GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 69-11

HALFWAY RIVER MAP-AREA, BRITISH COLUMBIA

(Report, 6 figures and Map 1232A)

E. J. W. Irish

Price, $2.00

1970

CANADA

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E. J. W. Irish

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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Price: $2.00 Catalogue No. M44-69-11

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Queen's Printer for Canada
Ottawa
1970

FOREWORD

This report, based on field work by the author during the years 1959 - 1962 was written in 1963 for publication as a Geological Survey Memoir, but publication was delayed. In the meantime, further stratigraphic and structural studies of the Halfway River area and adjacent regions were made during a program designed to complete the geological description of the northern Rocky Mountains. Although some of this more recent information has rendered certain parts out of date, the report and map remain as an important contribution to the geology of the area and have, in fact, formed the basis for subsequent work. It has been decided, therefore, to publish the report and map without major changes, but with addition of addenda to each section in order to inform the reader of the refinements and changes to the geology made subsequent to the writing of the original text.

D. J. McLaren,
Director,
Institute of Sedimentary and
Petroleum Geology.

Geological Survey of Canada,
Calgary, December 15, 1969.

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ABSTRACT

Halfway River map-area, British Columbia, lies between 56 and 57 degrees north and 122 and 124 degrees west; it includes part of the Interior Plains and all of the Rocky Mountains and Foothills along Peace River valley. Most of the area is mountainous, has been glaciated, and is underlain by a succession of sedimentary strata, about 25,000 feet thick, and of Precambrian to Late Cretaceous age. For descriptive purposes the map-area has been divided into Rocky Mountains, Foothills, and Interior Plains divisions.

The region has been deformed by thrust faulting and by folding as a result of compressive stresses. Thrust faulting is considered to be the more important and the initial type of structural deformation within the Rocky Mountains. Folding is thought to have started after or contemporaneously with the initial thrusts and to have persisted after movement on the faults had ceased. Most of the thrust faults are west-dipping and some are folded. In the Foothills and Plains divisions folding may be the more important type of deformation.

Paleozoic strata underlie the Rocky Mountain division within the map-area. Few formational names exist for the lower Paleozoic rocks in this area and, because of east-west and probably north-south facies changes, new names have not been given at this time. A brief lithological description of each formation or larger unit together with its distribution and probable age is given. Several unconformities occur within the Paleozoic succession.

Mesozoic strata underlie the Foothills and Plains divisions of the map-area. Within these rocks existing formational names have been used and the lithology, paleontology, and distribution of each formation is described. Unconformities are present at the top of the Fernie Formation and within the Lower Cretaceous sequence.

Natural gas, the most important economic mineral, is produced in the northeastern part of the map-area. Large reserves of good coal are known in the Lower Cretaceous Gething Formation, but no mining is being done at this time.

The site finally selected for the high dam now being constructed for the British Columbia Hydro and Power Authority is located a short distance downstream from the head of Peace River Canyon. Stratigraphy and structure were important considerations in the choice of the site.

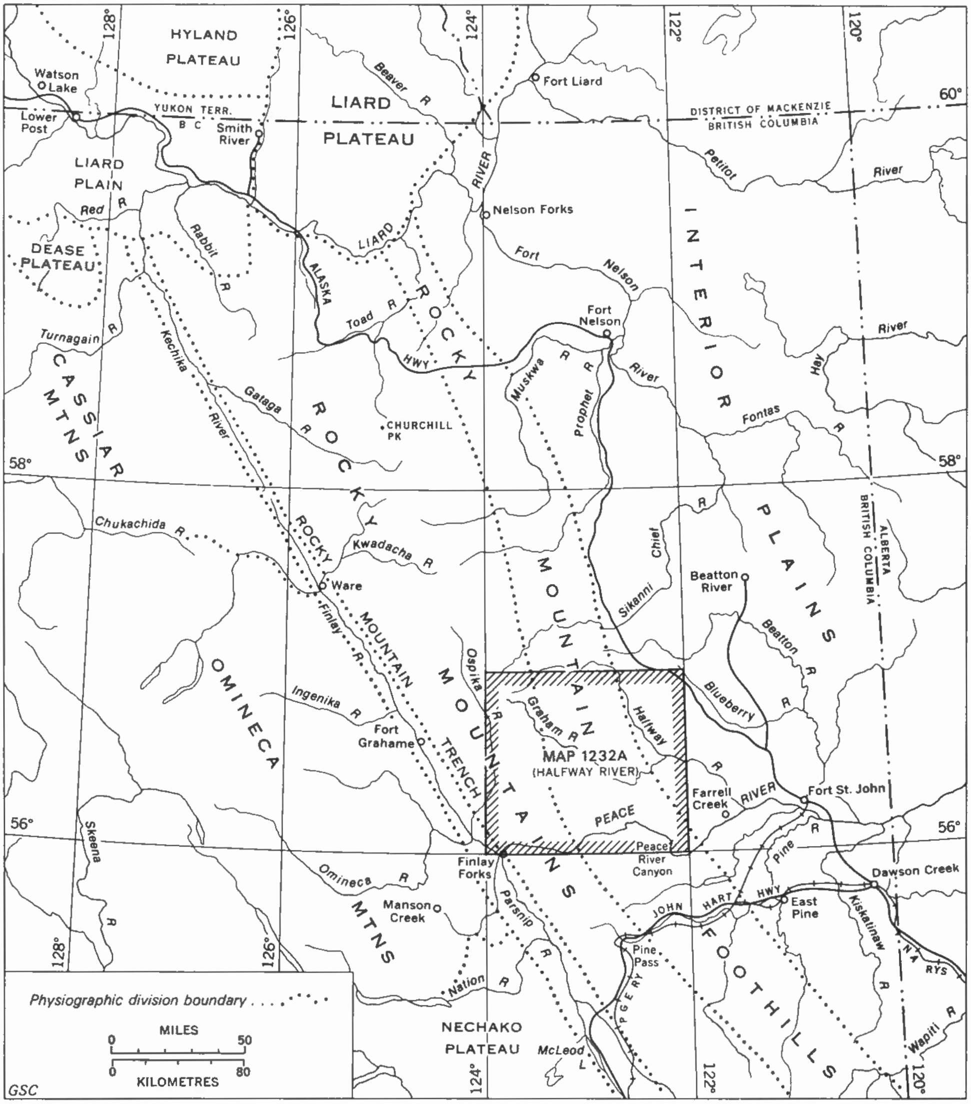

Figure 1. Location of map-area and chief physiographic divisions, northeastern British Columbia

HALFWAY RIVER MAP-AREA, BRITISH COLUMBIA

INTRODUCTION

Halfway River map-area comprises some 5,320 square miles of northeastern British Columbia, bounded by latitudes 56° and 57° N and longitudes 122° and 124° W. It includes parts of the Interior Plains, Foothills, Rocky Mountains, and the Rocky Mountain Trench.

Only a small part of the area is inhabited. The village of Hudson Hope, located at the lower end of Peace River Canyon, is the closest community to the map-area. Some grain farming is done, and several cattle ranches are located on the flats along Halfway River east of the Foothills and on the north side of Peace River for 20 miles west of the head of Peace River Canyon. The trapping of fur-bearing animals was once an important occupation in the district, but in recent years the number of full-time trappers has decreased considerably.

ACCESSIBILITY

The Alaska Highway, extending more than 1,500 miles northwest from Dawson Creek, British Columbia, to Fairbanks, Alaska, is the main route for the flow of goods into northeastern British Columbia. Dawson Creek can be reached by highway from Edmonton, Alberta, and by the Hart Highway from Prince George, British Columbia. The Alaska Highway crosses the extreme northeast corner of Halfway River map-area, and several poor dirt roads extend westward from the highway to the ranches along Halfway River. Farther south, a good all-weather road leaves the Alaska Highway at mile 54 and extends westward along the north side of Peace River valley as far as Hudson Hope (Pl. IA). From there a dirt road continues west through the pass known as the Rocky Mountain Portage to the western end of the Peace River Canyon, and then for another 20 miles well into the Foothills to Gold Bar, the site of the Beattie ranch.[1] From the Rocky Mountain Portage section of this road a branch extends northward to Beryl Prairie where several ranches are located. A poor road

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[1] Subsequent to the writing of this report, the hydro-electric dam near the head of Peace River Canyon has been completed with the result that the valley west of the canyon is now flooded and inaccessible.

Manuscript Received: November 15, 1963
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exists between East Pine on the Hart Highway and the south bank of Peace River opposite Hudson Hope. A Government ferry conveys vehicles to Hudson Hope on the north side of the river. If and when the river is bridged at this point the road will provide a more direct route for northbound traffic on the Alaska Highway from Prince George and southern British Columbia.[1]

Two railways service Dawson Creek: the Northern Alberta Railways from Edmonton was for many years the main link between Edmonton, Alberta, and the towns of the Peace River district; more recently the Pacific Great Eastern Railway joined Dawson Creek with Prince George via Pine Pass through the Rocky Mountains. Fort St. John, on the Alaska Highway north of Peace River, is serviced by a spur line of the Pacific Great Eastern that leaves the main line at East Pine in Pine River valley and crosses the Peace River about 3 miles above the highway bridge.

In the early days of the fur trade, and until relatively recent times, travel through northeastern British Columbia was by boat or horse in the summer, and by horse or dog sled in the winter.

Peace River is navigable for about 500 miles between Vermilion Chutes and Hudson Hope. Early settlers and travellers proceeded by horse and wagon from Edmonton north to what is now the town of Peace River and then up the river by paddle-wheel boat as far as Hudson Hope (Pl. IA). West of Hudson Hope it is necessary to portage around the 18-mile-long Peace River Canyon, but west of the head of the canyon the river is navigable again for small boats to its head and up both of its main tributaries, the Parsnip and Finlay Rivers. Travellers from Prince George can reach the head of Peace River by boat via Summit Lake, Crooked River, McLeod Lake, Pack River, and Parsnip River. Finlay River is navigable as far as Ware near the mouth of Kwadacha River, the only hazardous part being the half-mile-long Deserters Canyon.

In the early days of the Yukon gold rush, a pack-trail was cut from Old Fort St. John (just upstream from the Alaska Highway bridge) through the Rocky Mountains to Fort Grahame and thence to Whitehorse in Yukon Territory. The trail followed the north bank of Peace River and up Halfway River to Cypress Creek. From there it extended westward up Cypress Creek, through Laurier Pass, up Horn Creek, over a low pass into Ospika River valley, and then over to Ware on Finlay River. This trail can still be used today. Another pack-trail goes up the valley of Halfway River almost to Robb Lake at its head, then turns northward and crosses a low divide into the upper part of the valley of Sikanni Chief River. A third pack-trail into the map-area begins at Gold Bar, crosses the divide into Graham River valley, and then follows Graham River to join the other trails described above.

Besides these pack-horse trails, old trap-line trails still exist in places and can be followed with some difficulty. It is possible to travel with horses up Peace River from Gold Bar to Nabesche River, up Nabesche River, over into the valley of Needham Creek, and then over to join the trail up Graham River.

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[1] In 1963 Peace River was bridged just west of Hudson Hope and a paved highway completed from Chetwynd on the Hart Highway to Hudson Hope and the dam-site of the British Columbia Hydro and Power Authority near the head of Peace River Canyon. Secondary gravel and dirt roads also have been built.

Fort St. John can be reached by air from Edmonton, Alberta, and from Vancouver, B. C. via Prince George. Light float planes can land at several places on Peace River and on Lady Laurier Lake near the head of Horn Creek. Small wheel-equipped aircraft have landed on the long open river flat just north of Christina Falls on Graham River.

GENERAL CHARACTER OF THE REGION

In the Plains part of the map-area the country consists of low, somewhat flat-topped timbered hills and ridges separated by relatively wide stream valleys. West of the Plains, from northeast to southwest, the map-area changes progressively from the high, rounded, timbered ridges of the Foothills to the high, rocky, bare-topped ridges and peaks of the Rocky Mountains. The Rocky Mountains are bounded rather abruptly on the west by the Rocky Mountain Trench, a comparatively flat, narrow region that separates them from the Interior Ranges of British Columbia.

The region is generally forested below timber-line except where large areas have been burned. The typical forest community consists of white spruce, black spruce, lodgepole pine, and alpine fir. Balsam poplar (cottonwood or black poplar) is abundant on recent river flood plains and gravel bars, larch (tamarack) is confined to the muskegs, and paper brich, though not plentiful, is widespread in mixed stands. Aspen (white poplar) grows mainly east of the mountains, though it is common along the lower, grassy north slopes of Peace River valley. At most places where aspen grows, particularly along the valleys of Halfway River and its tributaries, there are associated open, grassy park lands. Above timber-line the vegetation consists of mosses, grasses, lichens, and alpine flowers.

The region has a relatively moderate climate. Most precipitation occurs as rain in the spring or early summer, the latter part of the summer being generally warm and dry. As on the plains to the east and southeast, there is a danger of harmful frosts, but much of the district produces first-class grain crops and is excellent for mixed farming and ranching. Garden produce, such as potatoes, cabbage, turnips, beans, peas, carrots, tomatoes, and beets are all raised on the fertile river flats along Peace River.

FAUNA

Big game is fairly plentiful throughout the district. Moose, caribou, mule deer, mountain sheep, mountain goat, black bear, and grizzly bear exist in varying numbers in selected ranges of the region. The smaller fur-bearers that are trapped include coyote, wolf, wolverine, lynx, fox, weasel, beaver, marten, otter, fisher, mink, and muskrat. Occasionally, a cougar or mountain lion is taken, but these cats are not common.

Game birds that may be hunted in season include Canada geese, many species of ducks, ruffed grouse, spruce grouse, and ptarmigan.

Rainbow trout, Rocky Mountain whitefish, Dolly Varden char, and Arctic grayling are found in most streams. Dolly Varden char weighing as much as 6 pounds have been taken from Robb Lake at the head of Halfway River, and pike may be caught in some of the more shallow lakes in the district.

HISTORY OF THE GENERAL REGION

Only a brief résumé of the more pertinent historical events is given here. For a more comprehensive history of the exploration of northeastern British Columbia, including Halfway River map-area, the reader is referred to McLearn and Kindle (1950).

The first white man to enter British Columbia via Peace River was Alexander MacKenzie (1801). In 1792 he established a fur-trading post at the mouth of Smoky River and, in May of 1793, went up Peace and Parsnip Rivers, then followed the Pack River - McLeod Lake - Crooked River route south to Fraser River. From there he travelled westerly to the Pacific coast by way of Westroad and Dean Rivers. Probably the first trading post in British Columbia was established in 1797 at the mouth of Tea Creek by John Finlay (the original site of Fort St. John). In 1805, Simon Fraser established posts at Hudson Hope and McLeod Lake and, from then on, the region was visited regularly by agents and voyageurs of the fur-trading companies. In 1824, John Finlay, an officer of the North West Company, first went up the river that now bears his name. Four years later, in 1828, Sir George Simpson (1872) travelled up Peace River and Parsnip River on a trip to the Pacific.

In his book, W. F. Butler (1874) described a trip during the winter of 1872 and spring of 1873 by dog sled from the forks of the Saskatchewan River to Fort St. John, then by canoe west from Peace River Canyon to Parsnip River. He travelled up the Omineca, an easterly flowing tributary of the Parsnip, to reach the Germansen River and Manson Creek placer fields, then proceeded south on foot and by horse to Quesnel. The Fort St. John of that day is described as a few ruined buildings on the south shore of Peace River, and Hudson Hope as a solitary house (Hudson Bay Company post).

In the following years the district was visited via the Peace River by such men as Horetzky and Macoun for the Canadian Pacific Railway, and by trappers such as Harry Moberly.

PREVIOUS GEOLOGICAL WORK

The first geological expedition into this region was headed by Alfred R. C. Selwyn for the Geological Survey of Canada in 1875. Selwyn, accompanied by botanist John Macoun, entered the country via Quesnel and Parsnip River. He travelled down the Peace River as far as Fort St. John and explored Pine River valley.

George M. Dawson of the Geological Survey of Canada passed through the Peace River country in 1879 en route from Port Simpson on the Pacific to Edmonton. On this trip Dawson was assisted by R. G. McConnell; they travelled a large part of the way with H. J. Cambie and H. A. F. MacLeod who were searching for a favourable railway route to the Pacific on behalf of the Canadian Pacific Railway. In 1893 R. G. McConnell re-visited the Peace River region. He travelled down Parsnip River and then Peace River as far as the Foothills and, after a hasty examination of the structure of the Rocky Mountains, returned to Parsnip River at Finlay Forks.

An investigation of the coal deposits near the south side of Peace River Canyon was made by C. F. J. Galloway for the British Columbia Department of Mines in 1912. In 1917, F. H. McLearn examined the rocks along Peace River from Twelvemile Creek (Dunlevy Creek) west of Peace River Canyon down to Vermilion.

In 1920 the British Columbia Department of Lands sent John A. Dresser and Edmund Spieker to examine the possibility of oil fields in the Peace River region. Dresser (1921) investigated an area north of Peace River and west of the Peace River block, while Spieker's report (see Dresser, 1921) includes a geological map that covers an area from Hudson Hope south to Pine River and southeast to Flatbed Creek. During the same summer F. H. McLearn (1921) studied sections along the north side of Peace River from the head of Peace River Canyon to 5 miles west of Schooler Creek.

From June 1921 to June 1922, the British Columbia Department of Lands bored five diamond-drill holes about a mile apart along Farrell Creek and tributary streams some 18 miles northwest of Hudson Hope. The holes were drilled to a depth of about 2,300 feet through Fort St. John shales and sandstones and ended within the top of the Bullhead Group. Some gas and water were encountered (Dresser, 1922). F. H. McLearn returned to this district in 1922 to study both the Triassic and the coal-bearing formations in the vicinity of Peace River Canyon. His report (1923) lists fifty coal seams in the Gething Formation.

In 1923 John D. Galloway visited the region for the British Columbia Department of Mines. His report (1924) describes the occurrence of coal on Carbon Creek, gives some notes on the coal deposits of Peace River Canyon, and describes briefly some placer mining operations on Peace River. During the summer of 1930 C. W. Sternberg of the Geological Survey of Canada made a study of the dinosaur tracks that are so plentiful in the Gething coal-bearing beds of Peace River Canyon.

M. Y. Williams and J. B. Bocock were engaged in geological investigations for the Pacific Great Eastern Survey of Resources during the summers of 1929 and 1930, under the joint auspices of the Province of British Columbia, the Canadian National Railways, and the Canadian Pacific Railway. They mapped the valley of Peace River from the mountains to the Alberta boundary, surveyed the entire valley of Pine River, and mapped the Peace River block.

During the summer of 1942, H. H. Beach and J. Spivak made a geological survey of the Dunlevy - Portage Mountain map-area west of Hudson Hope, between latitudes 55° 45' and 56° 15' and longitudes 122° and 122° 30'.

In 1943, during construction of the Alaska Highway, many field parties were engaged in geological reconnaissance studies along various parts of this road. In this same field season F. H. McLearn and E. J. W. Irish (1944) searched for workable coal seams in the Foothills on the north side of Peace River.

W. H. Mathews investigated the coal deposits and stratigraphy of the Carbon Creek - Mount Bickford map-area for the British Columbia Department of Mines in 1944 and 1945. His report (1947) includes a coloured geological map of the area.

Charlie Lake map-area, adjacent to the Halfway River map-area on the east, was mapped by E. J. W. Irish during the field seasons of 1956 and 1957. Pine Pass map-area, adjacent on the south to Halfway River map-area was mapped by J. E. Muller in 1959 and 1960. Detailed studies of the Triassic in Halfway River area have been made by B. R. Pelletier in 1960, 1961, and 1962, and of the Cretaceous strata by D. F. Stott in 1961 and 1962.

Since 1943 many oil companies have been conducting geological explorations in the country made accessible by the Alaska Highway and, for the past 5 or 6 years, several of these companies have been engaged in stratigraphic and structural studies in the Halfway River map-area.[1]

FIELD WORK AND ACKNOWLEDGMENTS

The field work on which this report is based was done during the summers of 1959, 1960, 1961, 1962.

To the following geology students, the writer wishes to convey his appreciation for satisfactory and, more often, excellent assistance in the field: G. F. Shillington, R. T. Bell, and F. Perrino in 1959; W. W. Nassichuk, W. J. P. Crawford, B. B. Hooker, and K. Domai in 1961; and by K. Domai, C. K. Roberts, K. V. Campbell and L. Meech in 1962.

Special thanks are extended to Mr. Donald MacDougall of Hudson Hope who held the position of cook on the writer's field parties; his whole-hearted co-operation was greatly appreciated. For assistance and numerous courtesies the writer is indebted to many residents of the district, particularly to R. Beattie, Jr., W. H. Beattie, J. H. Beattie, J. Barkley, M. E. Vince, and R. Lynn Ross. In a number of instances assistance was given by officers of various oil companies and, to these also, the writer wishes to express his thanks.

The Paleozoic fossils collected were identified and dated by D. J. McLaren, A. W. Norris, B. S. Norford, E. W. Bamber, P. Harker, T. E. Bolton, and G. W. Sinclair, and those of Mesozoic age, by F. H. McLearn, E. T. Tozer, H. Frebold, and G. Jeletzky, all of the Geological Survey of Canada.

PHYSIOGRAPHY

The map-area includes parts of two major, physiographic divisions: the Interior Plains and the Canadian Cordillera. Within the Cordillera most of the map-area takes in a part of the Rocky Mountains and Foothills, but to the southwest it includes, also, a small part of the Rocky Mountain Trench (see Fig. 1). The Rocky Mountains are only about 25 miles wide where they are traversed by Peace River; this is a minimum width since both north and south of this point they gradually widen.

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[1] References to geological and paleontological work within Halfway River map-area since this report was written are listed as addenda after each stratigraphic division.

The detail of the present landscape is considered to be the result of modifications by glacial and glaciofluvial processes dating from the occupation of the area by ice of the Pleistocene continental glaciers that covered the Plains and of the Cordilleran valley glaciers within the mountains. It is unlikely that the mountains were completely covered by the Cordilleran ice-sheet. The land surface left by the ice has been subsequently modified by frost and stream action to produce the present land forms. Erosion processes owing to frost and streams are still active, but no glaciers remain within the map-area.

TOPOGRAPHY

INTERIOR PLAINS

The Interior Plains comprise relatively high, rolling, or slightly undulating country that is underlain mainly by flat or gently folded Lower and Upper Cretaceous beds. In the southern half of the map-area the western boundary of the Plains is marked by the Butler Ridge - Hackney Hills line of folding and faulting. From there north, however, Pink Mountain, north of Halfway River and its extension south of Halfway River within the map-area, forms a prominent topographical feature that clearly marks the transition from Plains to Foothills.

West of Halfway River valley the main topographic features are relatively flat-topped, irregularly-shaped hills that are separated by wide, low areas with shallow, drift-filled river and creek valleys. The mesa-like hills owe their existence to a capping of relatively hard sandstone of Early Cretaceous age. The adjacent lower-lying areas, with subdued topography, are largely underlain by shale. The hills have an elevation of about 3,500 feet, whereas the valley bottoms are somewhat less than 2,500 feet, so that the relief for this region is approximately 1,000 feet. The region east of Halfway River has much the same relief but is featured by numerous southeast-trending stream valleys separated by long, relatively narrow, inter-stream areas, the high parts of which are capped by the relatively resistant Upper Cretaceous Dunvegan sandstone. The northeast side of Halfway River valley consists of a low scarp formed by the sandstones of the Sikanni Formation (Pl. I, B).

