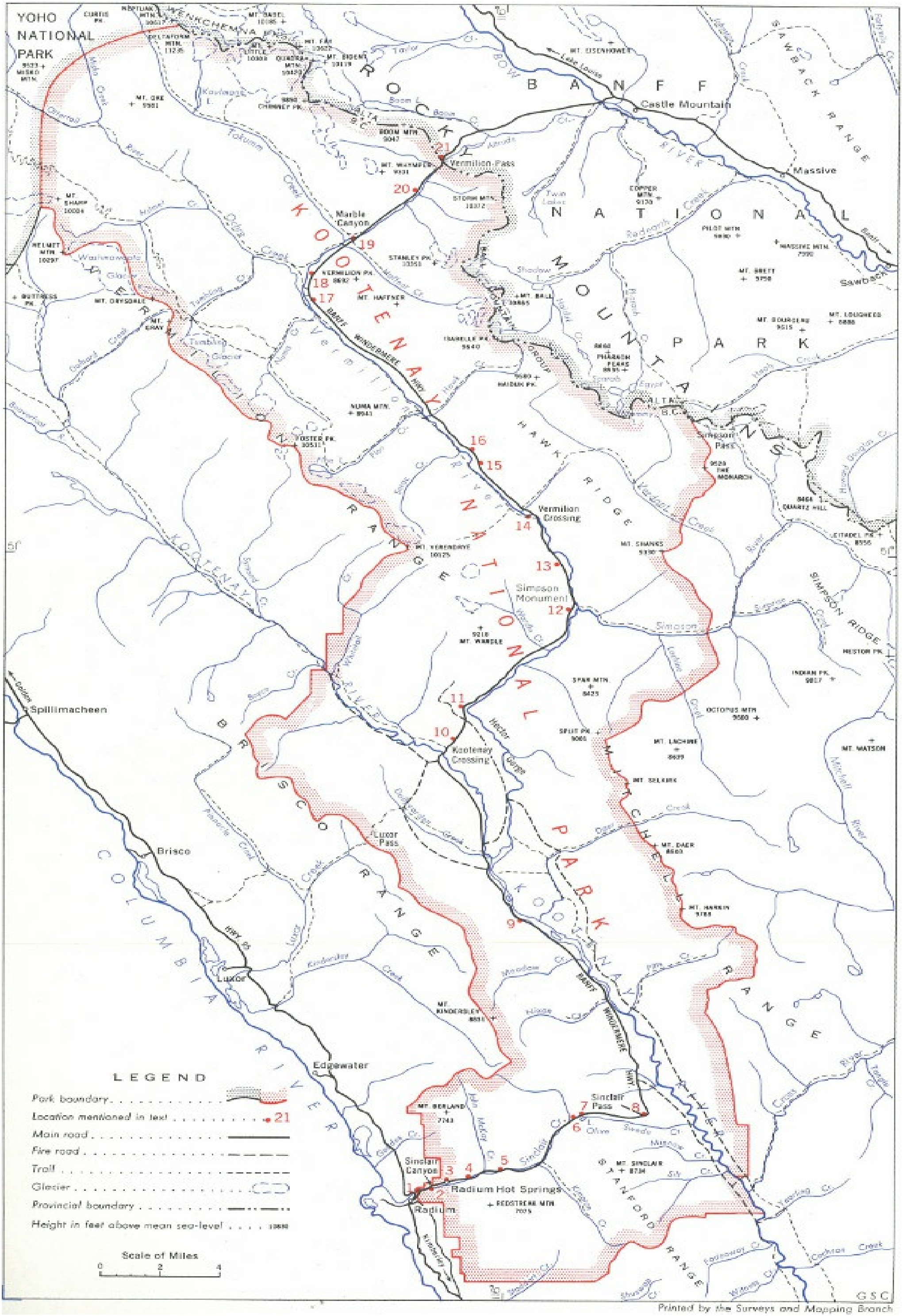

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This map at a higher resolution

Transcriber's Notes

- Some palpable typographical errors were corrected.
- Copyright and publisher's information was included from the printed copy: this eBook is public domain in the country of publication.
- In the Latin-1 version only, subscript numerals are preceded by an underscore and placed in brackets: as in "H_2O", the chemical symbol for water.

[The end of *Kootenay National Park: Wild Mountains and Great Valleys* by David M. Baird]