FOOTHILLS

The Rocky Mountain Foothills separate the Rocky Mountains on the west from the Interior Plains. They occupy a belt between 28 and 34 miles wide within the Halfway River map-area. The eastern front of the Foothills is marked by the first intensely folded and faulted zone west of the Plains. The western boundary of the Foothills is placed arbitrarily. In the southern half of the area it follows the eastern side of the Mount Brewster group of ridges and peaks and the series of high ridges composed of Mississippian beds north of this group as far as Needham Creek (Pl. VII, B). From Needham Creek northward Mississippian strata mainly underlie the topographically subdued area in which is located the upper part of Graham River valley, so that the Rocky Mountains - Foothills boundary is placed on the west side of this area.

The Foothills, underlain predominantly by Mesozoic rocks, are typically characterized by high northwesterly trending ridges and steep-sided valleys that are generally parallel with the strike of the underlying strata. These ridges are more rounded, and the slopes of the intervening valleys are more gentle than those of the Rocky Mountains. The ridges rise to altitudes of between 5,500 and 6,500 feet above sea-level, giving a local relief of between 2,500 and 3,500 feet. Since Peace River valley has an elevation of only 1,900 feet, however, the maximum relief for this region is 4,600 feet.

ROCKY MOUNTAINS

The Rocky Mountains lie between the Rocky Mountain Trench on the west and the Foothills on the east. This wall of mountains, traversed only by Peace River, consists of ranges that have a northwesterly alignment. This alignment is in part destroyed by subordinate east-west ridges that trend nearly normal to the strike of the formations. These ridges with the intervening valleys extend both east and west from a central divide. The lack of lineation in the mountains as compared with the Foothills is conspicuous on topographic maps of the district.

Except in the southwest corner of the map-area where metamorphosed sediments occur, the mountains are formed mainly by a thick succession of massive and resistant carbonate strata of Paleozoic age. These beds have been folded and faulted. Thrusting of the massive and resistant carbonate beds relatively to the northeast has resulted in steep northeast-facing slopes and, normally, gentle southwest-facing dip slopes. Erosion has produced rugged and precipitous ridges separated by deeply incised stream valleys. The altitude of the ridges above sea-level is between 6,500 and 8,000 feet. The average relief is about 3,000 feet, but is as much as 4,500 feet along the valley of Peace River. The highest peak is Mount Kenny, in the northwest corner of the map-area which reaches an altitude of more than 8,700 feet.

ROCKY MOUNTAIN TRENCH

The Rocky Mountain Trench forms the west boundary of the Rocky Mountains. In the extreme southwest corner of Halfway River map-area the valley of Finlay River and the head of Peace River valley occur within this trench. The Trench is 4 to 8 miles wide and its relatively flat floor is at an elevation of just under 2,000 feet above sea-level. Generally well-terraced gravels and silts obscure bedrock at most places.

DRAINAGE

Although glacial processes have produced much of the present detailed form of the landscape features within the map-area, the basic pattern of mountain ridges and valleys, which was available for modification, was the result of pre-glacial stream action.

All streams in the area are tributary to Peace River which empties into the Arctic Ocean. Its two largest tributaries are the Parsnip and Finlay Rivers that flow northwest and southeast, respectively, within the Rocky Mountain Trench and join just south of the southwest corner of the map-area to form Peace River. Ospika River flows southerly just within the west border, then turns west to empty into Finlay River west of longitude 124 degrees.

Nabesche River has its source on the eastern side of the Rocky Mountains and flows generally south to enter Peace River just east of the mountains. The position of this stream appears to be controlled by structure to a large extent. Graham River begins on the eastern side of the mountains, then flows in a general southeasterly direction through most of the Foothills before turning north of east through the eastern ridges to join Halfway River toward the eastern border of the map-area. The course of this stream appears to be partly guided by structure. Halfway River, having its source in the Rocky Mountains just south of the northern boundary of the map-area, flows east through the Foothills before turning southeast across the Plains. Cypress Creek, Chowade River, Horseshoe Creek, and Blue Grave Creek are east-flowing tributaries of Halfway River. Two of these, Cypress Creek and Chowade River, begin near the extreme western edge of the Foothills. Farther south the courses of Schooler Creek and Carbon Creek, flowing south and north to Peace River respectively, are controlled by the Foothills structures. Many of the small creeks throughout the map-area cut across the structures at various angles locally, but in general, their courses are guided by the distribution of the less resistant strata.

Peace River, from its head at the confluence of the Finlay and Parsnip Rivers in the Rocky Mountain Trench, cuts through the entire width of the Rocky Mountains and Foothills from west to east just north of the southern boundary of the map-area. The river now occupies a pre-glacial valley between 2 and 3 miles wide and roughly 700 feet deep which is possibly antecedent and shows very little structural control except at the site of the late Pleistocene diversion south of Portage Mountain. Its course around Portage Mountain, where the river now occupies a deep canyon, may have been locally controlled by a plunging anticline (Pl. VIII, A, B).

From the Rocky Mountain Trench to the head of Peace River Canyon the Peace River is mostly a smoothly flowing, navigable stream (Pl. III, A; Pl. IV, A). The only exceptions to this are at Rapide-qui-ne-parle-pas, just west of the mouth of Nabesche River, Little Parle-Pas Rapids just east of the mouth of Nabesche River, and Finlay Rapids (Pl. IVB) just east of the confluence of Parsnip and Finlay Rivers. Contrasting with the normal quiet flow in the mountains and foothills is the rough and turbulent water in Peace River Canyon, the upper reaches of which no boat can navigate. As it approaches the eastern border of the foothills, Peace River spills over the rocky wall on the south side of the valley instead of following its original, pre-glacial or interglacial course between Portage Mountain and the southern end of Butler Ridge (Pl. III, B). The old channel is now blocked with unconsolidated morainal deposits and is followed by the road known as Rocky Mountain Portage. The rock wall over which the river enters the canyon, though lowered somewhat by erosion, still acts as a dam and maintains within the foothills and mountains a higher base-level than the original level through the old gap; it thereby produces the low gradient upstream through the mountains and foothills.

Along the valley and between 20 and 40 feet above the river are broad flats underlain by gravel and silt. These flats alternate between the north and south sides of the river. Above these flats are high terraces carved from sandy gravel, boulder clay, and in some places bedded lake clay and silt that occur at elevations between

2,000 and 2,050 feet and between 2,300 and 2,400 feet (Pl. IX, A, B). Some of these terraces are continuous for miles, but most exist now only as remnants. Some terraces extend a considerable way up the valleys of such large tributaries as Schooler Creek and Carbon Creek. Similar terraces occur along the valleys of Graham, Halfway, and Ospika Rivers, though generally these do not have the striking appearance of those along Peace River valley. An isolated terrace remnant is present near the main fork of Gauvreau Creek between 5 and 8 miles above its mouth. The top of this remnant is just above the 3,000-foot contour.

Many of the smaller tributaries of Peace River flow in narrow valleys and cut V-shaped notches through the terraces where they enter the main valley. Low alluvial fans are built up by these streams where they flow out onto the valley flats.

Finlay and Ospika Rivers, flowing mainly through Pleistocene silts, are rarely clear and this condition is passed on to Peace River. The water of most other streams is quite clear except during the high water stages. During times of flood vast quantities of sand and silt are carried by all streams within the map-area.

GLACIATION

Glacial deposits are found in all the larger stream valleys and cover most of the Plains part of the map-area, the melting of the ice resulted in the deposition of boulder clay, sand, and gravel. Bedded clays and silts, some of which are varved, where laid down in the numerous temporary lakes that formed near the melting ice fronts.

Armstrong and Tipper (1948) presented evidence that indicates a great movement of glacial ice eastward across north-central British Columbia in Pleistocene time. Some of this ice escaped to the plains by way of the major river valleys and, perhaps by way of the lower mountain passes.

In the Rocky Mountains the effects of glaciation seem to have been less pronounced in the region just north of Peace River than in areas farther north and south. Within Halfway River map-area it seems likely that valleys on both sides of the drainage divide and, in some cases, the low divide itself were filled with ice. The heads of some valleys on the east side of the divide exhibit relatively flat basins or poorly developed cirques. The ridges and peaks, which are mostly sharp and very rugged, show no features that can be attributed to ice erosion. The terrace remnant in the valley of Gauvreau Creek, a westerly flowing tributary of Finlay River, is at an elevation of about 3,000 feet above sea-level, and since this terrace must have been formed subsequent to the retreat of glacial ice from the valley, the height of the ice at its maximum advance must have been above this elevation. No glaciers remain in the mountains in Halfway River map-area.

Glacial deposits mantling the upland areas east of Halfway River range in thickness from zero to about 50 feet and may have been left by the continental ice from the northeast. The relationship between fluctuations of the Laurentide ice on the east and the Cordilleran ice to the west is not yet fully understood. Also, just where these two ice sheets met on the plains has not been determined. Williams (1944) believed that the continental ice-sheet extended into the Foothills valleys for a time in the region west of Fort Nelson. Mathews (1962) considered it probable that the last advance of Cordilleran ice to a line about 10 miles southwest of the town of Fort St. John occurred after the continental ice had withdrawn east of this limit.

There is no doubt that the main valleys were filled with ice during some part or parts of Pleistocene time and that drainage systems were markedly modified by these glaciers. The advancing ice deepened the original valleys, truncated spurs, and, on retreating, left hanging valleys and deposits of morainal and outwash material (Pl. IV, A).

The valley of Peace River through Rocky Mountain Portage was so choked with morainal debris that a new route was occupied by water flowing from the retreating ice. This new route, south of Portage Mountain, was sufficiently low that waters dammed by continental ice to the east backed up through it to form a lake. At its maximum height this lake extended at least 40 miles west of Rocky Mountain Portage; over this distance there are terraces of lacustrine and pitted outwash sediments to an elevation of about 2,400 feet (Pl. IX, A, B). When this lake was later drained, Peace River, rather than cutting through the morainal fill in the pre-glacial channel through Rocky Mountain Portage, flowed over a low point on the west side of Portage Mountain and then south for 10 miles to join the Johnson Creek drainage. This latter northeasterly flowing stream joined the original Peace River valley a few miles east of Portage Mountain. Since that time the lacustrine fill has been removed and the river has cut to a depth of as much as 300 feet into bedrock, forming the Peace River Canyon (Pl. VIII, A, B). The slow cutting of the canyon resulted in a similar slow erosion of the lacustrine, till and outwash deposits occupying the valley upstream and produced a series of terraces along the valley sides.

On the Plains the present gradient of Peace River is approximately the same as that of the inter-glacial or pre-glacial channel, though somewhat lower. This fact excludes the possibility of any significant post-glacial tilting. Drilling has shown that the bedrock floor of Peace River within the mountains and foothills is roughly 300 feet deeper than it is out on the plains. Mathews (1962) attributed this overdeepening within the mountains and foothills to glacial scour by ice tongues moving easterly. Where these tongues reached the plains they spread out and lost most of their power of entrenching their floors.

Bedded and varved lake clays as well as sands and gravels occur also in the valleys of Halfway and Graham Rivers. At present these unconsolidated deposits appear to be confined to the present stream valleys or close to them, but once may have covered large areas of the present lowlands.

At the close of Pleistocene time the whole country may have been several hundred feet lower than at present, and the valleys clogged with morainal and glaciofluvial deposits. With the disappearance of the ice the land rose slowly and re-excavation of the stream channels began. The process is still continuing and is controlled to a large extent by the pre-glacial pattern. If, as happens in some places, the new channel crosses rock spurs in the old valley rapids may be formed.

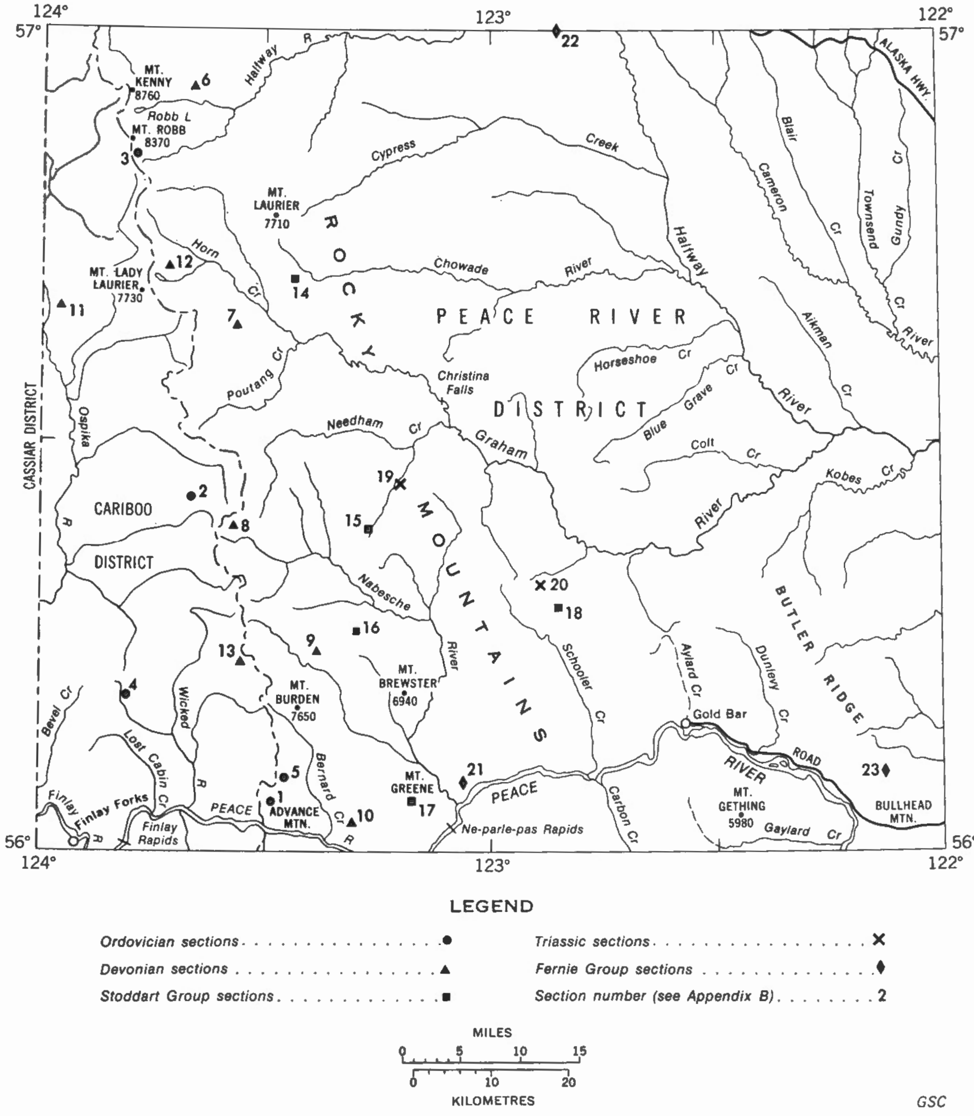

Figure 2. Index map showing location of measured sections

STRATIGRAPHY

The map-area is underlain by a succession of marine and non-marine sedimentary strata of Precambrian (?) to Late Cretaceous age with a total thickness of nearly 25,000 feet. The strata have been deformed by folding along axes having a general trend of N 30° W and by thrust faults that tend to parallel the axes of the folds. As a result, the rock formations within the Mountains and Foothills physiographic divisions are generally exposed as long, relatively narrow, northwest-trending bands. East of the Foothills, where deformation has been less intense, the formations are less regularly disposed.

Strata outcropping at the surface decrease in age progressively from west to east across the map-area. The Misinchinka Group, which probably includes the oldest rocks, is exposed only in the extreme southwest corner of the area along the western side of the Mountains and within the Rocky Mountain Trench. Paleozoic rocks of Cambrian to Permian age outcrop mainly in the Mountain division. The Foothills are underlain predominantly by Triassic, Jurassic, and lowermost Lower Cretaceous rocks; surface rocks in the Plains in the east and northeast parts of the map-area are of Early and Late Cretaceous ages.

The formations are best exposed in the mountain ranges where topography is rugged and relief pronounced. Elsewhere outcrops are found chiefly in canyons, cliffs, and on the higher ridges above timber-line. In most places outcrops are sufficient to permit reasonably accurate location of geological boundaries but, in parts of the area, these positions have had to be inferred from relatively few outcrop data.

The rock units in Halfway River map-area appear to be transitional lithologically between those of the same age in the more southern and more northern parts of the Rocky Mountains. Correlation within the area itself is complicated by facies changes both from east to west and from north to south.

Most of the terminology used for formations and groups within Halfway River map-area has already been established, but in much of the Paleozoic succession no division into formations has been attempted.

Terminology used in subsurface correlation in the oil and gas fields farther east is not generally applicable to the mapping of formations outcropping at the surface. A compromise has been made in some cases, but where this was not possible other names and other groupings have been made.

Lack of outcrop or lack of data in regions of complicated structure has necessitated the combining of formations or groups. Such combinations are in most cases termed 'undivided' and a brief description of such areas is given under the appropriate headings.

The following table of formations shows the approximate age and succession of all units.

TABLE OF FORMATIONS

Era	Period or Epoch	Group	Formation	Lithology	Thickness (feet)
MESOZOIC	Upper Cretaceous		Dunvegan Formation	Sandstone, shale and conglomerate (marine and non-marine)	200-400
	Lower Cretaceous		Sully Formation	Dark grey marine shale; with sideritic concretions; flaky black shale (marine)	300-1,000
		Fort St. John Group	Sikanni Formation	Fine-grained, laminated, sandstone and silty mudstone (marine)	350-1,000
			Buckinghorse Formation	Shale, siltstone and minor sandstone (marine)	3,300-3,600
		Bullhead Group	Gething Formation	Sandstone, shale, coal, conglomerate (non-marine)	1,000±
			Cadomin Formation	Conglomerate, pebbly sandstone (mainly non-marine)	300-400
		Minnes Group	Unnamed Unit	Sandstone, siltstone and some mudstone	800±
			Monach Formation	Sandstone and some shale (marine)	0-300
			Beattie Peaks Formation	Shale, sandy shale and sandstone (marine	0-900
			Monteith Formation	Sandstone and quartzite (marine	1,000
	Jurassic		Fernie Formation	Shale, siltstone and sandstone (marine)	150-1,100
	Triassic		Pardonet Formation	Limestone, calcareous sandstone, calcareous siltstone, shale (marine	400-1,500

TABLE OF FORMATIONS (cont'd.)

Era	Period or Epoch	Formation and Group		Lithology	Thickness (feet)
MESOZOIC	Triassic	"Grey Beds"		Calcareous sandstone and siltstone; limestone, dolomite (marine)	
		Liard Formation		Calcareous siltstone, limestone, shale (marine)	900-1,200
		Toad Formation		Calcareous siltstone, shale (marine)	900-1,600
PALEOZOIC	Permian	Fantasque Formation		Chert (marine)	0-100
	Permian Pennsylvanian Mississippian	Stoddart Group	Kiskatinaw and Taylor Flat Formations	Sandstone, siltstone, shale, limestone (marine)	1,000
			Golata Formation	Shale, siltstone (marine)	200-400
	Mississippian	Prophet Formation		Limestone, chert, dolomite (marine)	1,000-1,500
	Upper Devonian and Lower Mississippian	Besa River Formation		Shale, minor limestone (marine)	1,500-2,000
	Middle Devonian			Limestone, dolomite, sandstone (marine)	800-1,500
	Silurian			Dolomite, limestone, sandstone (marine)	3,000
	Ordovician and Upper Cambrian?			Limestone, dolomite, shale, siltstone, sandstone (marine)	2,000-3,000
	Middle Cambrian			Quartzite, sandstone, siltstone, silty dolomite, dolomite (marine)	2,000
	Precambrian and/or Palaeozoic	Misinchinka Group		Limestone, chlorite schist phyllite, calcareous sericite schist, schistose sandstone, quartzite	5,000-10,000

PRECAMBRIAN AND/OR PALEOZOIC

MISINCHINKA GROUP

The Misinchinka Group includes a succession of altered sediments that now consist of limestones, dolomites, schists, phyllites, schistose sandstones and quartzites. The mineral assemblages present in each of these types are mainly those that are stable under conditions of low-grade regional metamorphism.

These rocks were first observed by Alfred R. C. Selwyn in 1875 and were later named by G. M. Dawson (1881). In 1928 Dolmage mapped rocks resembling the Misinchinka Group on both sides of Finlay River valley and stated that they consist of "....mainly quartz-mica-schist, mica quartzite, and acid gneiss, but there are also a few small bands of impure limestone and lenses of hornblende gneiss".

Williams and Bocock (1932) tentatively referred that part of the group west of Andy Creek along Peace River valley to the Precambrian. They called the rocks east of Andy Creek and on the south side of Peace River valley the Mount Selwyn Formation, and suggested that these may be of Cambrian age.

Similar schists, phyllites, and quartzites west of Finlay River valley appear to be associated with limestones from which Lower Cambrian fossils were collected (see Armstrong and Roots, 1948).

In the Pine Pass map-area to the south Muller (1961) divided the Misinchinka rocks into three lithologic units: a lower unit consisting of chlorite schist, sericite schist, phyllite, schistose grit, and quartz-pebble conglomerate; a middle unit of limestone, calcareous schist with some slate, and chlorite schist; and an upper unit composed of black slate and slaty greywacke with minor amounts of quartzite and conglomerate.

No division has been attempted at this time in Halfway River map-area.

Distribution and Lithology

Rocks of the Misinchinka Group occur in the southwest corner of Halfway River map-area where they have been thrust relatively northeastward over strata of known early Paleozoic age. Their northeastern limit is indicated on the geological map accompanying this report (Map 1232A, in pocket) by a single fault trace, but since the position of this fault has not been accurately determined at all places, it may be more irregular than it is shown.

The predominant rock types include dark greenish grey to blue-green crenulated phyllite, quartz-mica-schist, chloritoid-quartz-mica-schist, schistose quartzitic sandstone, and relatively pure quartzite. A study of several selected thin sections of these rocks indicates that even the green phyllites contain some quartz as silt-size or fine sand-size grains. These schistose rocks weather silvery grey or buff to red-brown depending on their iron content and state of oxidation. Pyrite crystals as much as half an inch in edge length are common and do not appear to be confined to any one rock type. Many of the schists contain magnetite as scattered grains or as swarms of tiny euhedral crystals.

Grey to dark grey limestone, much of which is nodular, is interbedded with the schists and quartzites and ranges from sheared limestone through phyllitic limestone to calcareous phyllite. All types can occur together in a vertical range of a few tens of feet. Most of the limestone contains quartz grains; where the amount of quartz is significant, weathering removes the carbonate from around the quartz grains and leaves a very rough surface. Limestones that originally contained argillaceous material are now altered to banded, calcareous phyllitic rocks. Limestone units range from a few feet to more than 200 feet thick and evidence of bedding is obscured by cleavage.

Dolomite is not common and was seen only within a strip about 2 miles wide along the northeastern part of the metamorphic terrain where it is interbedded with quartzite and limestone. This rock is normally light grey, but weathers buff to reddish brown where pyrite is present.

Near the top of the ridge just south of Peace River and west of Colin Creek, pebbles of quartzite, schistose sandstone, and dolomite occur at a limestone - phyllite contact. These pebbles, which have been stretched and flattened, do not appear to form a bed but are scattered both in the limestone and in the underlying phyllite. These 'floating' distorted pebbles and cobbles average 4 inches in diameter, but some are as much as a foot in diameter.

On the same ridge a 2-foot-thick bed of mixed hematite and magnetite occurs within a unit of greenish chloritic phyllite or schist. The iron minerals are disseminated in the underlying phyllite and probably also in the overlying rock. The same bed or zone was seen on the north side of Peace River valley east of Lost Cabin Creek.

White quartz is present in large amounts throughout these strata along bedding and joint or shear surfaces in all types of rocks, but appears to be concentrated in larger masses near areas of sandstones or quartzites. It ranges from thin films or veinlets along joint or bedding surfaces to lenses as much as 4 feet thick. The thicker occurrences may be related to faults or shear zones, but most are parallel to bedding planes of the host rock. No minerals other than pyrite were seen with the quartz.

Thickness

Throughout the group there are numerous repetitions of lithologic types, but metamorphism has destroyed any obvious distinguishing features that may have existed between the various units. This lack of recognizable markers, together with numerous structural repetitions caused by relatively complex folding and faulting, renders of little value any estimate of rock thickness or of proportions of lithologic types. Muller (1961) estimated the thickness of the whole group at between 5,000 and 10,000 feet. The thickness of strata in Halfway River map-area is probably in excess of 5,000 feet.

Age and Correlation

The Misinchinka strata are thought to be the oldest rocks within the map-area, but their age relationship with the Lower Paleozoic strata could not be determined. No fossils were found in these rocks within the map-area.

Williams and Bocock (1932) tentatively referred the Misinchinka strata to the Precambrian. Muller (1961), describing these rocks in Pine Pass map-area to the south, stated that "... the upper unit of black slates grades without apparent unconformity into Lower (?) Cambrian orthoquartzite". This relationship was not seen in Halfway River area where Misinchinka strata appear to be thrust over Cambrian rocks. Although it is possible that part of this Group may represent metamorphosed westerly equivalents of the Cambrian strata, the difference in degree of metamorphism between the Misinchinka Group and the exposed Cambrian rocks is such that the writer favours a Precambrian age for the former.

Williams and Bocock (1932) separated the pink- to buff-weathering quartzites and siltstones occurring on the west slopes of Mount Selwyn and on both sides of Colin Creek from the Misinchinka Group (Pl. V, A). These beds were called the Mount Selwyn Formation and given a tentative Cambrian age because of lithological similarity with Cambrian quartzites in the more southern Rocky Mountains. Strata similar to those of the 'Mount Selwyn Formation' occur within a strip about 2 miles wide along the eastern boundary of the altered rocks in Halfway River map-area, but as no fossils have yet been found in them their age is still in doubt. Also, their stratigraphic and structural relationship to Middle Cambrian rocks on the west side of Ospika River valley has not been established. For these reasons the quartzites have been mapped with the Misinchinka Group.

PALEOZOIC

CAMBRIAN

For many years it was thought that Cambrian strata were present in the western part of the Peace River valley and also in the western part of the Rocky Mountains both north and south of Peace River. McConnell (1896), during his exploration of the Finlay and Omineca Rivers, noticed white and grey, unfossiliferous limestones, arenaceous limestones, and argillaceous limestones in the Rocky Mountains east of Finlay River, the age of which he considered to be 'Cambrian (?) and possibly younger'. Dolmage (1928) mapped this same band of limestone but did not determine their age or ages more specifically. Limestones of definite Early Cambrian age occur west of Finlay River valley on Mount Tsaydizkun (Armstrong and Roots, 1948).

Distribution and Lithology

Reconnaissance work on the more easterly parts of the mountains on the west side of Ospika River valley has shown the presence there of strata of probable Middle Cambrian age. These rocks occur with a small southwest dip on east-trending noses at and just north of latitude 56° 30'N and along longitude 124° W. They are at an altitude of about 5,500 feet above sea-level and approximately 2,000 feet above Ospika River. Only a partial section was examined so that the age of underlying strata down to river level and that of the overlying beds is not definitely known.

The lowermost beds seen by the writer consist of quartzites, quartzitic sandstones, and siltstones. These are overlain by dolomitic siltstones and silty dolomites and then by nearly pure dolomite. The quartzites and quartzitic sandstones are composed almost entirely of fine-grained quartz and are hard and resistant. Beds are between 2 and 5 feet thick. In the overlying dolomitic and calcareous siltstone and silty dolomites the thickness of the beds ranges between 3 inches and 5 feet. These rocks weather to buff and reddish brown and to platy and shaly debris.[1] Overlying the siltstones and silty dolomites are thick-bedded, cliff-forming dolomites that range in colour from light to dark grey and in texture from dense to medium crystalline. Much of this dolomite contains calcite-filled vugs as much as 3 inches across. Quartz veinlets are also present in some beds.

Thickness

The thickness measured is about 1,500 feet. Probable Middle Cambrian fossils were found in the lower 600 feet of this section and it seems likely that Cambrian strata consisting predominantly of quartzite or quartzitic sandstone underlie the measured section and extend to the valley floor of Ospika River about 2,000 feet below. No fossils were found in the overlying 900 feet of the measured section that consists chiefly of dolomitic beds. These are lithologically unlike Lower Ordovician strata farther east and so may be of Cambrian age.

Age and Correlation

Fossils were collected from two zones of calcareous or dolomitic siltstone within the lower 600 feet of the measured section. These fossils were identified by W.H. Fritz as follows:

GSC loc. 51288

Acrothele sp.
cf. *Chancia* sp. or *Alokistocare* sp.
?*Syspacephalus tardus* Rasetti
Yohoaspis sp.

GSC loc. 51287

Alokistocare? sp.
Caborcella sp.
?*Syspacephalus tardus* Rasetti

Fritz reported that both collections are of Middle Cambrian age and may belong to the *Albertella* or *Glossopleura* Zone.

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[1] Similar red- and buff-weathering beds are present throughout a limited area in the valley of Wicked River, and these, according to G.C. Taylor (pers. comm.), may be also of Cambrian age.

Addendum

Information obtained since the writing of this report can be found in the following references:

Jackson, D. E., Steen, G. E., And Sykes, D. W.
1965: Stratigraphy and graptolite zonation of the Kechika and Sandpile Groups in northeastern British Columbia; Bull. Can. Petrol. Geol., vol. 13, pp. 139-154.

Slind, O. L., and Perkins, G. D.
1967: Lower Paleozoic and Proterozoic sediments of the Rocky Mountains between Jasper, Alberta and Pine River, British Columbia; Bull. Can. Petrol. Geol. vol. 14, pp. 442-468 (dated 1966).

Street, P. J.
1966: Trilobite zones in the Murray Range, Pine Pass Map-area, British Columbia; Univ. British Columbia, unpub. M.Sc. thesis.

Taylor, G. C.
1969: Regional geology adjacent to the Alaska Highway between Fort Nelson and Muncho Lake, British Columbia; Edmonton Geol. Soc., 1969 Field Conf., Guidbook, pp. 16-29.

CAMBRIAN (?) AND ORDOVICIAN

Ordovician rocks outcrop in the Rocky Mountains throughout Halfway River map-area. No division into formations has been made; the whole sequence is mapped as a single unit. The lower limit of Ordovician beds has not been determined and it is possible that some strata of Late Cambrian age are included with this unit. No obvious lithologic break occurs between the Ordovician and Silurian successions and, therefore, for this report the upper contact of the Ordovician is placed about midway between the occurrences of Ordovician and Silurian fossils.

Distribution and Lithology

Rocks of Ordovician age occur in several east-west bands over a distance of about 14 miles along and near the valley of Peace River. The long, narrow bands are the result of several thrust faults that have repeated the Ordovician and, in places, the overlying Silurian beds. Farther north more extensive areas are underlain mainly by Ordovician and Cambrian (?) beds. Since both Silurian and Devonian beds may be included at some places in these regions, however, such areas have been designated on the accompanying geological map as "Lower Paleozoic Undivided".

The lowermost beds of known Ordovician age consist of grey to dark grey limestone and argillaceous limestone. Many of these beds exhibit a schistosity or cleavage. Stratigraphically below the known Ordovician strata are several hundred feet of limestone and impure limestone with lesser amounts of interbedded shale, siltstone, and dolomite, in which no fossils were found. The lower part of this succesion may be of

Cambrian age. The limestones and impure limestones are thin-bedded, tightly folded, and faulted. Most of these rocks now have a well-developed phyllitic or slaty cleavage that has almost obscured the original bedding. Thin beds or lenses of little-altered limestone or dolomite occur locally within units of phyllitic rocks. Above these calcareous beds, Ordovician rocks consist principally of dolomite, with lesser amounts of interbedded limestone, sandstone, siltstone, and shale.

Several partial sections were measured which, at this time, can be correlated only in a general way. These show that the formation of carbonate rocks was interrupted from time to time and clastic sediments in the form of silt and sand were deposited. Sections 1, 2, and 3 (see Appendix II) consist mainly of Late Ordovician strata that are located from southeast to northwest across the map-area. No marked or general lithological change is evident between sections 1 and 2. Section 3, however, located toward the northwest corner of the map-area, contains considerably more siltstone and sandstone near the Ordovician-Silurian boundary. Also, black graptolitic shales that are either of Late Ordovician or Early Silurian age are found in the section. These shales and siltstones, which may extend as far south as Mount Lady Laurier, indicate a major facies change during Late Ordovician and Early Silurian time within and beyond the northwest corner of Halfway River map-area.

Sections 4 and 5 (see Appendix II) indicate a lithologic change from east to west across the map-area. Section 4, the more westerly of these sections contains proportionately more shale and siltstone which suggests a general increase in clastic material from east to west. If, when additional data become available, more accurate correlations between sections show this east-west lithologic change to be general, then facies changes both north-south and east-west are present within the upper part of the Ordovician succession. B. S. Norford (pers. comm.) has recorded several hundred feet of quartzite beds of Ordovician age near Mount Hunter in the vicinity of Pine Pass, British Columbia, south of Halfway River map-area. It appears likely, therefore, that facies changes may be expected in the Ordovician succesion in this part of northeastern British Columbia.

Dolomite. Ordovician dolomites in the map-area are normally grey to dark grey, though steel grey, greenish grey, and brownish rocks occur. Weathered surfaces are grey, and buff. In the lower part of the succession pyrite is an important constituent in some beds. Such beds weather to brown and red-brown colours that are conspicuous for many miles. These rocks range in texture from dense to fine or medium crystalline; coarsely crystalline varieties are rare. Individual beds or zones of breccia occur throughout the succession and these consist of dolomite fragments of one or more types in a dolomite groundmass. Such rocks have a mottled appearance where weathered. Pisolitic beds are found in the lower part of the sequence but are not common. Fossils are commonly silicified and, on weathered surfaces, project above the surrounding carbonate. More coarsely crystalline dolomite patches in some beds probably indicate relict organic structures.

Many of these rocks are obviously silty or sandy. Thin sections show that the dolomites range in composition from those composed of nearly pure carbonate to those containing a large proportion of argillaceous material and/or silt- or sand-size quartz grains. The amount of quartz ranges from a few scattered grains to as much as 30 per cent of the rock. Beds immediately above and below sandstone or quartzite range from sandy dolomite to dolomitic sandstone.

Limestone. Limestone units interbedded with dolomite vary in colour through shades of grey to black and weather to dark grey or buff. These rocks are normally dense in texture, thin-bedded, and range from those composed of nearly pure calcium carbonate to those containing a large amount of argillaceous material. Weathering normally produces platy or shaly debris. Thin sections show that quartz grains of silt and sand size are a constituent of most limestone. Quartz grains may be present as a few scattered grains or the proportion may be as high as 20 per cent. Magnetite (as swarms of tiny crystals) as well as limonite (?) is present in some limestones of Early Ordovician age.

Sandstone. Sandstone beds or zones occur at several stratigraphic horizons within the Ordovician succession. In the northwestern part of the map-area sandstone and siltstone form an important part of the Upper Ordovician strata. These rocks vary from grey to light grey and are light grey, white, or buff where weathered. The strata are composed principally of poorly sorted quartz sand and are normally fine- to medium-grained. Thin sections show that a small amount of feldspar is normally present. Orthoquartzites have been formed in some cases where silica overgrowths on original grains have resulted in an interlocking texture. Some of the sandstones are calcareous, but others, including the orthoquartzites, contain no carbonate.

Siltstone. Siltstone is found mainly in the northwestern part of the map-area and all gradations exist between siltstone and shale. Most siltstone contains some carbonate.

Shale. Shaly strata occur at several horizons throughout the succession but are more common in the upper part in the northwestern regions. Shale, also, may be an important rock type in the lowermost Ordovician beds along the entire western part of the mountains.

Silica. Quartz veinlets and crystals of silica are present in nearly all rocks. Most vugs in limestone or dolomite, whether small or large, are filled or lined with white dolomite or calcite, euhedral or subhedral quartz crystals, or a mixture of these minerals. Quartz, forming a crisscross network of narrow veinlets, is not uncommon in some beds. Also, fossils are normally completely replaced by silica. At several places in the stratigraphic sequence, the carbonate beds contain scattered nodules and thin, discontinuous beds of black chert.

Carbonate veinlets. These are found cutting dolomite or limestone beds. Both dolomite and calcite are present, though the latter mineral seems to be most common. Carbonate, with or without quartz, occurs also as large and small pods or lenses along bedding-plane surfaces. These carbonate-quartz masses range from thin beds half an inch thick to lenses 2 feet thick and are as much as 20 feet long. They are most common in the relatively less competent rock types. Since in all cases these secondary minerals form concordant bodies, they may have been formed by diagenetic processes.

Thickness

It is not possible to obtain a reliable estimate of the total thickness of Ordovician strata in the map-area since the base of the system was not recognized, and the position of the Ordovician - Silurian contact could be placed only within broad limits.

On the east-west drainage divide just north of Advance Mountain, Silurian fossils (GSC loc. 46905) were collected between 100 and 120 feet above collection GSC loc. 46866, which has been assigned an Ordovician age. In this section the Ordovician - Silurian contact can be placed relatively accurately even though all strata appear to be conformable. At most places within the map-area, where Ordovician and Silurian fossils were found in more widely separated strata, this upper contact has had to be placed arbitrarily within a much thicker sequence of beds and, therefore, is much less accurately defined.

The most complete section measured is that on the east-west ridge located due west of the head of Needham Creek (Section 2, Appendix II). At this locality about 2,800 feet of strata are assigned to the Ordovician System, and it is probable that stratigraphically older beds are not exposed.

Age and Correlation

The strata are not markedly fossiliferous, partly because of the destruction of organic remains by the processes of dolomitization. Preservation is excellent in some beds where fossils were silicified prior to dolomitization. In a few places silicified corals and brachiopods occur in profusion where they have weathered from the enclosing rock and have remained more or less in place. Fossils representing Early, Middle, and Late Ordovician time have been identified.

One collection, GSC loc. 51297, has been assigned a definite Early Ordovician (Early Canadian) age whereas three others have been assigned a probable Early Ordovician (Canadian) age. Collections from GSC localities 51262 and 51297 were identified by B.S. Norford, and from 39955 and 39961 by G.W. Sinclair. The fossils were found in limestone or dolomitic limestone beds near the base of the Ordovician dolomitic succession and about 2,000 feet below the Ordovician - Silurian contact. Longitudes and latitudes are approximate.

GSC loc. 51262 - About 3 miles south of Mount Robb; from talus below cliff; 56° 50'N, 123° 48'W.

Lecanospira (*Barnsella*) *lecanospiroides* (Bridge and Cloud)
straight cephalopod
large planispiral gastropod
sponge or solitary coral

GSC loc. 51297 - About 6 miles southwest of Mount Robb; 56° 47'N, 123° 52'W.

asaphid trilobite
Kainella cf. *K. flagricauda* (White)

GSC loc. 39955 - On north-south nose of Advance Mountain; 56° 03'N, 123° 25'W.

resupinate orthid brachiopods
gastropods, spp.
Symphysurus? sp.

GSC loc. 39961 - South side of Advance Mountain, 3 miles north of the mouth of Bernard Creek; 56° 02'N, 123° 25'W.

Tritoechia sp.
Ceratopea sp.

These Early Ordovician fossils were found from Peace River in the south as far north as Mount Robb.

According to G. W. Sinclair the following two collections indicate a Middle Ordovician age:

GSC loc. 39944 - Advance Mountain, north and west of mouth of Bernard Creek; 56° 03'N, 123° 25'W.

Streptelasma sp.
Rafinesquina spp.
Rhynchotrema sp.
Trematis sp.
Resserella sp.
Hormotoma cf. H. gracilis
Ceraurus sp.
Zygospira sp.

GSC loc. 39946 - Advance Mountain, south of peak; 56° 03'N, 123° 27'W.

Sowerbyella sp.
Foerstephyllum sp.
crinoid fragments
Streptelasma sp.
Rafinesquina spp.
Rhynchotrema sp.

By far the largest number of Ordovician collections are of Late Ordovician age. One Late Ordovician horizon is common in the collections from localities 46888, 46841, 46896, 46916, 46917, 46919, 46927, and 46940. According to Norford, this horizon correlates with the lower part of the Beaverfoot Formation of the southern Rocky Mountains and, also, with part of the Maquoketa Formation of Iowa. The following fossils are representative of this zone:

bryozoa spp.
Streptelasma sp.
Streptelasma aff. S. prolongatum Wilson
Thaerodonta sp.
Thaerodonta aff. T. saxea (Sardeson)
Thaerodonta cf. T. dignata Wang
Rhynchotrema aff. R. kananaskia Wilson
Dinorthis sp.
echinoderm fragments
gastropods spp.
Glyptorthis cf. G. insculpta (Hall)

Platystrophia cf. P. equiconvexa Wang
Plaesiomys aff. P. bellistriata Wang
Oepikina sp.
Tetraphaleria sp.
Diceromyonia sp.
Strophomena sp.
zygospirid sp.
Catenipora sp.

Norford thinks that another horizon of probable Late Ordovician age is indicated by collections from localities 46907, 46851, and 46939 which include the following genera:

?Austinella sp.
?Glyptorthis sp.
Dinorthis sp.
?Streptelasma sp.
orthid brachiopod
sowerbyellid brachiopod
echinoderm fragments

This suggestion is supported by the fact that collections 46939 and 46907 occur stratigraphically below those correlated with the Beaverfoot Formation. Collection 46939 lies about 250 feet stratigraphically below 46917. Collection 46907 occurs approximately 300 feet below 46919 on the ridge between Ignatieff Creek and Cowart Creek. The stratigraphic position of collection 46851 was not determined.

The black shale facies occurring in the northeast corner of the map-area is exposed at several localities on the ridges just southeast and northeast of Mount Robb and on both sides of Halfway River valley. From this shale, 2,060 feet above the base of section 3 (see Appendix II), B.S. Norford identified ?Dicranograptus sp. and diplograptid graptolites from collection 51264. These graptolites are too poorly preserved for specific identification and their age has been determined as probably Late Ordovician.

On the basis of available data these shale strata are placed stratigraphically near the top of the Ordovician and/or base of the Silurian sequence (section 3, Appendix II). Present information indicates, therefore, that strata of Early, Middle, and Late Ordovician ages are present in Halfway River map-area; that one and probably two fossil horizons can be recognized within the Late Ordovician succession, and that a major facies change occurs in the northwestern part of the area. The relationship between the shale facies and the uppermost Ordovician beds of the southerly parts of the map-area has not been determined.

POST - ORDOVICIAN INTRUSIVE ROCKS

The only igneous rocks within Halfway River map-area consist of brown-weathering, dark grey or greenish grey, crystalline intrusions. Of the five exposures seen, three are dykes and two appear to be sill-like bodies having concordant relationships with the enclosing limestone and dolomite. They occur within Ordovician limestone or dolomite, but were not seen in or cutting through strata of known Silurian or younger ages.

The least altered of these intrusive rocks is within crenulated Ordovician limestone on the south side of Peace River opposite the mouth of Wicked River. This is a concordant body about 19 inches thick that is exposed at low water. In outcrop the rock appears dense, but thin sections show it to be composed of crystals of biotite, pyroxene, magnetite, apatite, calcite, and zircon in a very fine-grained to aphanitic groundmass.

Another sill-like body occurs on the east-west ridge due west of the head of Needham Creek (see section 2, Appendix II). The composition of this rock is similar to that described above but is more altered. This sill is about 10 feet thick and is overlain and underlain by dolomite.

The positions of the other three exposures of intrusive rock occurring south and southwest of Mount Robb are shown on the accompanying geological map; these are dykes that cut across the sedimentary strata at approximately right angles to the strike. Thin sections show that they are lithologically similar to those described above, and are between 6 and 10 feet thick at the outcrop. These rocks are fine-grained, basic intrusions and are classed as lamprophyres. Their contacts with the enclosing strata are concordant or discordant. The lamprophyres are more easily weathered than the enclosing carbonates so that they normally occur in slight depressions.

Addendum

More recent data on the Ordovician System in northeastern British Columbia are given by the following authors:

Davies, E. J. L.
1969: Ordovician and Silurian between Peace and Tuchodi Rivers, northeastern British Columbia; Edmonton Geol. Soc., 1969 Field Conf. Guidebook, pp. 4-15.

Jackson, D. E., Steen, G. E., and Sykes, D. W.
1965: Stratigraphy and graptolite zonation of the Kechika and Sandpile Groups in northeastern British Columbia; Bull. Can. Petrol. Geol., vol. 13, pp. 139-154.

Ketner, K. B.
1966: Comparison of Ordovician eugeosynclinal and miogeosynclinal quartzites of the Cordilleran geosyncline; U. S. Geol. Surv., Prof. Paper 550-C, pp. 54-60.

1968: Origin of Ordovician quartzite in the Cordilleran miogeosyncline; U. S. Geol. Surv., Prof. Paper 600-B, pp. 169-177.

Norford, B.S.
1965: Ordovician- Silurian, Part II - Cordillera; Geological History of Western Canada; J. Alta. Soc. Petrol. Geol., pp. 42-48 (dated 1964).

1969: Ordovician and Silurian stratigraphy of the southern Rocky Mountains; Geol. Surv. Can., Bull. 176.

Slind, O.L., and Perkins, G.D.
1967: Lower Paleozoic and Proterozoic sediments of the Rocky Mountains between Jasper, Alberta and Pine River, British Columbia; Bull. Can. Petrol. Geol., vol. 14, pp. 442-468 (dated 1966).

Street, P.J.
1966: Trilobite zones in the Murray Range, Pine Pass Map-area, British Columbia; Univ. British Columbia, unpub. M.Sc. thesis.

Taylor, G.C.
1969: Regional geology adjacent to the Alaska Highway between Fort Nelson and Muncho Lake, British Columbia; Edmonton Geol. Soc., 1969 Field Conf., Guidebook, pp. 16-29.

Tedrick, R.L.
1962: Ordovician geology of the Prophet River map-area, British Columbia; Univ. of Alberta, unpub. M.Sc. thesis.

SILURIAN AND (?) DEVONIAN

Rocks of Silurian age outcrop within the Rocky Mountain division from the south to the north boundary of the map-area and have been mapped as a single unit. The Ordovician - Silurian contact has been placed arbitrarily within broad limits as described previously. It is probable, therefore, that in some places the unit may include some beds of Late Ordovician age. The upper contact is more definite and is placed at the top of a thick succession of nearly barren dolomite beds that are overlain by fossiliferous Middle Devonian limestones and dolomites. The poorly fossiliferous dolomite unit is arbitrarily placed in the Silurian sequence on the accompanying geological map though it may be of Early Devonian age.[1]

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[1] Subsequent to the writing of this report the dolomite unit has been traced from the north into Halfway River map-area by G. C. Taylor (see Taylor and MacKenzie in press) who divided the strata into a lower Muncho - McConnell Formation and an upper Wokkpash Formation. The Muncho - McConnell lies disconformably on the Silurian Nonda Formation (Norford et al., 1966) and the Wokkpash is overlain disconformably by the Middle Devonian Stone Formation (Taylor and MacKenzie, in press).

The age of the unit (Wokkpash and Muncho- McConnell) is now considered to be Early Devonian. This age is based on fossil fish fragments collected from these strata north of Halfway River map-area and identified by R. Thorsteinsson of the Geological Survey of Canada (see Gabrielse, 1962; Norford et al., 1966; and Denison, 1964).

Distribution and Lithology

The distribution of Silurian strata is generally similar to that of the Ordovician beds. Near Peace River the beds have been repeated by numerous thrust faults. Farther north, thrust faulting was a factor in the location of these strata, but folding was also important where the beds have been preserved within synclines. The largest single area of outcrop is along the Bernard anticline.

Silurian strata consist mainly of dolomite, sandy dolomite and argillaceous dolomite with lesser amounts of sandstone. Limestone is rare except in the northwest corner of the map-area where it occurs associated with the siltstone - shale facies of possible Early Silurian age (section 3, Appendix II). The rock types differ very little from those of Ordovician age.

The dolomites are grey to dark grey rocks that weather to grey, light grey, and buff. Dense to finely crystalline types are most common, but some crinoidal beds are very coarsely crystalline. The thickness of the beds ranges from about 3 inches to massive 15- to 20-foot units. Several zones contain scattered nodules or thin, discontinuous beds of black chert. Dolomite breccias are also present throughout the succession.

Grey and buff, grey- and brown-weathering sandstone and quartzite beds occur at several places in the stratigraphic succession. These rocks consist predominantly of quartz sand and silt, and all grade between sandy dolomite and sandstone. Some dolomitic sandstones are crossbedded. Sandstone is particularly prevalent near the top of the unit. Silica has replaced fossils and is common as veinlets in many beds and as crystals lining vugs or other cavities. Carbonate is also conspicuous as veinlets and cavity fillings in some beds.

Within Halfway River map-area the most complete Silurian section was measured on the high ridge just south of Poutang Creek. There, more than 3,000 feet of beds are assigned to the Silurian System. At the top, this sequence includes about 1,200 feet of unfossiliferous beds.

Below the Middle Devonian strata, east of Mount Kenny (section 6, Appendix II), and near the head of Nabesche River (section 8, Appendix II) there are between 1,000 and 1,200 feet of unfossiliferous dolomite beds that are placed in the Silurian succession but whose age may be Early Devonian.

In the Pine Pass map-area south of Halfway River map-area, B. S. Norford (pers. comm.) measured a section of Silurian strata west of Clearwater River and about 6 miles southwest of Ducette Peak. A total of 2,100 feet of Silurian beds, including an upper 900 to 1,000 feet of barren, sandy dolomite was recorded.[1]

These few data are inconclusive, but do suggest that the unfossiliferous dolomite beds overlain by Middle Devonian rocks and underlain by fossiliferous Silurian strata maintain approximately the same thickness from the Clearwater River section

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[1] In 1965, Norford published this Clearwater River section in schematic form with a different interpretation, putting the upper beds into the Devonian (see Norford, 1965 in Addendum).

northward as far as latitude 57° 00'N. The total thickness of Silurian beds, however, appears to increase to the north from the locality of the Clearwater section, the variation occurring in the lower fossiliferous part.

Age and Correlation

Silicified fossils are generally well preserved. Numerous collections were obtained throughout the map-area, and most of these have been assigned a late Llandoverian (Early Silurian) or earliest Wenlockian (Middle Silurian) age by B. S. Norford.

A single faunal assemblage appears to be represented by collection from GSC localities 46891, 46905, 46911, 46912, 46913, 46914, 46920, 46921, 46932, 46937, 51292, 51298, 51304, 51305, and 51318, and includes the following fossils:

Atrypa aff. *A. gabrielsi* Norford
?*Thamnopora* sp.
Streptelasma sp.
Catenipora sp.
Catenipora cf. *C. simplex* (Lambe)
Favosites cf. *F. discoideus* (Roemer)
Favosites sp.
Favosites cf. *F. favosus* (Goldfuss)
Favosites cf. *F. brownsportensis* Amsden
Coenites sp.
Coenites cf. *C. laminatus* (Hall)
Coenites rectilineatus (Simpson)
Hesperorthis sp.
"*Homoeospira*" sp.
colonial rugose corals
stromatoporoids
straight cephalopods
Receptaculites sp.
?*Ptychophyllum* sp.
Halysites cf. *H. occidens* Norford
Halysites cf. *H. sandpilensis* Norford
Cystihalysites cf. *C. magnitubus* (Buehler)
Cystihalysites spp.
Syringopora sp.
Syringopora verticillata Goldfuss
Heliolites spp.
?*Striatopora* sp.
Clorinda sp.
Fletcheria cf. *F. deadwoodensis* Norford
?*Glassia* sp.
Pentamerus sp.
strophomenid and rhynchonellid brachiopods
gastropods
Cystiphyllum sp.

Norford stated that this fauna can be correlated with that occurring near the top of the Sandpile Group about 200 miles to the northwest in the Interior Ranges of British Columbia.

It is probable that another and perhaps lower Silurian faunal zone is represented by fossil collections from GSC localities 46904 and 46938 and listed below:

?Palaeophyllum sp.
Catenipora sp.
colonial rugose coral
Columnaria columbia Norford
?Halysites sp.

Norford (pers. comm.) stated that in the Clearwater section this fauna occurs near the top of the fossiliferous Silurian succession without the younger Sandpile fauna being present. This suggests that the stratigraphically higher beds of the fossiliferous Silurian unit in the Clearwater region have been removed by erosion and indicates an unconformity between this unit and the overlying unfossiliferous dolomite.

Addendum

Cosburn, S. S., and Callan, D. M.
1963: Preliminary geological report, Redfern Lake area; British Columbia Dept. Mines and Petroleum Resources.

Davies, E. J. L.
1969: Ordovician and Silurian between Peace and Tuchodi Rivers, northeastern British Columbia; Edmonton Geol. Soc., 1969 Field Conf., Guidebook, pp. 4-15.

Jackson, D. E., Steen, G. E., and Sykes, D. W.
1965: Stratigraphy and graptolite zonation of the Kechika and Sandpile Groups in northeastern British Columbia; Bull. Can. Petrol. Geol., vol. 13, pp. 139-154.

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1969: Ordovician and Silurian stratigraphy of the southern Rocky Mountains; Geol. Surv. Can., Bull. 176.

Norford, B. S., Gabrielse, H., and Taylor, G. C.
1967: Stratigraphy of Silurian carbonate rocks of the Rocky Mountains, northern British Columbia; Bull. Can. Petrol. Geol., vol. 14, pp. 504-519 (dated 1966).

Taylor, G. C.
1969: Regional geology adjacent to the Alaska Highway between Fort Nelson and Muncho Lake, British Columbia; Edmonton Geol. Soc., 1969 Field Conf., Guidebook, pp. 16-29.

Taylor, G. C. and MacKenzie, W. S.
in press: Devonian stratigraphy of northeastern British Columbia; Geol. Surv. Can., Bull. 186.

DEVONIAN

Devonian rocks within Halfway River map-area were first recorded by Williams and Bocock (1932) who collected fossils of Middle Devonian age from dark limestones on a small island in the channel of Peace River about 3 miles above the mouth of Clearwater River (just south of this map-area). Similar rocks were seen a short distance downstream from the mouth of Wicked River.

The Devonian succession[1] comprises a lower, unnamed part that consists principally of carbonate rocks and which is mainly of Middle Devonian age, and an upper, thick shale sequence, the Besa River Formation of Sutherland (1958). Throughout most of the map-area this shale is of Late Devonian age, but Middle Devonian fossils have been collected from low in the Besa River Formation where it is exposed east of Ospika River and west of Balden Creek. The uppermost part of the formation, although unfossiliferous, was considered by Sutherland (1958) to be of Mississippian age.

Middle Devonian

Distribution and Lithology

Strata of Middle Devonian age outcrop at two localities along Peace River. The

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[1] Since this report was written there has been considerable refinement of the Devonian succession in northeastern British Columbia. North of Halfway River map-area G. C. Taylor has divided the succession into 5 formations and proposed 4 new names (Taylor, G. C., and MacKenzie, W. S., in press). The Muncho-McConnell and Wokkpash Formations and the lower part of the Stone Formation are of Early Devonian age. The upper part of the Stone Formation and the overlying Dunedin Formation are of Middle Devonian age. The Besa River Formation is mainly of Late Devonian age in the eastern exposures but, in the northwest is, in part, of Middle Devonian age.

Whether or not these units can be applied wholly or in part to the Devonian succession in Halfway River map-area is not yet clear. It may be that much of the more easterly subsurface terminology is more applicable.

For the most recent information on the Devonian System the reader is referred to the addendum at the end of the section on Devonian stratigraphy.

more easterly of these is just east of the mouth of Bernard Creek where a narrow band of Middle Devonian rocks has been thrust northeastward over Triassic strata. Associated with, and lying above this fault, are two minor thrust plates within which the same Devonian strata occur in two tightly folded synclines. None of these bands of rocks extends more than 8 miles to the north of Peace River, but all cross the river to the southeast.

The second locality is about 1 1/2 miles upstream from the mouth of Selwyn Creek. There, Middle Devonian rocks crop out in a belt about 1 1/2 miles wide that crosses Peace River and extends northwestward for 14 miles.

Devonian strata, repeated by faulting, occur in two bands around the south-plunging nose of the Bernard anticline north of Mount Burden. The most northerly of these bands is exposed around the nose and along the east flank of the fold as far north as Horn Creek. Similar strata are exposed again still farther north in and on the north side of Halfway River valley. Shales containing fossils of Middle Devonian age are present on two southwest-trending noses at the south end of the ridge lying between Ospika River and Balden Creek.

The Devonian carbonate succession is mapped as a single unit, though division into formations may be possible.[1] The lower part of the Devonian succession consists of limestone, dolomite, argillaceous and silty limestone, silty to sandy dolomite, and lesser amounts of shale and sandstone. The base of the Devonian System in the southern part of the map-area is placed arbitrarily at the upper contact of a barren silty dolomite succession that is overlain by limestone beds containing a Middle Devonian fauna. The unfossiliferous dolomite[2] below the limestone may be also of Devonian age, but until more information is available it is included with the Silurian strata. The upper contact of the Devonian carbonates is, at most places abrupt, but in some places it is gradational through a thickness of between 50 and 100 feet to the overlying shales of the Besa River Formation.

Within the carbonate succession there appears to be a change of lithology from predominant limestone and argillaceous limestone in the south, to predominant dolomite in the northern part of the map-area (section 6, 7, 8, 9, and 10, Appendix II). Section 10 (Appendix II) is a composite section from two widely separated localities on the north side of Peace River valley, and for this reason its total thickness may be exaggerated. The carbonate succession in this section is composed mainly of limestone and argillaceous limestone with minor amounts of calcareous shale and dolomite. Section 9 (Appendix II), about 20 miles farther north, contains proportionately more dolomite, while the more northerly sections, 6, 7, and 8, are composed predominantly of dolomite with some interbedded limestone. In these sections where the lithology of the Devonian rocks is similar to that of the underlying Silurian strata it has not been

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[1] The Middle Devonian carbonate succession in the southern half of the Halfway River map-area may include recognizable equivalents of the subsurface Chinchaga, Pine Point, Sulphur Point, Watt Mountain, and Slave Point Formations of northeastern British Columbia.

[2] This barren dolomite is now known to include equivalents of the lower part of the Middle Devonian Stone Formation and the Lower Devonian Muncho-McConnell Formation and to be of Early Devonian age (Taylor and MacKenzie, in press).

possible, with data available at present, to indicate accurately a lower boundary of the Middle Devonian succession.

The facies change from carbonate to the shales of the Besa River Formation is illustrated by sections 7, 11, and 12 (Appendix II). At section 7, just west of the mouth of Horn Creek, the Middle Devonian is represented by dolomite and calcareous dolomite with some interbedded limestone. Section 11, about 15 miles west of section 7, comprises hundreds of feet of shale, silty shale, and calcareous shale, with a few beds or lenses of limestone, some of which contain a Middle Devonian fauna. At no other place within the map-area were Middle Devonian fossils found in the Besa River Formation. This suggests a facies change from dolomite to shale west of the mouth of Horn Creek. Section 12 (Appendix II), just north of Lady Laurier Lake, lies between sections 11 and 7. The presence there of a large amount of calcareous shale and siltstone, which does not occur farther east, suggests a facies intermediate between those of sections 11 and 7. These localities are about 15 miles apart but are separated by several thrust faults so that the original distance between them must have been considerably greater.

Dolomite. Dolomite is the most common rock type comprising the Middle Devonian carbonate succession within Halfway River map-area. Dolomitization together with silicification has produced much of the present texture of these rocks. The various rock types are dolomite, dolomitic shale, dolomitic sandstone, dolomitic siltstone, sandy or silty dolomite, argillaceous dolomite, and calcareous dolomite. They include dense, microcrystalline to medium crystalline textural varieties, and their colours are light grey, grey, and light brown. The rocks form blocky or shaly debris of grey, buff, and brown colours. Strata composed of coarsely crystalline dolomite were seen only toward the top of the Horn Creek section (section 7, Appendix II).

Quartz grains of silt and fine sand size are a conspicuous component of many beds. In others, though sand grains may be present in small amounts scattered throughout the rock, they can be detected only in thin sections. Where there is much silt or sand a very rough weathered surface is produced. Many sandy or silty beds grade into dolomitic sandstone or dolomitic siltstone. In some beds the sand grains are concentrated as lenses or irregular patches, and where this occurs a bumpy weathered surface is formed.

Dolomite breccias are found from north to south throughout the map-area, but are more common toward the north. Some brecciated beds are composed of one rock type only; others appear to comprise fragments of several different rock types that are cemented with secondary, coarsely crystalline, white dolomite.

Another feature of some strata is a banding or mottling on weathered surfaces. Commonly the lighter coloured bands or patches are composed of more coarsely crystalline dolomite than the darker areas, and some of these may represent relict organic structures. Dark grey chert nodules are present in some strata, and locally become so numerous as to form thin, discontinuous beds.

Fossils are generally silicified and are remarkably well preserved, but they are difficult to collect except when weathered from the rock. Where dolomitization has taken place prior to silicification fossils are partly or wholly destroyed, though their outlines may be preserved because of a difference in either colour or crystal size.

Dark flecks and stains in some beds are attributed to the presence of pyobitumen. Ferruginous specks and tiny cubes of pyrite are present in some beds but are not common.

Limestone. Limestone rock types, particularly in the southern half of the map-area, range from dense (microcrystalline or microgranular) to medium crystalline. There are also all gradations between argillaceous limestone and calcareous shale. Rocks containing comminuted hard parts of crinoids and other organisms are common. Colours exhibited by these strata include grey, grey-brown, and black; on weathered surfaces they are dull grey to brown. The crystalline types weather to blocky fragments, but platy to shaly debris results from the weathering of the more argillaceous beds. In general the limestone talus is finer than that derived from the more resistant dolomites. One of the most common types consists of shell fragments now composed of relatively coarse white calcite imbedded in a darker lime mud.

Sandstone. Beds of sandy dolomite grading to sandstone are common in the lower part of the Devonian succession in the northern part of the map-area, but are not as numerous in the southern part. These rocks are predominantly grey, pinkish grey, and dark grey; when weathered they are various shades of grey or brown. They are mostly fine to medium grained and range from sandy limestones or sandy dolomites to calcareous or dolomitic sandstones. Some pure sandstones have been cemented with silica to form hard, resistant orthoquartzites. Clean, light-coloured quartz sandstones are typical, but in some cases argillaceous material imparts a dark colour to the rock. Quartz, the major component of these beds, is present as sub-angular to sub-rounded grains that are poorly sorted in most cases, though they may be well sorted locally. Siltstones form a small proportion of the arenaceous rocks and are normally argillaceous or dolomitic.

Silicification. Evidence of silicification is present in nearly all dolomite and limestone beds and, also, in some of the sandstones. Veinlets and crystals of quartz are widespread. Nearly all vugs, whether large or small, are filled or lined with secondary, white dolomite or calcite, with euhedral quartz crystals, or with both of these minerals. Many of the quartz crystals are beautifully formed and may be as long as 4 inches.

Thickness

The thickness of Middle Devonian carbonates in most of Halfway River map-area ranges from 800 to 1,500 feet. Muller (1961) stated that Middle Devonian rocks are about 1,000 feet thick in the adjacent Pine Pass map-area to the south.

In the southern part of the area (see section 10, Appendix II) the lower boundary is arbitrarily placed at the change from dolomite to limestone and the upper boundary at the change from limestone to shale. A thickness of about 1,300 feet is indicated, but there may be some overlap in this composite section. In sections 6, 7, and 8, (see Appendix II) composed predominantly of dolomite, the lower contact of the Middle Devonian strata is placed arbitrarily between the last appearance of Silurian fossils and the first appearance of a Middle Devonian fauna. There is, (as has been suggested previously) a pronounced facies change from southeast to northwest; the upper contact with the Besa River Formation is diachronous and the carbonate thickness will vary with this contact.

Age and Correlation

Fossils are relatively plentiful in the limestone part of the Devonian carbonate unit, but are not as numerous in the dolomite. In some beds fossils have been partly or wholly destroyed by dolomitization. If, however, the fossils have been silicified as is common in these dolomites, they weather out of the rock in a remarkably well-preserved state.

A Middle Devonian age ranging from early Middle Devonian (Eifelian) to late Middle Devonian (Givetian) has been assigned by A. W. Norris and D. J. McLaren to most fossils collected by the writer from these strata. A composite list of all Middle Devonian fossils collected includes the following forms:

Eifelian

Brachiopods

- Nucleospira? sp.
- cf. Plectospirifer compactus (Meek)

Arthropoda

Crustacea

Trilobita

- Dechenella (Dechenella) sp.

Givetian

Coelenterata

Hydrozoa

- ?Syringopora sp.
- Thamnopora sp. E.
- Favosites sp. D.
- Trachypora sp.
- Alveolites sp.
- Cladopora sp.
- ?Coenites sp.
- cf. Argutastrea arguta Crickmay
- Hexagonaria sp. A.
- Australophyllum? cf. A? thomasae (Hill and Jones)
- Atelophyllum sp. A.

Stromatoporoidea

- Amphipora sp.
- Strachyodes sp.

Arthropoda

Crustacea

Trilobita

- proetid tails

Brachiopoda

- Atrypa cf. A. perfimbriata Crickmay
- Atrypa cf. A. arctica (Warren)

Atrypa sp.
Spinatrypa cf. S. lata (Warren)
Spinatrypa cf. S. andersonensis (Warren)
Spinatrypa sp.
Warrenella cf. W. franklini (Meek)
Athyris? sp.
cf. Cassidirostrum pedderi McLaren
productellid
Schuchertella sp.
Gypidula sp.
Plectospirifer sp.
?Emanuella sp.
Spirifer n. gen. ? cf. S. superbus Eichwald
Stringocephalus sp.
?Chonetes aurora Hall
Schizophoria sp.

Mollusca
Pelecypoda
cf. Buchelia tyrrelli (Whiteaves)

Cephalopoda
cf. Michelinoceras sp.
cf. Gomphoceras sp.

Gastropoda
Mastigospira sp.

Some of the species collected in Halfway River map-area occur also in the Middle Devonian formations of the Yukon Territory and the District of Mackenzie.

Upper Devonian

Besa River Formation

The name Besa River Formation was proposed by F. A. Kidd (1962) for the thick, black shale unit occurring in northeastern British Columbia and lying between the Middle Devonian carbonates and the Mississippian Prophet Formation. The type locality is about 4 miles north of the Muskwa River and about 8 miles east of the pack trail crossing that river. Kidd stated: "The Besa River Formation consists almost entirely of shales, dark grey to black, thin bedded to fissile, varying from slightly calcareous to non-calcareous. Black chert and pyrite are present at intervals throughout the section, siltstone and thin limestones are in places evident near the top".

The name Besa River Formation is used in this report and on the accompanying geological map for this shale succession which, in Halfway River map-area, is a mappable unit from Peace River valley in the south to and beyond the northern boundary.

Distribution and Lithology

The Besa River Formation has a distribution similar to the underlying carbonate strata. A large part of Horn Creek valley is carved entirely within these shales. The formation weathers readily because of its relative softness and for this reason tends to be largely tree covered in the valleys and to form gentle slopes within the mountains. Complete exposures of the formation are very rare, and because of its incompetency relative to the underlying and overlying strata the shales are commonly contorted and faulted.

Strata of the Besa River Formation consist almost entirely of dark grey to black, fissile to thin-bedded or splintery shales. These are normally non-calcareous, but zones of calcareous shale, sometimes with intercalated thin, argillaceous limestone beds, are present. In some places the formation includes one unit, in other places two units, composed predominantly of limestone. For purposes of description these have been designated the 'Upper and Lower Limestone Units'.[1]

Section 9 (Appendix II) indicates that the Lower Limestone is about 50 feet thick and is 400 feet above the base of the formation; the Upper Limestone is about 110 feet thick and is 1,000 feet above the base of the formation. In section 7 (Appendix II), however, the Upper Limestone is only 600 feet above the base of the formation and the Lower Limestone is apparently missing. The Lower Limestone appears to be missing also in section 13 (Appendix II) which is approximately 9 miles west of section 9. Thus, the Lower unit probably grades into shale both to the west and northwest.

The shales range from very soft and papery to very hard, flinty types. Colours may be brownish grey locally, but are commonly dark grey to black. The most common weathering colours are buff to brownish grey with a few reddish brown to yellowish beds. Some strata weather slightly bluish grey or silvery grey. Small pyrite cubes are present in some beds.

Intimate mixtures of coarse cleavable carbonate and white quartz are common as lenses as much as a foot thick or as thinner discontinuous beds. These masses appear to occur along shear surfaces or to be interbedded with the shale.

Thickness

The contact between the Middle Devonian carbonates and the overlying Besa River Formation is normally sharp, but may be gradational and is locally diachronous. The contact with the overlying Prophet Formation is transitional through 100 to 200 feet of interbedded siltstone, limestone, shale, and black chert. The base of the formation is taken at the top of the massive limestone or dolomite and the top is placed at the base of the first massive limestone of the Prophet Formation. The contacts, therefore, may not be at the same horizon in all localities.

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[1] Where these limestone units occur in the Besa River shales it may be possible to subdivide the formation using the subsurface terminology of northeastern British Columbia (see Belyea and McLaren, 1962. reprint, 1964).

The section measured just north of Mount Burden (section 9, Appendix II) is the most complete one the writer has seen; the Besa River Formation there is about 1,450 feet thick. To the northwest where Middle Devonian fossils occur in these shales (section 11, Appendix II), the formation may be considerably more than 2,000 feet thick. Kidd (1962) estimated the thickness of the Besa River Formation to be about 3,000 feet in the vicinity of the type section near Muskwa River.

Age and Correlation

Fossils are sparse in the Besa River Formation and were collected only from the interbedded limestone units. These fossils are of Late Devonian age except for those of the most westerly section (section 11, Appendix II) which have been determined as of Middle Devonian age. According to E.W. Bamber (pers. comm.) the base of the Prophet Formation on Nabesche River is of early Meramecian (early Visean) age. The Besa River Formation, therefore, probably includes beds of Early Mississippian (Tournaisian) age.

The Lower Limestone Unit, where present, is known to contain an early Late Devonian (Frasnian) fauna and, therefore, the boundary between the Upper and Middle Devonian successions lies below the base of the Lower Limestone Unit of the Besa River Formation and above the uppermost beds of the carbonate development. Where the Lower Limestone Unit is missing in section 7 near the mouth of Horn Creek and in section 13 on the ridge 2 miles south of Wicked Lake (see Appendix II) this contact cannot be determined with any accuracy and is placed at the limestone-shale contact in the southern sections even though some of the overlying shale may be of Givetian age.

In the Horn Creek section (section 7, Appendix II) the Upper Limestone Unit[1] is 600 feet above the base of the formation and near the top contains fossils of Famennian age.

Fossil collections of Frasnian age (GSC locs. 46945 and 46884) are from section 9 (see Appendix II). With reference to these, D.J. McLaren reported that the fauna is probably of fairly late Frasnian age and suggested a correlation of these strata with the Mount Hawk Formation of the Alberta Rocky Mountains and possibly with the Kakisa or Redknife Formations of the upper Mackenzie Valley region. Fossil collection from GSC loc. 47017 on the northwest spur of Mount Brewster and collections from GSC localities 42627 and 42630 from west of the mouth of Horn Creek are of Famennian age; they correlate with the upper part of the Alexo Formation or lower part of the Palliser Formation of the Alberta Rocky Mountains and with the Tetcho Formation of the Trout River area, Northwest Territories and of northeastern British Columbia.

The Upper Devonian collections with their approximate locations are listed below. Collections from GSC localities 46884 and 46945 are assigned a Frasnian age by D.J. McLaren, whereas collections from localities 47017, 42630, and 42627 are considered to be of Famennian age by D.J. McLaren and A.W. Norris. Longitudes and latitudes are approximate.

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[1] This limestone unit may be equivalent to the subsurface Tetcho Formation of northeastern British Columbia (see Belyea and McLaren, 1962. reprint, 1964).

Frasnian

GSC loc. 46884 - 7.5 miles north of Mount Burden and 1,100 feet above base of Besa River Formation; 56° 17'N, 123° 25'W.

Brachiopoda

Atrypa? sp.
stropheodontids

Coelenterata
Hydrozoa

Metriophyllum sp. A. of Smith, 1945?
"Disphyllum" sp.

GSC loc. 46945 - 7.5 miles north of Mount Burden and 1,130 feet above base of Besa River Formation; 56° 17'N, 123° 25'W.

Brachiopoda

Atrypa sp. or Spinatrypa sp.

Coelenterata
Hydrozoa

Charactophyllum? sp.
Thamnopora sp.

Famennian

GSC loc. 47017 - Most northerly ridge of Mount Brewster; 56° 16'N, 123° 16'W.

Brachiopoda

Cyrtiopsis sp.
"Camarotoechia" sp.

Coelenterata
Hydrozoa

rugose coral

GSC loc. 42627 - About 3 1/2 miles west of the junction of Horn Creek and Graham River and 630 feet above base of Besa River Formation; 56° 42'N, 123° 34'W.

Brachiopoda

Athyris sp.
Cyrtiopsis cf. C. minetes Crickmay
Basilicorhynchus basilicum Crickmay
large productellid indet.

GSC loc. 42630 - At junction of Horn Creek and Graham River and 630 feet above base of Besa River Formation; 56°42'N, 123°30'W.

Brachiopoda

Basilicorhynchus basilicum Crickmay
Athyris sp.

Addendum

Additional refinements and information on the Devonian succession of northeastern British Columbia obtained since this report was written are included in the following references.

Norford, B.S.
1965: Ordovician - Silurian, Part II - Cordillera: Geological History of Western Canada; Alta. Soc. Petrol. Geol., pp. 42-48 (dated 1964).

Pelzer, E.E.
1965: Mineralogy, geochemistry and stratigraphy of the Besa River shale, British Columbia; Bull. Can. Petrol. Geol., vol. 14, pp. 273-321.

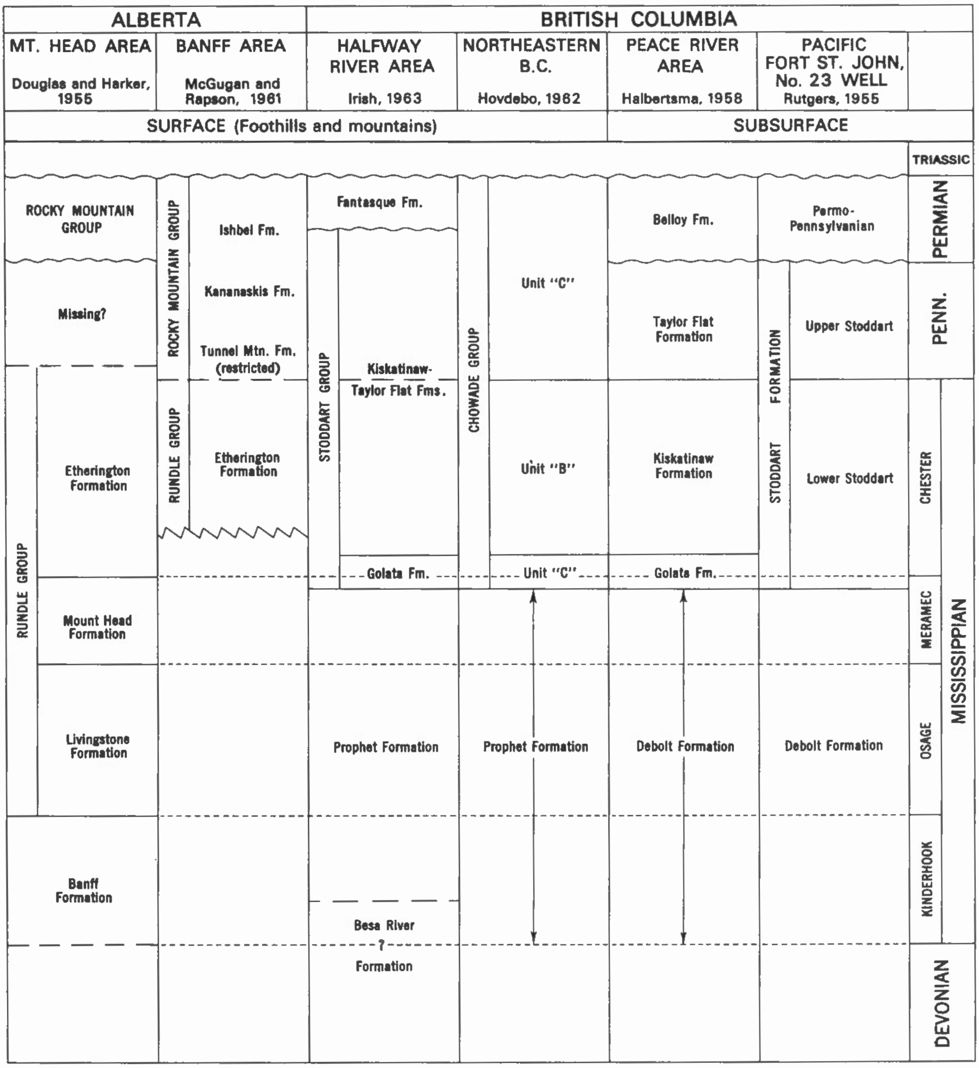
Taylor, G.C.
1969: Regional Geology adjacent to the Alaska Highway between Fort Nelson and Muncho Lake, British Columbia; Edmonton Geol. Soc., Ann. Field Conf., Guidebook.

Taylor, G.C., and MacKenzie, W.S.
in press: Devonian Stratigraphy of northeastern British Columbia; Geol. Surv. Can., Bull. 186.

Taylor, G.C., and Stott, D.F.
1968: Fort Nelson, British Columbia; Geol. Surv. Can., Paper 68-13.

MISSISSIPPIAN

Rocks of Carboniferous age exposed on a rocky point on the north bank of Peace River about 3 miles above Rapide-qui-ne-parle-pas have been known since Selwyn's exploration in 1875. Williams and Bocock (1930) list a small fauna from this limestone that includes corals and brachiopods of Mississippian age. More recently, P.K. Sutherland, H.R. Hovdebo, and other geologists mapping in the mountains have shown that Carboniferous rocks are present from the southern to the northern boundary of Halfway River map-area. These strata are readily divisible into a lower cherty carbonate succession, the Prophet Formation, and an upper clastic sequence, the Stoddart Group.



GSC

Figure 3. Correlation chart of the Mississippian, Pennsylvanian (?), and Permian formations, Alberta and northeastern British Columbia

Prophet Formation

The name Prophet Formation was given to the cherty carbonate succesion by Sutherland (1958) who studied the stratigraphy and coral faunas of these strata. The type section he proposed is on Bat Creek (originally Bull Creek), a tributary of Muskwa River, at approximately 57° 47'N and 123° 47'W. At this locality the Prophet Formation is unconformably overlain by beds of Triassic age; the intervening Stoddart Group, Fantasque Formation, and an unknown thickness of the upper strata of the Prophet Formation have been removed by erosion. For this reason, Hovdebo (1962) suggested an alternate type section located 8 miles east-southeast of Redfern Lake at 57° 17'N and 123° 47'W. At this locality the Prophet Formation is about 600 feet thick, the strata are much more cherty than at the location given by Sutherland, and the lower contact is gradational with the underlying Besa River Formation. The upper contact is not described by Hovdebo.[1]

Distribution and Lithology

Strata of the Prophet Formation underlie a relatively narrow belt along the eastern border of the Rocky Mountains. Included in this belt are most of the Mount Brewster group of peaks and ridges, the high ridges north of Mount Brewster and south of Needham Creek (Pl. VII, B), and the upper part of the valley of Graham River. Other exposures of these rocks occur on the east side of Mount Greene and on the ridge just northeast of Mount Burden. Near the northern boundary of the map-area rocks of the same age are exposed on two anticlines near longitude 123° 30' and just east of the main belt.

On the accompanying geological map it has been possible at most places to show the approximate boundaries of the regions underlain predominantly by the Prophet Formation. Where there are faults or complex folds, however, or where overburden obscures the bedrock, strata of the overlying Stoddart Group or the underlying Besa River Formation may be included. Such areas are mapped as "Mississippian Undivided".

The contact of the Prophet Formation with the underlying Besa River Formation is gradational. The upper contact is placed at the abrupt lithologic change from cherty carbonate to dark grey shale or silty shale of the Golata Formation. Sutherland divided the Prophet Formation, on lithological differences, into three units with gradational boundaries which he termed A, B, and C. These units can generally be recognized throughout Halfway River map-area, but the thicknesses are variable.

Member A, the lower part of the Prophet Formation, is 200 to 500 feet thick and consists of thin-bedded chert and limestone with interbedded shale, silty shale, and siltstone. The proportion of shale decreases upward, and chert beds become more numerous so that there is a gradation into the overlying more prominent, massive, cliff-forming beds of the middle part of the Prophet Formation. These strata, member B of Sutherland, consist of 500 to 600 feet of thick-bedded to massive chert, cherty limestone, and limestone. The limestone grades from light to dark grey, and the chert from light grey to black.

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[1] E. W. Bamber (pers. comm.) states that the upper contact at this locality is sharp.

The overlying member C consists of as much as 150 feet of interbedded cherty limestone, grey limestone, and thin nodular to thick wavy beds of chert. These beds are lithologically similar to the underlying strata, but are normally more thinly bedded and weather more readily.

The outstanding lithological character of the Prophet Formation is the large chert content which varies between 20 and 70 per cent. Within the formation all gradations occur both vertically and laterally from pure chert nodules and lenses to pure carbonate. Fossils exist in carbonate and chert indiscriminantly. From south to north throughout the map-area there is little variation in lithology other than the relative proportions of limestone and chert.[1]

Thickness

Sutherland (1958) estimated the thickness of the Prophet Formation to be between 1,150 and 1,400 feet. Hovdebo (1962) gave a thickness of only 600 feet for his alternate type section southeast of Redfern Lake, but indicated a range of thickness between 600 and 1,500 feet between that section and the Halfway River map-area to the south. E.W. Bamber (pers. comm., 1964) states that the Prophet Formation is about 3,000 feet thick just north of Mount Brewster.

No complete sections of the Prophet Formation were measured in Halfway River map-area. In the northern part of the area graphic measurements indicate a minimum thickness of 1,300 feet and, in the southern part, at least 2,000 feet of strata are assigned to this formation, indicating a thinning from south to north.

Age and Correlation

The lower part of the Prophet Formation, member A, and the lowermost part of member B yielded no fossils. According to Sutherland (1958), member A together with the upper part of the underlying shale is of Mississippian (probably Kinderhook) age and is equivalent to some part of the Banff Formation of the Alberta Rocky Mountains.

The writer collected fossils of Osage or early Meramec age from the middle of member B, and those dated as Meramecian were collected from the upper part of member B and from member C. The lowermost collections are from the middle of member B, from 200 to 400 feet above the base and about 800 feet below the top of the formation. These have been assigned an Osagean or early Meramecian age and the beds have been correlated with the Livingstone Formation in the Rundle Group of the Alberta Rocky Mountains.

The following collections from member B, which were identified by E.W. Bamber, indicate an Osage or early Meramec age.

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[1] More recent work by E.W. Bamber (in Bamber, Taylor, and Procter, 1968, pp. 7 and 8; and pers. comm.) has shown that east-west lithologic changes demonstrated to the north are present in Halfway River map-area.

GSC loc. 46969 - Northwest ridge of Mount Brewster; 56° 16'N, 123° 15'W.

Spirifer cf. S. minnewankensis Shimer
endothyrid foraminifera

GSC loc. 46993 - northeast ridge of Mount Brewster; 56° 16'N, 123° 12'W.

orthotetacean brachiopod
rhynchonellid brachiopod
fenestellid bryozoan
Spirifer sp.
Ekvasophyllum inclinotabulatum Sutherland

GSC loc. 46883 - Northwest ridge of Mount Brewster; 56° 00'N, 123° 16'W.

Zaphriphyllum cf. Z. disseptum Sutherland
Lithostrotion (Siphonodendron) sinuosum (Kelly)

GSC loc. 46863 - Head of west fork of Emerslund Creek; 56° 22'N, 123° 15'W.

Amplexizaphrentis cf. A. enniskilleni (Edwards and Haime)
Koninchophyllum sp.
Spirifer minnewankensis Shimer
pelecypod indet.
Productella sp.

Collections from member C and the upper part of member B, that is from the upper 500 feet of the formation, are assigned a Meramecian age by E. W. Bamber. The strata containing these fossils are correlated, therefore, with the upper part of the Livingstone Formation and the Mount Head Formation of the Rundle Group. The Osage-Meramec faunal boundary occurs low in member B or in member A from 500 to 600 feet below the top of the formation.

The following collections from approximately the upper 500 feet of the Prophet Formation are assigned a Meramecian age by E. W. Bamber.

GSC loc. 46936 - 2 miles due west of highest point on Black Bear Ridge.

Ekvasophyllum? cf. E. harkeri Sutherland

GSC loc. 46865 - Head of west fork of Emerslund Creek; 56° 22'N, 123° 15'W.

Orthotetes sp.
fenestellid bryozoan
Echinoconchus sp.
Spirifer sp.
Reticularia cf. R. pseudolineata (Hall)
Schellwienella sp.
Stigerites altonensis (Norwood and Pratten)
Ekvasophyllum cf. E. turbineum Parks

GSC loc. 46858 - East ridge of Mount Greene; 56° 05'N, 123° 12'W.

Ekvasophyllum inclinatum Parks
Syringopora sp.

GSC loc. 46870 - Head of west fork of Emerslund Creek, 30 feet below Prophet-Golata contact; 56° 22'N, 123° 15'W.

Lithostrotion (Siphonodendron) whitneyi of Meek
Syringopora sp.

GSC loc. 46858 - Most easterly ridge of Mount Greene about 10 feet below the Prophet-Golata contact;

Ekvasophyllum inclinatum Parks
Syringopora sp.

Collection GSC loc. 46858 has been assigned a Meramecian age by E.W. Bamber which suggests that in some places beds younger than Meramecian are not included in the Prophet Formation. Hovdebo (1962), however, referring to a location in the Halfway River map-area, stated that "another locality 5 miles south of section 1 showed the Meramec-Chester faunal break to occur a few feet below the Prophet-Chowade contact". This would be the Prophet-Golata contact of this report. Thus, there is some measure of disagreement as to just where this faunal break occurs relative to the top of the Prophet Formation.

The upper part of the Debolt Formation, which underlies the Golata Formation in the subsurface east of the map-area, is also considered to be of Meramecian age (Macauley, 1958).[1] Therefore, although the top strata of the Prophet Formation may not be precisely the same age at all localities, it is possible to correlate, in general, the upper part of the Prophet Formation with the upper part of the Debolt Formation.

Stoddart Group

The name Stoddart Formation was proposed by Rutgers (1958) for the sequence of late Paleozoic strata that lies above the Mississippian Debolt Formation and is unconformably overlain by the so-called Permo-Pennsylvanian beds in the Pacific Fort St. John No. 23 well. This well is located in lsd. 3, sec. 29, tp. 83, rge. 18, W.6th mer. Rutgers divided the formation into a lower 1,250 feet of predominantly clastic sediments (Lower Stoddart) and an upper 910 feet (Upper Stoddart) consisting of cherty, silty, or sandy limestone and dolomite with interbedded sandstone and siltstone (see Fig. 3).

In 1959 Halbertsma proposed four new formational names for the Paleozoic strata lying between the Mississippian Debolt Formation and beds of Triassic age. Strata defined as the Stoddart Formation by Rutgers (1958) were divided into the

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[1] See also (Bamber, E.W., Taylor, G.C., and Procter, R.M., 1968, p. 8).

Golata, Kiskatinaw, and Taylor Flat Formations. The name Belloy was proposed for the Pennsylvanian and Permian beds. Halbertsma reported that both spore and megafossil content indicated that the Golata Formation is of Mississippian age, that spores from Kiskatinaw strata suggest an uppermost Mississippian (Chesterian) age, and those from the Taylor Flat Formation have been determined as Pennsylvanian. Megafossils from the Belloy beds indicate a Permian age.

Hovdebo (1962) proposed the name Chowade Group for the Carboniferous and Permian sediments of the Rocky Mountains and Foothills lying between the Mississippian Prophet Formation and beds of Triassic age. He recognized three lithologic units within the Group. The lower two units, A and B, correspond to the Golata and Kiskatinaw Formations, respectively, of Halbertsma. The upper unit, C, includes strata equivalent in age to the combined Taylor Flat and Belloy Formations of Halbertsma. In the northern part of the region studied by Hovdebo unit C becomes very sandy and he stated that the separation there of units B and C was not possible.

The writer considers that the succession within Halfway River map-area should be given group status and is, therefore, in agreement with both Halbertsma and Hovdebo. Because the name Stoddart has priority, however, and because of the general similarity between the surface strata and those of the type subsurface section of the original Stoddart Formation, the name Stoddart Group is preferred.

Stoddart Group, as used in this report, includes all strata overlying the Mississippian Prophet Formation and overlain by the Permian Fantasque Formation. Within the group are recognized a lower Golata Formation, and an upper Kiskatinaw-Taylor Flat Formation. The Kiskatinaw and Taylor Flat Formations can be recognized individually in the southern part of the map-area, but in the north this division is impractical. The Stoddart Group includes higher beds than Rutger's Stoddart Formation, but is somewhat more restricted than Hovdebo's Chowade Group, which includes the chert beds that are referred to the Fantasque Formation in this report.

Within Halfway River map-area the group becomes thinner toward the north and east and may be missing near latitude 57° N. Beyond the northern boundary of the map-area, the group is missing at some places (Sutherland, 1958).

Golata Formation

The Golata Formation of Halbertsma (1959) represents the lower part of the "Lower Stoddart" in the type section of Rutger's Stoddart Formation. The use of the name is extended here to include strata of similar lithology and equivalent age in the mountains and foothills.

Distribution and Lithology

Throughout Halfway River map-area the Golata Formation is a mappable unit overlying the Prophet Formation and overlain by the Kiskatinaw-Taylor Flat Formation. Its distribution is similar to that of the underlying Prophet Formation. For the most part it is exposed along the eastern side of the Rocky Mountains but one large area and several smaller areas of outcrop occur within the foothills.

The formation consists, mainly, of dark grey, fissile to platy shale and silty shale, with varying amounts of interbedded siltstone, sandstone, and dense, grey-brown limestone. At some localities thin, discontinuous beds of clay-ironstone are common.

Thickness

The contact of the Golata with the underlying Prophet Formation is normally abrupt, but apparently conformable. The upper contact with the Kiskatinaw-Taylor Flat Formation is not well-exposed anywhere. Complete exposures of the Golata Formation are rare, but data available indicate a range in thickness between 200 and 600 feet.

Age and Correlation

Fossils collected about 30 feet below the top of the Golata Formation have been assigned a late Meramecian or Chesterian age by E. W. Bamber. These include the following forms:

GSC loc. 46882 - East ridge of Mount Greene; 56° 05'N, 123° 14'W.

Choristites sp. ?
Spirifer sp.

Hovdebo (1962) recorded a Chesterian fauna from the topmost beds of the Prophet Formation in his section No. 4 (north of this map-area) and stated that at a locality 5 miles south of his section No. 1 the Meramec-Chester faunal boundary occurs a few feet below the Prophet-Golata contact.

Available evidence indicates that the Golata Formation is probably of Chesterian age, correlative with the Golata of the subsurface of the Plains and with the lower part of the Etherington Formation of the Alberta Rocky Mountains.

Kiskatinaw - Taylor Flat Formation

Kiskatinaw Formation was the name proposed by Halbertsma (1959) for the main upper part of the Lower Stoddart of Rutgers. In the type section (Pacific Fort St. John No. 23 gas well), this formation near the base consists principally of clean, fine-grained, quartzose sandstone, but higher in the section it contains interbedded, greenish grey shales and thin carbonate beds. It is overlain, apparently conformably and gradationally, by the Taylor Flat Formation.

The name Taylor Flat Formation was proposed by Halbertsma (1959) for the Upper Stoddart of Rutgers (1958). At the base it consists of argillaceous limestone that grades to fragmental limestones and dolomites higher in the section. Sandy dolomites and dolomitic sandstone are present near the top in some areas.

The Belloy Formation of Halbertsma comprises those strata called "Permo-Pennsylvanian" by Rutgers (1958). These beds are of sandstone, siltstone, and carbonate with some massive to bedded white chert.

Because the two formations, (Kiskatinaw and Taylor Flat), as defined by Halbertsma, cannot be separated satisfactorily in the northern part of the Halfway River map-area they are, in this report, combined as the Kiskatinaw-Taylor Flat Formation. As the writer uses the terms, they include that part of Halbertsma's Belloy Formation below the chert. [1]

Distribution and Lithology

The distribution of the Kiskatinaw-Taylor Flat Formation is similar to that of the underlying Golata Formation. The lower part, the Kiskatinaw Formation of Halbertsma (1959) and unit B of Hovdebo (1962), consists predominantly of fine-grained quartzose sandstone. Limestone, shale, and siltstone are interbedded and the proportion of all rock types varies somewhat between different sections. The proportion of sandstone within the lower, Kiskatinaw part of the formation appears to decrease northward.

The upper, or Taylor Flat part of the formation comprises argillaceous and silty limestone and crinoidal limestone with interbedded soft, fissile shale, siltstone and sandstone. Within Halfway River map-area sandstone appears to increase in proportion toward the north.

Sandstones in the lower part are typically fine grained and grey to light grey; their light grey to buff colour when weathered is quite distinctive. Generally, the sandstones are composed of clean, clear quartz grains, though small amounts of dark grey chert grains and pebbles are present in some beds. Both calcareous and non-calcareous types are present. These strata are medium to thick bedded and form blocky talus. The unit is relatively more resistant than either the underlying or overlying beds and generally forms a gentle ridge. Higher in the formation buff- to grey-weathering, grey to brown, laminated sandstones occur that are generally not as massive as those near the base. The sandstones are commonly crossbedded throughout the succession.

Shales are typically dark grey to black and weather to grey and buff. Normally these are non-calcareous, soft, and fissile to papery, but generally contain some carbonate where they grade to siltstone.

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[1] Since the writing of this report the dark siltstones comprising the uppermost part of the Kiskatinaw-Taylor Flat Formation and overlain by the Fantasque Formation have been referred to the Kindle Formation by E. W. Bamber (1968, p. 10) and to the Mount Greene beds by McGugan (1967).

Correlation of the Kindle Formation and recognition of a sub-Permian unconformity are discussed by Bamber (1968, pp. 9, 10).

Limestones in the Kiskatinaw-Taylor Flat Formation range from dense, hard, brownish grey to black, fine to coarse crystalline types. The crystalline rocks are normally crinoidal and are softer than the more compact types.

Clay-ironstone concretions occur in some shale or siltstone units throughout the formation but are generally not as common as in the underlying Golata Formation. Where present they form thin discontinuous beds or scattered individual concretions 1/2 to 3 inches long.

Thickness

The most complete section measured (section 14, Appendix II) is in the northern part of the map-area and is about 750 feet thick; this is not considered to be a maximum for the area. More than twice this thickness is reported for equivalent strata to the southeast in the Fort St. John No. 23 gas well and E.W. Bamber (pers. comm., 1964) estimated a thickness of more than 1,000 feet for the formation on the high ridge north of the Mount Brewster group of peaks.[1]

Age and Correlation

No fossils were found in the lower part of the Kiskatinaw-Taylor Flat Formation. Toward the top of the formation (see sections 15, 16, and 18; Appendix II) the writer collected fossils that have been assigned a Pennsylvanian or Permian age by E.W. Bamber. These collections are listed below.

GSC loc. 42513[2] - Head of northeast-flowing branch of Graham River, 65 feet below the Fantasque Formation; 56° 18'N, 122° 04'W.

Linoproductus sp. ?
Waagenoconcha sp.
Spirifer sp.
Dielasma sp.

GSC loc. 46875 - Northwest ridge of Mount Brewster; 620 feet above base of formation; 56° 13'N, 123° 17'W.

Lophophyllidium sp. ?
spiriferid brachiopod

GSC loc. 47013 - Head of west fork of Emerslund Creek; 390 feet above base of formation; 56° 22'N, 123° 15'W.

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1 E.W. Bamber (pers. comm., 1969) states that the thickness on the west flank of Mount Greene is 1,250 feet excluding the upper beds which are assigned to the Kindle Formation. See also McGugan (1967).

2 GSC loc. 42513 has recently been assigned a definite Early Permian age by E.W. Bamber.

lophophyllid coral
Schellwienella sp. ?
Squamularia sp. ?
Punctospirifer sp.
Spirifer sp.
fenestellid bryozoan

Besides the above collections several others were made by the writer from the upper beds of the formation. These indicate the presence of strata of Pennsylvanian or Permian age beneath the Fantasque Formation in the south and as far as 5 miles north of Needham Creek. Some of these collections with their locations are listed below, although their stratigraphic position below the Fantasque Formation is not known exactly.

GSC loc. 46880 - 1 1/4 miles upstream from the mouth of Needham Creek; about 200 feet below the Fantasque Formation; 56° 32'N, 123° 07'W.

Orbiculoidea sp.
rhynchonellid brachiopod
ostracods indet.

GSC loc. 46887 - East ridge of Mount Greene; 56° 32'N, 123° 14'W.

Orbiculoidea sp.
rhynchonellid brachiopod
ostracods indet.

GSC loc. 46876 - On hill just north of the southern bend of Justice Creek; 56° 34'N, 123° 25'W.

Amplexizaphrentis sp.
spiriferid brachiopod
Neospirifer sp.
pelecypod indet.
productid brachiopod

GSC loc. 46862 - Head of west fork of Emerslund Creek just east of section 15; 56° 22'N, 123° 14'W.

Amplexizaphrentis sp.
cf. Spiriferella sp.

GSC loc. 46965 - Half a mile west of the most westerly of the Emerslund Lakes; 56° 22'N, 123° 05'W.

rhynchonellid brachiopod
Orbiculoidea sp.
ostracods indet.

The age of the upper part of the Kiskatinaw-Taylor Flat Formation, as indicated by the above collections, is Pennsylvanian or Permian. Equivalent strata in the subsurface have been assigned a probable Pennsylvanian age on spore content (Halbertsma, 1959). The lower part of this formation is considered to be correlative with the Etherington Formation and part of the Rocky Mountain Group of Alberta, and with the Mattson Formation of the Northwest Territories (Patton, 1958; Douglas and Norris, 1959; Harker, 1961).

The abrupt lithologic change between the Kiskatinaw-Taylor Flat Formation and the overlying Fantasque Formation suggests a disconformable contact. Such a disconformity is recorded by Halbertsma (1959) between the Permian Belloy and the Pennsylvanian Taylor Flat Formations. Erosion prior to deposition of the bedded cherts of the Fantasque Formation could explain the apparent thinning of the Stoddart Group from south to north and the lack of fossils of Pennsylvanian or Permian age in the northern part of the map-area.

PERMIAN

Fantasque Formation

Harker (1961) gave the name Fantasque Formation to a succession of beds consisting mainly of grey to black cherts that occurs above the Mattson Formation on the flanks of Kotaneelee Range, La Biche Range, and on the east side of the Beaver River basin in the Northwest Territories. The type section proposed by Harker is that described by Kindle (1944) on the north side of Beaver River southwest of Mount Merrill. The formation is presumed by Harker to be of Permian age. The Fantasque Formation lies unconformably on the underlying Mattson Formation; younger beds have presumably been removed by pre-Fantasque erosion (Douglas and Norris, 1959).[1]

In Halfway River map-area a mappable unit of bedded cherts unconformably overlies the Stoddart Group and is unconformably overlain by either the Grayling or Toad Formation of Triassic age. Both upper and lower contacts of the Fantasque Formation are sharp, and the lithologic change is abrupt. These chert beds are similar both lithologically and in relative stratigraphic position to the Fantasque Formation of the Northwest Territories. Also, like the Fantasque Formation, they are separated from both the overlying and underlying beds by unconformities. Accordingly, the name Fantasque Formation is applied to these beds in Halfway River map-area.

Distribution and Lithology

Outcrops of the Fantasque Formation are normally associated with exposures of the Stoddart Group and have a similar distribution. The formation was seen to be present as far north as Halfway River where the base of the Triassic or top of the

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[1] In 1965 E. W. Bamber re-studied and re-measured the type section of the Fantasque Formation. (Bamber, Taylor, and Procter, 1968, p. 12).

Carboniferous is exposed. North of Halfway River the Fantasque Formation was not seen by the writer but is present north of the map-area.

The formation is composed almost entirely of bedded, dark grey to black chert with, in some places, a small amount of interbedded, dark grey, hard siltstone in beds as much as 6 inches thick. The chert normally occurs in wavy layers ranging in thickness from about 1 inch to 1 foot but, in the measured section (section 18, Appendix II), the proportion of siltstone is greater and much of the chert is nodular to lenticular. The chert is normally fractured and veined with white calcite. It weathers to dark grey, dull grey, or brown, has conchoidal fracture, and forms blocky talus.

Thickness

Within the map-area the thickness of the formation ranges from zero to a maximum of about 100 feet. Farther east in subsurface sections the variations in thickness and, to some extent, in the character of equivalent beds of the Belloy Formation take place from one well to another. Most of this variation in the thickness of the Fantasque Formation is probably the result of pre-Triassic erosion.

Age and Correlation

No fossils were found in the formation in this map-area, but it is assumed to be of Permian age. The formation is considered by the writer to be equivalent in age to the upper part of the Rocky Mountain Group (Ishbel Group)[1] (McGugan and Rapson, 1963).

Addendum

For recent information on and refinements of the Carboniferous of northeastern British Columbia since this report was written the reader should note the following references.

Bamber, E.W.

1965: Stratigraphy of Permo-Carboniferous rocks, Operation Liard; in Report of Activities, Field, 1964; Geol. Surv. Can., Paper 65-1, pp. 42-43.

1966: Stratigraphy of Carboniferous and Permian rocks, Operation Liard; in Report of Activities, May to October, 1965; Geol. Surv. Can., Paper 66-1, p. 50.

Bamber, E.W., Taylor, G.C., and Procter, R.M.

1967: Upper Paleozoic rocks of northeast British Columbia; in Report of Activities, May to October, 1965, Geol. Surv. Can., Paper 67-1, Part B.

[1] McGugan (1967) used the name 'Ranger Canyon' for these beds on Mount Greene within Halfway River map-area.

Bamber, E.W., Taylor, G.C., and Procter, R.M.
1968: Carboniferous and Permian stratigraphy of northeastern British Columbia; Geol. Surv. Can., Paper 68-15.

Harker, P.
1963: Carboniferous and Permian rocks, southwestern District of Mackenzie; Geol. Surv. Can., Bull. 95.

Macauley, G., Penner, D.G., Procter, R.M., and Tisdall, W.H.
1964: Carboniferous; in Geological History of Western Canada; Alta. Soc. Petrol. Geol., pp. 89-102.

McGugan, A.
1967: Permian stratigraphy, Peace River area, northeast British Columbia; Bull. Can. Petrol. Geol., vol. 15, pp. 82-90.

MESOZOIC

TRIASSIC

Introduction

Triassic rocks have been known in northeastern British Columbia, and particularly in Halfway River map-area, since 1875 when Alfred R.C. Selwyn of the Geological Survey of Canada found them on Peace River. Until recently, most of our knowledge of these Triassic strata has come from the work of F.H. McLearn of the Geological Survey of Canada. McLearn's numerous publications between 1918 and 1950, which are summarized in McLearn and Kindle (1950), resulted in a terminology, fossil zonation, and time-stratigraphic subdivision which have been the bases for subsequent work (see Fig. 4).

The term Schooler Creek was introduced by McLearn (1921) to include three faunal zones. From later work McLearn eventually recognized three units within the Schooler Creek Formation which he called, in ascending order, "Dark siltstones", "Grey beds", and "Pardonet beds". In 1960, McLearn raised the latter unit to formational status.

In 1944 E.D. Kindle introduced the Grayling and Toad Formations for strata in the Liard River area. Later (see McLearn, 1946), Kindle divided the Toad Formation into an upper and a lower formation. The name 'Toad' was retained for the lower sandstones, siltstones, and shales; and the name 'Liard' was proposed for the upper part which included massive, grey sandstones and grey limestones.

The terms Grayling Formation, Toad Formation, and Liard Formation were extended southward to the Halfway River area by B.R. Pelletier (1963, 1964). In 1959 Hunt and Ratcliffe raised the Schooler Creek Formation to group status and re-defined it to embrace all the Triassic beds above the Toad-Grayling Formations. They also introduced three new formational names (Baldonnel, Charlie Lake, and Halfway) for

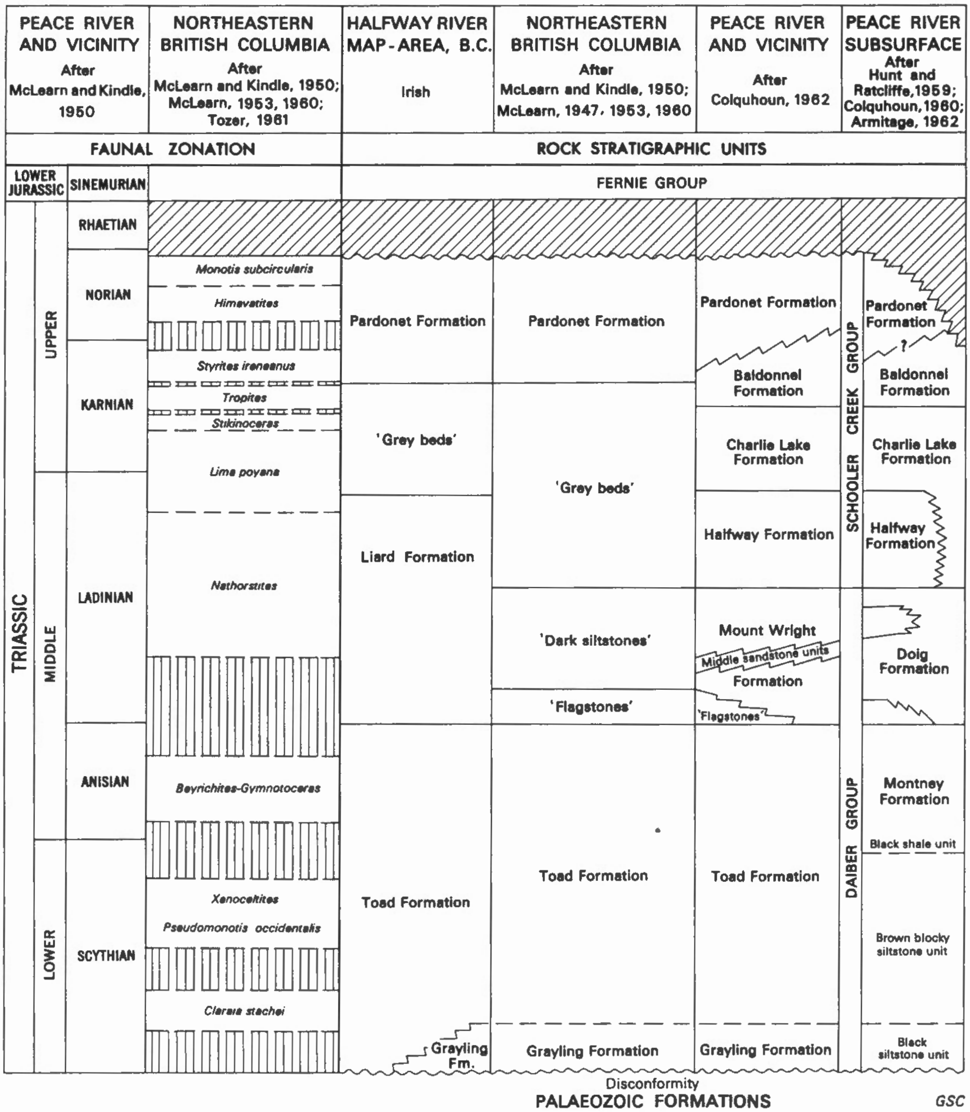

Figure 4. Correlation chart of Triassic stratigraphic units and formations

the subsurface divisions of the Schooler Creek Group (Fig. 4). Colquhoun (1960, 1962), with minor changes and additions, used the classification of Hunt and Ratcliffe for both surface and subsurface strata. In 1962, Armitage formally introduced the term Daiber Group for all Triassic strata underlying the Halfway Formation in the subsurface. Armitage also introduced the terms Doig Formation and Montney Formation (Fig. 4).

The subsurface terms Baldonnel, Charlie Lake, and Halfway can be applied, in part, to surface exposures of the Triassic strata throughout most of the eastern part of the foothills within the map-area, but it is doubtful if these lithologic units maintain their identity to the most western Triassic exposures. The lithology of individual stratigraphic units is generally persistent along the strike for many miles, but may change across the strike of the beds within a few miles.

The Triassic is described herein under the headings of Grayling, Toad, and Liard Formations, "Grey Beds", and Pardonet Formation. Formational boundaries are generally gradational, placed arbitrarily, and not necessarily at the same stratigraphic position in all sections. For this reason Triassic strata have been shown as a single unit on the accompanying geological map.

Triassic strata outcrop mainly within the Foothills and occupy a belt about 24 miles wide north of Peace River to and beyond the northern border of the map-area. Within this belt and particularly in the northern half of the area, some strata of Permian, Pennsylvanian?, Mississippian, Jurassic and Cretaceous ages occur that have been either exposed by erosion of anticlines or preserved in synclines.

In Halfway River map-area, Triassic rocks lie unconformably on the Permian Fantasque Formation and, locally, on the Kiskatinaw-Taylor Flat Formation. The thickness of the Triassic succession in Halfway River map-area ranges from about 2,000 feet in eastern sections to nearly 4,000 feet in extreme western sections.

Grayling Formation

In the Liard River region the basal Triassic formation is the Grayling of Early Triassic (Griesbachian) age. In Halfway River map-area the lowermost Triassic beds, which may be equivalent to the Grayling Formation, have the lithological characteristics of the Toad Formation that, in the Liard region, overlies the Grayling. It is possible, however, that in some places a few feet of Grayling shale occurs at the base of the Triassic succession in this area.

Toad Formation

In Halfway River map-area the base of the Triassic succession is exposed at only a few localities which are, mainly, along the western part of the Triassic belt. The lower contact with the Permian Fantasque Formation was seen about 3 miles upstream from the mouth of Needham Creek, at the south end of the ridge between Graham River and the headwaters of Chowade River, on the ridge at the head of Chowade River, in Emerslund Creek valley near the Emerslund Lakes, and on the ridge at the head of the east fork of Bernard Creek. At most of these localities the Triassic beds overlying the Fantasque Formation consist of several hundred feet of thick-bedded, hard, calcareous siltstone with interbedded units of more argillaceous siltstone and some shale. The lowermost 200 to 300 feet of this siltstone contain concretionary lenses as much as 4 feet in diameter, some of which contain fossils. Lower Triassic strata (but generally not the lowermost beds) are exposed at several other localities within the map-area and are all similar in lithology.

In the more easterly part of the Triassic belt these lower beds are not exposed.

Thickness

In the eastern foothills only a few poor exposures of the Toad Formation occur so its thickness there is not known. In the western sections as much as 1,200 feet of strata are assigned to this formation. The position of the Liard - Toad contact is, in some sections, difficult to place where the upper Toad and lower Liard beds are lithologically similar (sections 19 and 20, Appendix II).

Age and Correlation

Fossils of Early Triassic age where collected at three places within the map-area. These fossils with their localities are listed below:

GSC loc. 46978 - 3 miles up Needham Creek from its confluence with Graham River. About 265 feet above the Fantasque Formation; 56° 31'N, 123° 10'W.

ammonite indet.
Pseudomonotis occidentalis (Whiteaves)

GSC loc. 46990 - Mount Greene, about 315 feet above base of Triassic; 56° 05'N, 123° 15'W.

Posidonia cf. P. aranea Tozer
crushed ammonites, Prosphingites? sp.

GSC loc. 42538 - 2 miles north of Graham River and 4 miles east of the confluence of Graham River and Horn Creek. About 300 feet above the Fantasque Formation.

Pseudomonotis occidentalis (Whiteaves)
Xenoceltites cf. X. subevolutus Spath

According to E.T. Tozer GSC locs. 46978 and 42538 are of Smithian age and GSC loc. 46990 is of Spathian age. All collections are from strata considered by the writer to belong to the Toad Formation.

B.R. Pelletier (pers. comm.) collected Lower Triassic ammonites of Dienerian age as well as fish remains from beds stratigraphically lower than those yielding collection GSC loc. 46978. Fish remains were found by the writer near the Emerslund Lakes just above the Permian Fantasque Formation.[1]

Liard Formation

Lithology

In the Liard River area, Toad strata are overlain by the Liard Formation. In Halfway River map-area beds of similar lithology overlying the Toad Formation are also referred to as the Liard Formation. These beds include the "Dark Siltstones" and "Flagstones" of McLearn (McLearn and Kindle, 1950). Along the eastern half of the Triassic belt, from Peace River northward at least as far as Sikanni Chief River, Liard strata are overlain by the "Grey Beds" which are thought to be equivalent in the subsurface to the Halfway, Charlie Lake, and Baldonnel Formations (Hunt and Ratcliffe, 1959).

Toward the west all sandstone units tend to lose their lithological identity owing to an increase in the proportion of silt to sand. In these regions division into the eastern formational units is more difficult because much of the succession has changed to siltstone and silty limestone.

In the eastern half of the Triassic outcrop area the lowermost beds of the Liard Formation consist of fine- to medium-grained, calcareous, thin-bedded to medium-bedded, grey, grey- buff-weathering, quartzitic sandstones that may represent McLearn's "Flagstones". Most of these form platy or flaggy talus and some contain carbonaceous plant detritus. Above these strata is a unit (probably the "Dark siltstones" unit) consisting mainly of brown-grey and dark grey, grey- and buff-weathering calcareous siltstone with minor amounts of interbedded quartzitic, grey, fine-grained sandstone and, in some sections, one or two dark grey silty limestone beds containing a large proportion of shell fragments. Gradation between calcareous siltstone and silty limestone is common. Generally the limestones are dark grey, microcrystalline rocks, but some beds in the upper part of the unit contain a large amount of broken shell debris with or without some whole shells. Lenses of this rock type, between 5 and 30 feet thick, cap some of the ridges between Graham River and the upper part of Chowade River. Similar strata interbedded with dark siltstone and limestone occur on the north side of Laurier Pass. Thin beds of cryptocrystalline dolomite also may be present.

Westward across the Triassic belt the amount of sandstone decreases and appears to be replaced progressively by siltstone, making the separation of the various units much more difficult. Even the lower boundary of the Liard Formation must be placed arbitrarily within broad limits.

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[1] After completion of field work by the writer extensive collections of Dienerian, Smithian and Spathian ammonoids were obtained from the Toad Formation by E. T. Tozer. A summary of the sequence now recognized is given by Tozer (1967, pp. 73-74).

"Grey Beds"

The "Grey Beds" of McLearn have been divided into the Halfway, Charlie Lake, and Baldonnel Formations by Colquhoun (1962) and Pelletier (1964). They are predominantly sandstone with interbedded grey and dark grey limestone, grey-buff dolomite and dark grey, calcareous or dolomitic siltstone. The sandstones are mainly quartzose with either a calcareous or dolomitic cement. They are fine- to medium-grained, light grey to buff rocks that weather light grey, buff, ochre, and reddish brown and, for the most part, are thick bedded to massive. Crossbedding, ripple-marks, scour features, and coquinoid layers are present. The basal beds are commonly thick-bedded sandstone (Halfway Formation). Several thin, brecciated sandstones occur within the middle part of this unit that may be collapse breccias from which gypsum or anhydrite has been leached. It is these beds that are generally regarded as the equivalent of the Charlie Lake Formation. Such brecciated beds occur in the canyon below Christina Falls on Graham River. Carbonate beds are more common near the top of the unit. These are relatively thick-bedded, commonly cherty and may represent the Baldonnel Formation.

Thickness of Liard Formation and "Grey Beds"

The Liard Formation probably thickens from east to west, though the amount of this change depends to a large extent on the placement in the succession of the Toad - Liard contact. Where rocks of the "Flagstones" facies can be recognized in western sections there is no difficulty in recognizing the contact, but where little or no sandstone is present, equivalent strata might be included in the upper part of the Toad Formation.

The "Grey Beds" become progressively less sandy westward so that in the western sections where siltstone predominates, they are difficult to distinguish from the Liard facies.

The combined Liard Formation and "Grey Beds" range in thickness between 1,300 and 2,200 feet.

Age and Correlation of Liard Formation and "Grey Beds"

The Liard Formation of the map-area has yielded numerous ammonoids of Upper Ladinian age. Nathorstites, which is now known to occur throughout much of the Ladinian[1] is the most common genus. The Nathorstites fauna described from Beattie Ledge on Peace River by McLearn (1947) represents the early Upper Ladinian Meginae Zone. The writer's work has shown that the Liard beds also contain the uppermost Ladinian Sutherlandi Zone, as shown by the following collections identified by E. T. Tozer.

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[1] For a discussion of the stage the reader is referred to Tozer (1967, p. 28).

GSC loc. 51329 - 2 miles south of Halfway River. From calcareous siltstone about 1,600 feet below Triassic - Fernie contact; 56° 57'N, 123° 25'W.

Nathorstites mcconnelli (Whiteaves)
Daxatina canadensis (Whiteaves)
Paratrachyceras cf. P. sutherlandi McLearn

The "Grey Beds" commonly contain only brachiopods and bivalves that do not permit a precise determination. McLearn (1947) recorded ammonoids (including Nathorstites) from the basal "Grey Beds" of Peace River. These ammonoids are assigned to the uppermost Ladinian Sutherlandi Zone by Tozer. The writer made one important ammonoid collection from the "Grey Beds" as follows:

GSC loc. 51265 - Due south of peak (7,526') near headwaters of Fiddes Creek and north of headwaters of Cypress Creek. (bearing from peak 7,526' is 187° and distance in 5.3 miles).

Halobia sp.
Discotropites smithi Kutassy
"Juvavites" hyatti Smith
Homerites n. sp.

This collection, according to Tozer, is of Upper Karnian age (Welleri Zone).

The uppermost carbonate strata of the "Grey Beds" (Baldonnel) have provided the "Lima" poyana fauna described by McLearn (see McLearn and Kindle, 1950, p. 52; Tozer, 1967, p. 8).

In other parts of northeastern British Columbia, according to Tozer (1967), the lower beds of the Liard Formation contain Lower Ladinian ammonoids and the "Grey Beds" have provided Lower Karnian faunas. In summary, it would appear that the Liard Formation is mostly Ladinian and the "Grey Beds" are mostly Karnian, with the stage boundary apparently lying just above the lithological boundary.

Pardonet Formation

Lithology

In Halfway River map-area the "Grey Beds" are overlain by the Pardonet Formation. McLearn (1960) assigned the beds on Pardonet Hill along Peace River as the type section of this uppermost Triassic Formation. The lower contact of the Pardonet Formation is gradational with the underlying "Grey Beds" but the transition beds are not thick. Pardonet beds are unconformably overlain by the Jurassic Fernie Formation.

Rocks of the Pardonet Formation are exposed at several places along Peace River and at numerous localities from Peace River north to and beyond Halfway River.

Complete sections are scarce, but the uppermost beds and the contact with the overlying Fernie shale are exposed repeatedly by folding on the ridges between Chowade River and Halfway River and several places within the Hackney Hills. A particularly well exposed section was discovered by the writer on Crying Girl Prairie Creek.

The Pardonet Formation in the eastern sections consists of dark grey, grey- to buff-weathering, finely crystalline limestone, much of which contains a large amount of shell remains or broken shell remains. Interbedded with the limestone are lesser amounts of dark grey, calcareous siltstone which is normally thin bedded to platy. The thicker western sections are characterized by a greater proportion of siltstone to limestone. A characteristic layer is a fissile, dark grey, calcareous siltstone or silty limestone which owes its cleavage to closely packed and flattened shells of Halobia and, in some places, Monotis.

Thickness

The Pardonet Formation is about 250 feet thick at the eastern exposures along Peace River (McLearn and Kindle, 1950, pp. 53, 54) but in the western sections it is much thicker. McLearn measured more than 2,000 feet of these beds at the type section designated by him on Pardonet Hill. Recent work by Tozer (1965) however, has shown that the thickness at Pardonet Hill is considerably less than this figure. Whether the westward thickening of the Pardonet Formation is general throughout the map-area could not be ascertained because of the lack of complete sections in the northwest part. Colquhoun (1962) stated that the thickness of these beds in the subsurface decreases to zero a short distance east of the foothills.

Age and Correlation

The basal Pardonet beds, at Pardonet Hill, contain ammonoids of latest Karnian age (Tozer, 1965), but in most sections the greater part, if not the whole of the formation, is of Norian age with ammonoid zones representing the Lower, Middle and Upper parts of this stage. All these Norian zones have been recognized from collections made on Peace River by McLearn (1960). McLearn's section at Brown Hill, on the north side of Peace River, provides all the basic data for recognizing the sequence. McLearn considered that part of the sequence at Brown Hill was Karnian, but in the interpretation proposed by Tozer (1965, 1967) it is all Norian.

The writer's field work led to the discovery of some important new localities north of Peace River. The writer's collections were examined by E. T. Tozer, who has provided an account of the occurrence of Lower and Middle Norian ammonoids at Crying Girl Prairie Creek, and Middle Norian at Mount Ludington (Tozer, 1967, pp. 54, 60).

The uppermost Pardonet strata in most of Halfway River map-area contain the Monotis subcircularis zone of Upper Norian age. At Rapide-qui-ne-parle-pas the Monotis subcircularis zone is overlain by beds with Rhabdoceras suessi Hauer and other ammonoids (McLearn, 1960, p. 6; Tozer, 1965, p. 22). These beds, like the underlying strata with Monotis, are also Upper Norian according to Tozer.

On the north bank of Peace River just west of the mouth of Nabesche River are dark grey, calcareous siltstones of the Pardonet Formation. At low water the exposed skeleton of the marine reptile Ichthyosaurus may be seen (Williams and Bocock, 1932). Reptile bones are quite common in the upper Pardonet beds throughout the map-area, but whole skeletons were not found.

Addendum

As noted in an earlier footnote, the valley of Peace River is now flooded to an elevation of approximately 2,000 feet. Such features as Rapide-qui-ne-parle-as, Little parle pas rapids, and Finlay Rapids no longer exist. Also, one of the original fossil localities of F.H. McLearn at Goldbar (Beattie Ledge) as well as the Ichthyosaurus skeleton at the mouth of Nabesche River are now covered by waters of the lake.

Considerable refinement of the Triassic succession of this and adjacent areas has been accomplished since the field work was done on which this report is based. The reader is, therefore, referred to the following publications.

Gibson, D.W.

1968: Triassic stratigraphy between the Athabasca and Smoky Rivers of Alberta; Geol. Surv. Can., Paper 67-65.

1969: Triassic Stratigraphy of the Rocky Mountain Foothills, northeastern British Columbia (93O, 94B, G) in Report of Activities Part A: April to October, 1968; Geol. Surv. Can., Paper 69-1, pp. 235-36.

Tozer, E.T.

1963: Contributions to Canadian Palaeontology; Geol. Surv. Can., Bull. 96.

1967: A Standard for Triassic Time; Geol. Surv. Can., Bull. 156.

Pelletier, B.R.

1964: Triassic stratigraphy of the Rocky Mountain Foothills between Peace and Muskwa Rivers, northeastern British Columbia; Geol. Surv. Can., Paper 63-33.

1965: Paleocurrents in the Triassic of northeastern British Columbia; Soc. Econ. Paleont. Min., spec. publ. No. 12, pp. 233-245.

JURASSIC

Fernie Formation

The name "Fernie shale" was first applied by Leach (1912) to Jurassic shales in the Crowsnest Pass region that had been grouped with the Kootenay. It was later defined by Leach (1912) as a formation applicable to the Jurassic shale sequence of the

Fernie area. The use of the term has subsequently been extended northward and has until recently been referred to as a group. Frebold (1957) divided the group into Upper, Middle, and Lower units and recognizes various "members" and "beds", but has not proposed formal names for these units. More recently, these strata have been called the Fernie Formation.

Three lithologic divisions are recognized within the Halfway River map-area.[1] A lower black limestone and calcareous shale unit may be equivalent in part to the Nordegg Member of Spivak (1940). A middle unit, consisting mainly of shale, may contain beds equivalent in age to the Rock Creek Member (Warren, 1934, p. 59; see also Frebold, 1957). The transitional unit occurring at the top of the succession throughout most of this area is probably equivalent to the "Passage Beds" of Frebold (1957).

Distribution and Lithology

Fernie strata are confined to the Foothills part of the map-area; their most westerly exposure occurs in a syncline just east of the lower reaches of Nabesche River and the extension of this fold south of Peace River. For the most part the group is exposed as narrow bands on the limbs and around the noses of the many folds within the greatly contorted strata between the Rocky Mountains and the Plains. The Fernie Formation weathers readily because of its softness and for this reason underlies stream valleys or forms saddles and gentle slopes within the mountains. Owing to their recessive nature these strata are largely covered by vegetation and are rarely completely exposed.

The lower contact of the formation is disconformable; the basal calcareous shales and limestones of Early Jurassic age lie on Pardonet beds of Late Triassic age. The upper contact with the Minnes Group is transitional in the southern part of the map-area but in the northeast corner the Fernie is overlain unconformably by the Gething Formation.

Throughout central Alberta, and at least as far north as Wapiti River, the Nordegg Member consists mainly of black, phosphatic limestone and contains a fauna of Sinemurian age. In Halfway River area strata of equivalent age consist of fissile, dark grey to black, calcareous shales. In most places beds of brownish grey to black limestone between 2 and 4 inches thick are interbedded with the shale; limestone makes up a small proportion of the unit.

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[1] Stott (1967a) recognized six lithologic units in the Fernie Formation of the Halfway River map-area and correlated them with the units defined by Frebold (1957). The units are (1) a basal unit of calcareous siltstone, limestone, and shale that is lithologically similar to the Nordegg Member; (2) a calcareous papery shale probably equivalent to the Toarcian Paper Shales; (3) rusty weathering shale corresponding to both the Rock Creek Member and Grey Beds; (4) glauconitic mudstone and siltstone representing the basal Green Beds; (5) sideritic shales equivalent to the upper Green Beds and lower Passage Beds; and (6) interbedded sandstone and mudstone similar lithologically to upper Passage Beds.

The middle shale unit consists mainly of black, non-calcareous, papery to platy shale, much of it silty to sandy, that weathers to grey-buff and, in places, rusty colours. The lower part of this unit is normally a very fissile shale that weathers to paper-thin lamellae. Above this, however, there is no consistent lithologic variation. The shales are mostly silty or sandy and contain sporadic stringers and thin beds and lenses of dark grey, buff-weathering siltstone and sandstone. Concretions and lenses of ironstone are normally present.

The Passage Beds consist of dark, silty or sandy shales interbedded with thin, grey, non-calcareous, buff-weathering, fine-grained sandstone, much of which is finely laminated and crossbedded. Buff- to orange-weathering ironstone nodules are present in most sections. The proportion of sandstone to shale increases upward forming a transition into the overlying Minnes Group. The contact is normally placed at the first massive sandstone unit; this unit is about 10 feet thick. The Passage Beds are present throughout the map-area except on Halfway River and at Pink Mountain where they appear to have been removed by erosion.

Thickness

The maximum thickness of the Fernie Formation within this map-area is near the southern border along Peace River. Beach and Spivak (1944) recorded a thickness of about 1,000 feet on Black Bear Ridge just north of Peace River. The formation thins uniformly northward and eastward from the Black Bear Ridge locality (sections 21, 22, and 23 in Appendix II). In the French Petroleum Company Richfield Brenot Creek No. 1 well, located on Brenot Creek on the east side of Butler Ridge, the total thickness of the strata is only about 500 feet. On Pink Mountain, just north of the area, between 150 and 160 feet of strata is assigned to the Fernie. Still farther north on Sikanni Chief River only 30 feet of strata are present (Hage, 1944).

Neither the basal calcareous unit nor the Passage Beds vary greatly in thickness. The basal unit is normally between 60 and 120 feet thick; the Passage Beds are from 100 to 130 feet thick throughout most of the map-area but are absent in the extreme northern part. Thus the general eastward thinning of the Fernie may be owing, mainly, to convergence of the middle shale, and the thinning to the north caused mainly by erosion.

Age and Correlation

A few poorly preserved ammonites were collected at several localities. The fauna, which has been assigned a probable Toarcian age by Frebold, is found about 100 feet above the base of the group in the northern part of the area. Fossils from the same general district collected by D. F. Stott (pers. comm.) were assigned a tentative

Sinemurian age by Frebold.[1] Hamilton (1962) recorded Sinemurian fossils from localities within Halfway River map-area, and Hage (1944) collected fossils of Early Jurassic age just north of this area. No fossils indicative of the younger faunal stages were found, but is probable that succeeding strata represent the Middle and Upper Jurassic throughout most of the area.

CRETACEOUS

Lower Cretaceous

The thick succession of sandstones, conglomerates, shales, and coal seams lying above the Triassic and overlain by marine Lower Cretaceous beds were originally called the Bull Head Mountain Formation by McLearn (1918). It was later pointed out (McLearn and Kindle, 1950, p. 63) that the name was meant to apply to beds overlying and not including the Jurassic Fernie shales. When originally defined the formation was divided into upper and lower members; the upper member was later given the name Gething by McLearn (1923). Wickenden and Shaw (1943) raised the formation to group status and shortened the name to Bullhead (see Fig. 5).

In 1944 Beach and Spivak gave the name Dunlevy to the lower part of the group, placing the boundary between the massive conglomerates and the overlying coal-bearing beds of the Gething Formation.

In the Carbon Creek basin, west of the type region of the Dunlevy and Gething Formations, Mathews (1947) recognized a marine and a non-marine division of the Bullhead Group. He divided his basal marine Bullhead into three new formations: Monteith, Beattie Peaks, and Monach. The non-marine Bullhead included the Gething and the upper part of the Dunlevy Formation (Mathews, 1947, p. 12).

Warren and Stelck (1958) suggested that two additional units (Nikanassin and Shaly beds) could be recognized below the Monteith Formation. Subsequently Muller (1961), in his studies of Pine Pass map-area (which includes the Carbon Creek basin), used Mathews' terminology and mapped the Monteith Formation as lying directly above the Fernie shales, thereby disagreeing with the interpretation of Warren and Stelck.

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[1] Frebold, in recent reports to Stott (March 28, 1969 and June 5, 1969), re-identified many of the fossils collected by Stott in the Halfway River map-area and also many of those collected by C.O. Hage. Most of the fossils previously assigned a Sinemurian age were re-dated by Frebold as Upper Pliensbachian. Frebold commented as follows:

"The facies of the Pliensbachian beds in the Halfway River map-area is essentially the same as that of the Pliensbachian in the Red Deer River and Clearwater River areas. The beds concerned were assigned by the writer to the "Red Deer Member" of the Fernie Group which is between the Oxytoma bed of the Nordegg Member at the bottom and the Toarcian paper shale at the top (see Frebold, 1969, pp. 80, 81; Fig. 1, section 11)".

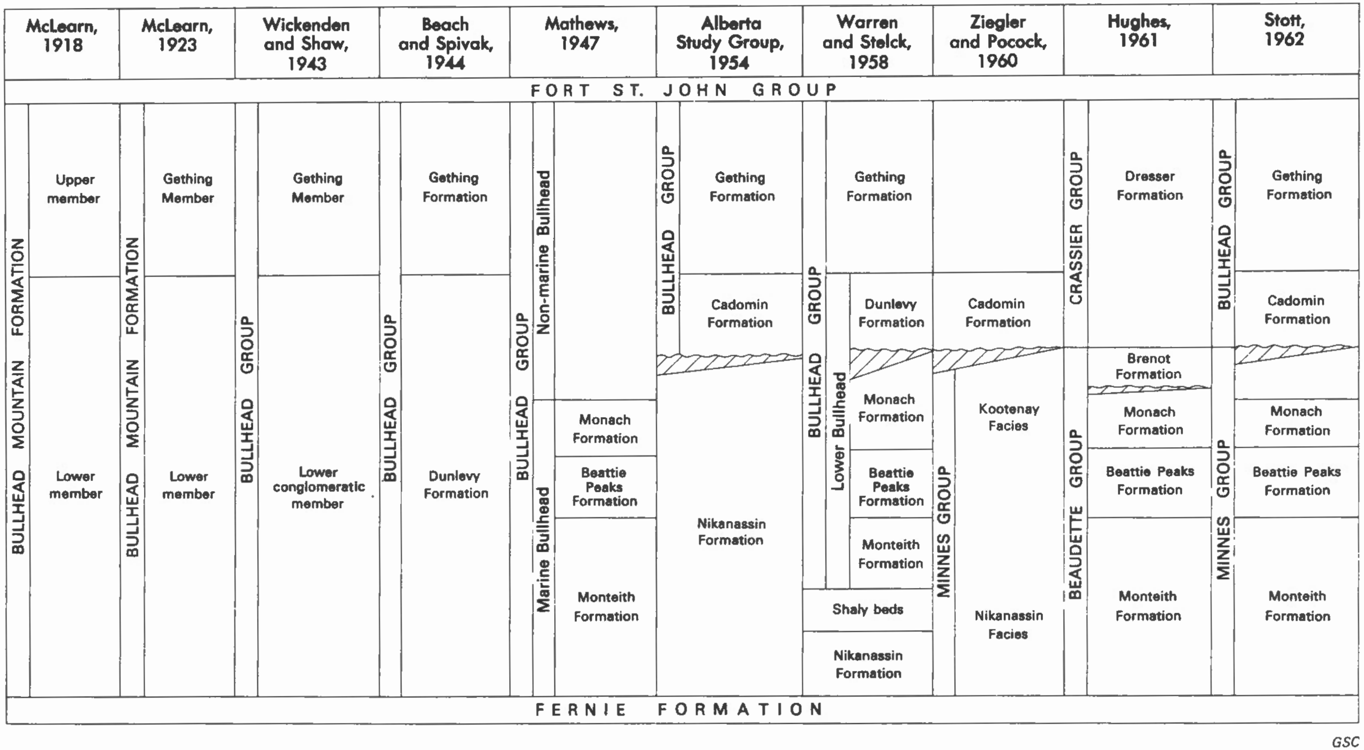

Figure 5. Comparison of nomenclature of strata lying between the Jurassic Fernie Formation and the Lower Cretaceous Fort St. John Group

Stott (1962), and in press)[1] restricted the Bullhead Group to the Gething and underlying Cadomin Formations and refers the lower formations, the Monteith, Beattie Peaks, Monach, and an unnamed unit to the Minnes Group. An unconformity separates the two groups. The writer agrees with Stott in making a two-fold division at the major erosional unconformity, placing the earliest Cretaceous rocks in the Minnes Group and the coal-bearing beds of the Gething Formation and underlying conglomerates in the Bullhead Group.

The Minnes and Bullhead Groups together include all Upper Jurassic and Lower Cretaceous strata between the underlying Jurassic Fernie Formation and the overlying Lower Cretaceous Fort St. John Group. The two groups were not separated in the field and are shown on the accompanying geological map as a single unit.

Minnes Group

Distribution and Lithology

The most westerly exposures of the Minnes Group in the southern part of the map-area are in the Nabesche syncline, a fold that extends both north and south of Peace River. East of this, on the north side of the river, remnants of the lower part of the group occur in two, small, south-plunging synclines located west of Schooler Creek. South of Peace River Minnes strata underlie a large part of the region from the east side of Pardonet Hill to the eastern border of the map-area. Along the eastern edge of the Foothills formations of the Minnes Group form part of a complex structural belt from the southern to the northern boundary of the map-area. Some beds occur in the Fiddes syncline that extends northwestward from Chowade River and beyond the northern boundary of the area.

In the southern part of the map-area the Minnes Group consists of thick-bedded, hard, fine- to medium-grained quartzitic sandstones interbedded with softer argillaceous sandstones and carbonaceous shales. The sandstones are grey to dark grey and weather light grey and grey-brown. Massive units as much as 60 feet thick are intercalated with those that are well bedded, flaggy, and as much as 10 feet thick. Much of the sandstone is crossbedded and ripple-marked. In the Carbon Creek basin, where the Monteith, Beattie Peaks, and Monach Formations were named, the group probably reaches its maximum thickness. Stott (1962)[2] considered that the lower two formations (Monteith and Beattie Peaks) can be recognized on Butler Ridge and at Rainbow Rocks on the north side of Peace River (Pl. VII, A). The upper formation, (Monach) of the Carbon Creek basin has not been definitely recognized north of Peace River. A facies change northeastward to more shaly strata could account for this, and beds equivalent to the Monach Formation may be present in the upper part of the Beattie Peaks Formation.

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[1] See Stott (1967a, 1968).

[2] Stott, in a more recent publication (1967a), describes, in some detail, the stratigraphy of the Minnes Group in the Foothills between Peace River (latitude 56° N) and Prophet River (latitude 57° 40'N).

Just south of Chowade River and about 2 miles west of 123° 00'W the writer collected fossils of Valanginian age from recessive beds composed of buff-weathering argillaceous sandstone and silty mudstone; these beds are therefore equivalent in age to the Beattie Peaks Formation. They are underlain by 300 to 400 feet of mainly thick-bedded, hard, quartzitic sandstones that probably represent the Monteith Formation. North of this point the character of the beds changes to such an extent that were the Cadomin Formation is not exposed they are difficult to separate from overlying beds that are equivalent in age to the Bullhead Group.

Thickness

No sections of the Minnes Group were measured in the southern part of the map-area. In the Carbon Creek basin Mathews (1947) gave a thickness of about 3,350 feet at Beattie Peaks south of the map-area, but only 2,050 feet near Peace River. On Mount Gething Beach and Spivak (1944) estimated a total thickness of between 3,000 and 3,200 feet for the Dunlevy Formation. This thickness, however, includes about 500 feet of conglomerate and pebbly sandstone now included in the overlying Cadomin Formation. Accordingly, the thickness of the Minnes Group, as used in the present report, is 2,500 to 2,700 feet.

Age and Correlation

No fossils were found in the lower part of the Minnes Group, but Muller (1961) reported marine shells of Berriasian to early Valanginian age from the Monteith Formation.[1] Muller (1961) also reported an early Valanginian fauna in the Beattie Peaks Formation. Strata considered by the writer to belong to the Beattie Peaks Formation are present as far north as Chowade River, and the following fossils were collected there. These fossils were identified by Jeletzky as being of middle to late Valanginian age.

GSC loc. 47018 - About 5 miles northwest of Christina Falls and between 400 and 500 feet above the Fernie Formation; 56° 35'N, 122° 44'W.

> *Buchia* (=*Aucella*) nov. sp. aff. *B. inflata* (Toula) (common)
> *Buchia* (=*Aucella*) cf. *B. keyserlingi* (Trautschold) (rare)

Available evidence indicates, therefore, that most of the Minnes Group is of early Lower Cretaceous age. The possibility exists that the lowermost beds of the Monteith Formation could be Upper Jurassic.

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[1] A discussion of the fauna of the Monteith, Beattie Peaks, and Monach Formations is contained in Hughes (1964), and the zonation has been outlined by Jeletzky (1964, 1967).

Bullhead Group

Distribution and Lithology

The Bullhead Group, which includes the Cadomin and Gething Formations, underlies extensive areas south of Peace River. On the north side of the river it is exposed on both sides of Dunlevy Creek and on the east side of Butler Ridge. The Gething Formation extends beyond the northern border of the map-area in the eastern foothills.[1]

On Mount Gething about 400 feet of coarse-grained sandstone, pebbly sandstone, and conglomerate underlie the typical Gething Formation. At the head of the Peace River Canyon these strata are 300 feet thick and on Butler Ridge they measure about 600 feet. These conglomerates and pebbly sandstones are referred to the Cadomin Formation, and although the massive conglomerate of the Cadomin Formation of the Alberta Foothills is lacking in this region, the beds probably represent a northern continuation of that formation. According to Stott (1962) this conglomerate unit lies well above the Monach Formation in the Carbon Creek basin. Near Rainbow Rocks west of Peace River Canyon the unit overlies the Beattie Peaks Formation, and farther east on Butler Ridge it occurs just above the Monteith Formation. Since equivalent beds appear to rest directly on the Jurassic Fernie Formation at Sikanni Chief River (north of this map-area) Stott postulated a major erosional unconformity to explain these relationships.

The Cadomin Formation, in the southern half of the map-area, consists mainly of a succession of massive, crossbedded, coarse-grained, grey- to brown-weathering, conglomeratic sandstones and fine conglomerate in beds 5 to 20 feet thick. Interbedded with these are 6-inch to 2-foot-thick beds of buff-weathering, soft, fine-grained sandstone, dark carbonaceous shales, and thin coaly seams. Some beds consist entirely of conglomerate with sub-rounded pebbles of dark chert, white quartz, and quartzite strongly cemented in a matrix of coarse- to medium-grained sandstone. The pebbles, which may be as large as 2 inches in diameter, average about half an inch. Individual conglomerate beds are lenticular and either wedge out rapidly along strike or grade laterally into sandstone.

Where these strata, as well as those of the overlying Gething Formation, are exposed near the head of Peace River Canyon, it is readily seen that some of the higher, coarse sandstones of the Cadomin Formation grade laterally into interbedded coal, sandstone, and shale of the Gething Formation. The two formations are, therefore, in part lateral equivalents, although in general the Cadomin underlies the Gething.

The typical Gething Formation consists of interbedded, grey- and buff-weathering, medium- to fine-grained, grey to dark brown sandstones, grey to black shales, dark siltstones, and coal seams. Sandstone beds, many of which are carbonaceous and micaceous, predominate over shale and siltstone. Concretionary clay-ironstone beds are common. Beds range in thickness from 2 inches to 25 feet.

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[1] Recent publications that discuss the Bullhead Group as it occurs in the vicinity of Peace River include Hughes (1964) and Stott (1968, 1969). Stott (1967b) also outlines the Gething Formation as it occurs north of Halfway River map-area.

North of Peace River the coal-bearing beds grade laterally into clean, fine-grained sandstones separated by thin shaly units with some interbedded, clay-ironstone bands. Coal development, which is at a maximum in Peace River Canyon area, becomes less important to the north where fewer seams occur within the succession.

On Pink Mountain, just north of Halfway River, the Cadomin Formation is represented by a 7-foot thickness of pebble conglomerate that marks the base of the Cretaceous strata and lies disconformably on the Fernie Formation. The conglomerate is composed of sub-rounded pebbles as much as an inch in diameter of dark chert and quartzite in a quartzitic matrix. It is overlain by 8 feet of fine-grained, dark grey sandstone interbedded with dark grey carbonaceous shale. Above this again are coarse-grained, quartzitic sandstone beds with some conglomerate and scattered pebbles of chert, quartzite, and some limestone in the basal part. Thin units of dark grey carbonaceous shale are interbedded with the sandstone. It may be that some of the conglomerate beds at this locality are equivalent to strata of the Gething Formation farther south. According to Hage (1944) the base of the Cretaceous on Pink Mountain is marked by a 5-foot-thick coal seam. This was not seen by the writer. Coal seams do occur, however, in the beds above the conglomerate zone.

The Cretaceous strata on Pink Mountain lie disconformably on the Jurassic Fernie Formation and are age equivalents of the Gething and Cadomin Formations of the Bullhead Group.

Thickness

No sections of the Gething Formation were measured. Beach and Spivak (1944) give its thickness as approximately 1,400 feet. McLearn (1923) showed that the type section in Peace River Canyon was about 1,400 feet thick, but a revision by Stott (1962) indicates that the thickness is near 1,000 feet.[1] The thickness of the Bullhead Group at the northern boundary of the map-area is estimated to be greater than 1,200 feet.

Age and Correlation

In some beds the Gething Formation contains tree remains, pieces of wood, rootlets, and fronds. Identifiable flora include the remains of ferns, cycads, and conifers. These plants were dated by W. A. Bell and D. C. McGregor as Aptian (Early Cretaceous). A similar flora occurs in the lower member of the Commotion Formation south of Pine River (Stott, 1962). The Commotion Formation, however, also contains marine fossils of middle Albian age and, therefore, the Lower Blairmore - Luscar - Gething flora must extend upward into rocks of middle Albian age. Thus the Aptian age for the Gething may be too restrictive and it can be dated only as Neocomian to Albian.

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1 The section along the western cliffs of Peace River Canyon was described by Stott (1968) who provisionally concluded that the section was disrupted by a small fault and that the total thickness was in the order of 1,600 feet. Stott now considers (pers. comm., Nov. 13, 1969) that no fault occurs within the succession and that total thickness of the Gething in the canyon region approaches 1,800 feet.

The formation is correlated, on the basis of these determinations, with part of the Blairmore Formation of southern Alberta and with the basal part of the Luscar Formation of the central Foothills of Alberta.

Fort St. John Group

The name Fort St. John was originally given by Dawson (1881) to the 'Lower dark shales' of Peace River and Pine River valleys. Since that time it has been used in more than one sense (see McConnell, 1896; McLearn, 1918 and 1932). In 1943 Wickenden and Shaw reverted to McLearn's first definition, which includes all strata between the Gething and Dunvegan Formations; they also gave the term group status.

The Fort St. John Group now includes all of the late Lower Cretaceous formations of the northern Foothills and Plains lying between the Bullhead Group below and the Dunvegan Formation above.[1] Because the lithological succession varies from place to place, local formations are required. In Halfway River map-area the Fort St. John Group comprises the Buckinghorse, Sikanni, and Sully Formations (Fig. 6).

Buckinghorse Formation

Distribution and Lithology

For the most part the Buckinghorse Formation underlies the areas of low relief in a belt extending northwesterly across the map-area and bounded by the eastern edge of the Foothills on the west and by Halfway River on the east. These strata extend southward to Peace River where the group is divided into the Moosebar, Gates and Hasler Formations. Within the Foothills Buckinghorse beds occur only in the Chowade syncline.

Shales of the Buckinghorse Formation yield readily to erosion and, therefore, underlie areas of low relief and are normally concealed by vegetation; exposures consist of a few small outcrops where streams cut through the low-lying areas. The strata consist predominantly of fissile and thin-bedded to blocky, grey to dark grey shale. Interbedded with this are thin, fine-grained sandstone beds, sandy shale zones, and varying amounts of brown- to yellow-weathering ironstone concretions and concretionary beds. Hage (1944) recorded thin bentonite beds in the lower part of the formation.

Thickness

Strata of the Buckinghorse Formation are poorly exposed in this map-area. Scattered outcrops in some of the stream valleys confirm the presence of the formation but are insufficient to give any reliable indication of thickness. North of Halfway River

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[1] The Fort St. John Group as it occurs in the vicinity of Peace River and southward in the Foothills is described by Stott (1968) and in the region between Peace and Tetsa Rivers, by Stott (1967b).

		McLearn, 1923, Wickenden and Shaw, 1943	Hage, 1944		Stott, 1960	Faunas	Thickness in feet
LOWER CRETACEOUS	FORT ST. JOHN GROUP	Cruiser Formation	Sikanni Formation	Shale member	Sully Formation		380
		Goodrich Formation		Sandstone member	Sikanni Formation	*Neogastroplites, Posidonomya nawisi* and varieties	600 - 650
		Hasler Formation	Buckinghorse Formation		Buckinghorse Formation	*Gastroplites*	3300 - 3600
		Gates Formation					
		Moosebar Formation				*Lemuroceras*	

Figure 6. Comparison of nomenclature for the Fort St. John Group

GSC

map-area, where the Sikanni Chief and Buckinghorse rivers cut across these strata, Hage (1944) assigned a thickness of between 3,300 and 3,600 feet to the Buckinghorse Formation.

Age and Correlation

Fossils are rare and poorly preserved in the Buckinghorse shales.[1] One lot was collected in Halfway River map-area from beds near the top of the formation which are considered to be transitional with the overlying Sikanni Formation. The fossils are listed below.

GSC loc. 30775 - North bank of Halfway River, about 3/4 of a mile above the mouth of Kobes Creek; 56° 29'N, 122° 04'W.

Neogastroplites sp. indet. (a form transitional between N. cornutus (Whiteaves) and N. selwyni McLearn
Pecten (Entolium) sp. indet.
Inoceramus? or Posidonomya? sp. indet.

According to J.A. Jeletzky (pers. comm.)[2] this fauna represents the lower part of the generalized Neogastroplites zone.

Hage (1944) reported the following fossils from the lower part of the formation on Sikanni Chief River.

Aucellina? dowlingi (Aucellina gryphaeoides Sowerby?)
Lemuroceras? sp.

The genus Lemuroceras is typical of the Moosebar and Gates Formations on Peace River. The general Neogastroplites zone occurs in the Goodrich Formation south of Peace River and on Peace River in shales about 1,000 feet above the Gates Formation. Thus the Buckinghorse Formation is approximately equivalent in age to the combined Moosebar, Gates and Hasler, and lower Goodrich Formations farther south (Fig. 6).

Sikanni and Sully Formations

Distribution and Lithology

The Sikanni Formation as first named and defined by Hage (1944) consists of a

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[1] Arcthoplites (Freboldiceras) irenense (McLearn) was collected by Stott (1968, p. 55) from upper Moosebar shales on Johnson Creek and the same species was reported by McLearn and Kindle (1950, p. 76) from near the top of the formation in the vicinity of Peace River Canyon. This Arcthoplites, according to Jeletzky (1964, 1967) belongs to the Arcthoplites irenense subzone of early middle Albian age.

[2] The zonation of Cretaceous marine macrofossils is outlined and discussed in two reports by J.A. Jeletzky (1964, 1968).

lower member about 380 feet thick comprising four thick sandstones separated by dark shales, and an upper member about 600 feet thick composed mainly of dark shale.

Stott (1960) restricted the name Sikanni to the lower sandstone member of Hage and gave the name Sully Formation to the upper member (Pl. I, B). Because of the difficulty of showing a thin formation like the Sikanni on the scale of the accompanying map, it has been combined with the Sully Formation and the two mapped as a single unit.

In Halfway River map-area the Sikanni Formation caps the mesa-like hills between Halfway River and the Foothills and forms a conspicuous escarpment along the east side of the Halfway River from the northern boundary southeastward beyond the eastern border of the map-area. It overlies the Buckinghorse Formation conformably and is overlain conformably by the Sully Formation.

The Sikanni Formation comprises three thick sandstones, each as much as 70 feet thick and separated by shale units as much as 60 feet thick. The evenly bedded sandstones are grey and grey weathering and fine to medium grained. They are conspicuously banded and some are crossbedded. The interbedded shales are grey, in part sandy, and contain scattered ironstone concretions.

The Sully Formation, which is nowhere well-exposed, underlies extensive areas on the ridges between Halfway and Cameron Rivers. The formation is composed almost entirely of dark grey shale and silty shale. It is overlain conformably by the Upper Cretaceous Dunvegan Formation.

Thickness

The Sikanni Formation consisting of three sandstones is about 300 feet thick where measured. On Sikanni Chief River Hage (1944) reported the presence of four sandstones and a total thickness of 380 feet. No measurements of the Sully Formation were made, but the writer has estimated it to be between 550 and 650 feet.

Age and Correlation

Three fossil collections from the lower sandstone of the Sikanni Formation are listed below.

GSC loc. 30772 - Near the mouth of Seventy-four Mile Creek; 56° 31'N, 122° 14'W.

Modiolus archisikanni McLearn
Modiolus sp. indet. (nov. sp. ?)
Pecten (Entolium) sp. indet.
Pteria (Oxytoma) sp. indet.

GSC loc. 30773 - From the lower sandstone on the east side of Halfway River, 300 yards below the mouth of Seventy-four Mile Creek; 56° 31'N, 122° 13'W.

Modiolus viaalaska McLearn
Corbicula? sp. indet.
Pinna cf. P. hagi McLearn
Pteria (Oxytoma) sp. indet.
Pecten (Entolium) sp. indet.
Arctica? sp. indet.
gastropod, genus and species indet.

GSC loc. 30774 - Top of ridge on northeast side of Colt Creek; 56°30'N, 122°25'W.

Posidonomya nahwisi McLearn cf. var. P. goodrichensis McLearn
pelecypods, genus and species indet.

Marine fossils have been collected from the various sandstones along Halfway River by Hage (1944) and others (see McLearn and Kindle, 1950).[1] Among those collected the diagnostic fossils Posidonomya nahwisi var. P. goodrichensis and Neogastroplites are the most important for age determination and correlation. On the basis of the presence of the Neogastroplites fauna, the Sikanni Formation, including probably the transition beds at the base, is equivalent in age to the Goodrich Formation on Pine and Peace Rivers and to shales high in the Shaftesbury Formation east of Cache Creek on Peace River (Irish, 1958). The Sully Formation is, therefore, roughly equivalent in age to the uppermost part of the Shaftesbury Formation of Peace River and the Cruiser Formation south of Peace River, and is mainly of late Albian age.

Upper Cretaceous

Dunvegan Formation

The name 'Dunvegan' was first used by G. M. Dawson (1881) and applied to what he called the 'Lower Sandstones and Shales' of Pine River and Peace River valleys. The type locality is presumably the section described by him that is exposed in the cliffs on the north side of Peace River west of Hudson's Bay Company trading post at Dunvegan. The formation covers large areas of northeastern British Columbia.

Distribution and Lithology

Sandstones and shales of the Dunvegan Formation comprise the youngest consolidated strata in the map-area. These beds cap some of the interstream ridges between Halfway and Cameron Rivers and underlie most of the interstream areas east of Cameron River. The contact between this succession and the underlying Sully For-

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[1] Neogastroplites selwyni McLearn, from the basal subzone of the late Albian Neogastroplites zone, has been reported by Jeletzky (1964, p. 11) from lower beds of the Sikanni Formation on Halfway River. N. ex gr. cornutus-muelleri occurs in upper sandstone at Sikanni Chief River, indicating that the Sikanni Formation of the type region lies within the lowest two subzones of Neogastroplites.

mation is normally transitional and is laterally diachronic (Stelck and Wall, 1955; Stelck, 1962). Only the lower part of the formation is present as the upper beds have been removed by erosion. Dunvegan strata dip gently to the northeast or are very gently folded; they are covered, for the most part, with a veneer of glacial material. Good outcrops are rare.

In this map-area the formation consists of 200 to 400 feet of fine- to coarse-grained, grey, buff- to brown-weathering mudstone and shale. Many of the sandstones are crossbedded, some contain ironstone concretions as much as 3 inches in diameter, and nearly all have carbonaceous particles along bedding planes. Scattered pebbles and lenses of pebble conglomerate are commonly associated with the coarser sandstone beds.

Thickness

The Dunvegan Formation is about 1,200 feet thick in the Mount Hulcross - Commotion Creek map-area south of Pine River and southwest of the present map-area (Wickenden and Shaw, 1943). Its thickness decreases to the east and south as the formation interfingers with marine shale formations. More than 900 feet of Dunvegan strata were measured on Mount McAllister south of Peace River (Stott, 1962). East of Halfway River map-area, in the adjacent Charlie Lake area where the formation is complete, it ranges in thickness between 500 and 600 feet (Irish, 1962); 200 to 400 feet of the lower part of the Dunvegan Formation is present in Halfway River map-area.

Age and Correlation

No fossils were collected from these strata in Halfway River map-area so that their correlation with the Dunvegan Formation of adjacent areas is based only on their similar stratigraphic position.

The Dunvegan Formation comprises sediments of deltaic and nearshore environments. It contains the *Inoceramus dunveganensis*, *Inoceramus rutherfordi*, and *Unio (Pleurobema) dowlingi* fauna, which J. A. Jeletzky (pers. comm.)[1] tentatively considers to be contemporaneous with the *Acanthoceras* fauna of Late Cretaceous (Cenomanian) age.[2]

Addendum

The following references published since the present report was written give more recent information on the Jurassic and Cretaceous strata of Halfway River map-area.

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[1] See also Jeletzky, 1964, 1967.

[2] Bell (1963), basing his conclusions on a large number of fossil plant collections considered that the Dunvegan flora was of Cenomanian age.

Frebold, Hans

1969: Subdivision and facies of Lower Jurassic rocks in the southern Canadian Rocky Mountains and Foothills; Proc. Geol. Assoc. Can., vol. 20, pp. 76-89.

Hughes, J. E.

1964: Jurassic and Cretaceous strata of the Bullhead succession in the Peace and Pine River Foothills; British Columbia Dept. Mines and Petroleum Resources, Bull. 51.

Stott, D. F.

1963: Stratigraphy of the Lower Cretaceous Fort St. John Group and Gething and Cadomin Formations, Foothills of northern Alberta and British Columbia; Geol. Surv. Can., Paper 62-39.

1967a: Fernie and Minnes strata north of Peace River, Foothills of northeastern British Columbia; Geol. Surv. Can., Paper 67-19 (Parts A and B).

1967b: Jurassic and Cretaceous stratigraphy between Peace and Tetsa Rivers, northeastern British Columbia; Geol. Surv. Can., Paper 66-7.

1968: Lower Cretaceous Bullhead and Fort St. John Groups, between Smoky and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia; Geol. Surv. Can., Bull. 152.

1969: The Gething Formation at Peace River Canyon, British Columbia; Geol. Surv. Can., Paper 68-28.

Bell, W. A.

1963: Upper Cretaceous floras of the Dunvegan, Bad Heart, and Milk River Formations of western Canada; Geol. Surv. Can., Bull. 94.

Jeletzky, J. A.

1964: Illustrations of Canadian fossils; Lower Cretaceous marine index fossils of the sedimentary basins of western and Arctic Canada; Geol. Surv. Can., Paper 64-11.

1968: Macrofossil zones of the marine Cretaceous of the western interior of Canada and their correlation with the zones and stages of Europe and the western Interior of the United States; Geol. Surv. Can., Paper 67-72.

STRUCTURE

Halfway River map-area completely straddles the Rocky Mountains and Foothills of northeastern British Columbia at latitude 56 degrees. A cross-section beginning in the southwest corner of the map-area and extending northeasterly would include a small part of the Rocky Mountain Trench, the Rocky Mountains, the Foothills, and a part of the Interior Plains.

Major folds and subparallel thrust faults generally trend about N23° W. Normally the surfaces of the thrust faults dip westward. Several small normal faults are known and others may be present. Folds in the northern half of the map-area plunge both to the north and south, but along any one fold the direction of plunge may be reversed. Thus, no net plunge occurs. In the southern half of the map-area, however, all folds plunge southerly or southeasterly.

The structure of each of the three physiographic divisions - Rocky Mountains, Foothills, and Interior Plains, is described separately.

ROCKY MOUNTAINS

The Rocky Mountains are bounded on the west by the Rocky Mountain Trench and on the east by the Foothills Belt, with the division between Rocky Mountains and Foothills placed at the Brewster fault. West of this fault the exposed strata are mainly of Paleozoic age; east of the fault Mesozoic rocks predominate. West of the Brewster fault the topography is much more rugged and the average elevation above sea-level is generally higher than in the region to the east.

With the exception of one large anticline (the Bernard anticline) folds are small and occur mainly in the northern part of the area.

Structural deformation has produced large west-dipping thrust faults along which slices of the massive carbonate strata have been moved relatively to the northeast. Stratigraphic displacement on these faults ranges from a few tens to thousands of feet. Along Peace River valley the presence of numerous, closely-spaced thrusts has resulted in an imbricate structure. Farther north at least two large faults, the Mount Burden and Nabesche faults, appear to have been folded during the formation of the underlying Bernard anticline. Folding of thrust faults is apparent also in the northwest part of the map-area.

Strata (composed mainly of lower Paleozoic rocks) on the western side of the Rocky Mountains are either vertical or dip steeply to the southwest. The surfaces of faults cutting these strata also dip steeply to the southwest, and the angle between bedding planes and fault surfaces is small. On the eastern side of the mountains where faults cut younger rocks the angles between the bedding planes and the fault surfaces are somewhat greater although the actual dips of the faults are generally less than those of the faults to the west.

In the southern third of the map-area all folds plunge southward, with the result that the fault slices involve younger strata in that direction.

The part of the Rocky Mountains east of Mount Burden and including most of Mount Greene is a synclinorium in which the upper strata have been intensely crenulated and broken. Another region of tight folds accompanied by faults occurs along the east margin of the Mountains between Needham Creek and Mount Brewster where the exposed rocks are mainly of Mississippian age. The structure there appears to be a complex anticlinorium. Both the above parts of the map-area reflect intense squeezing of the strata and probably are much more severely faulted than is shown on the acccompanying map.

Several normal faults of small displacement and limited linear extent were seen. These appear to strike at various angles to the trend of the principal faults and folds. Such faults are of minor displacement and are too small to show on the present map.

FAULTS

Mount Brewster Fault

This is the most easterly fault included within the Mountains and the one arbitrarily chosen to separate Mountains and Foothills. It extends northwesterly from the southern boundary of the map-area to a point in the Graham River valley just west of Mount Laurier. North of there it could not be followed with any certainty. Near the northern boundary of the map-area the most easterly folded thrust fault can be traced for several miles south into the valley of Graham River, and it seems likely that this fault is the northern extension of the Mount Brewster fault. If so, this fault or fault zone extends from the southern to the northern boundary of the map-area, a distance of about 78 miles.

If these two parts are considered to be the same fault, its surface trace is exposed, from north to south, progressively higher in the stratigraphic succession and the stratigraphic displacement may be decreasing to the south. At the northern boundary of the map-area Silurian beds are brought into fault contact with those of Mississippian age. Farther south Middle Devonian, Upper Devonian, and Mississippian strata are in turn faulted onto the Mississippian. In the southern part of the area Mississippian and Pennsylvanian (?) beds overlie those of Triassic age.

Nabesche Fault

The next important fault to the west has been named the Nabesche fault. From north to south its trace can be followed from near the northern border of the map-area around the lower part of the east side of Mount Kenny and into Halfway River valley about a mile east of Robb Lake. Between Halfway River valley and the valley of Horn Creek the trace follows a sinuous course around the east slopes of the mountains that form the west side of Graham River valley. At Horn Creek the fault trace turns west and then south to follow the west limb of the Bernard anticline to a point just south of the head of Nabesche River. From this point it turns east around and over the nose of plunging anticline, the fault trace forming an S-curve before turning south again to pass through Mount Brewster.[1] The fault is assumed to cut the Carboniferous and Triassic strata just north of Peace River.

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[1] More recent work by G.C. Taylor (pers. comm., Sept., 1969) has shown that the Nabesche fault is not continuous around the nose of the Bernard anticline, but apparently terminates in a recumbent anticline on the west side of the major fold. The southern part of the thrust of this report (see geological map), when traced from south to north, swings around as shown but then cuts westerly across the nose of the Bernard anticline and butts against the more westerly Mount Burden thrust fault.

The irregular trace of the Nabesche fault indicates change of dip of the fault surface along the strike. In the more easterly parts or salients dips are low to moderate, but where the trace is now exposed much farther west because of erosion the dips are as large as 65 degrees to the west. This fault with its overlying strata was folded when the Bernard anticline was formed. Subsequent erosion has removed the faulted strata from the crest of the main part of the fold.

Although the Nabesche fault could not be traced definitely in the vicinity of Peace River it is assumed to extend both north and south of the map-area. From west to east the fault cuts beds progressively higher in the stratigraphic succession and, because of the southward plunge of the structures, successively younger strata are preserved above the fault from north to south.

Mount Burden Fault

The Mount Burden fault is west of the Nabesche fault. The position of its northern extremity within this map-area is partly assumed, but is shown on the accompanying geological map to cross the western border of the map-area at approximately 56° 50'N. From there its trace maintains a course south and east for about 48 miles to where it is folded over the Bernard anticline. From this point it turns east and north over the fold and then south again around Mount Burden. From its northern end as far as Mount Burden Ordovician or older beds are thrust over progressively younger Paleozoic strata, and from Mount Burden south Silurian and then Middle Devonian strata are in fault contact with beds of Triassic age. The dip of the fault surface is assumed to be relatively steep except along the part that is folded.

Other Faults

Numerous other west-dipping thrust faults occur west of the Mount Burden fault, but none of these has been named. They involve mainly lower Paleozoic rocks, though Middle and Upper Devonian beds are exposed in a belt just west of Wedge Peak.

Data are lacking on the Misinchinka - lower Paleozoic contact. It is a fault contact, with Misinchinka strata thrust relatively to the northeast over Lower Ordovician and perhaps Cambrian beds. The contact is probably more irregular and complex than is shown on the map.

FOLDS

Bernard Anticline

The Bernard anticline is a relatively large fold between 4 and 6 miles wide and about 2,500 feet high at its crest. It can be traced for 45 miles from near the head of Horn Creek southeasterly to just south of Mount Burden. South of the headwaters of Nabesche River the anticline plunges southerly at approximately 800 feet per mile, and south of Mount Burden it becomes obscured by the overriding fault slices described previously.

North of the head of Nabesche River the Bernard anticline exposes strata of Silurian age along its length and over most of its width. Devonian carbonate and shale strata form a band along the northeast limb, and these rocks wrap around the nose of the plunging fold about 6 miles south of Nabesche River and extend northwest along the southwest limb until overridden by the Nabesche fault. Over this part of the fold the strata dip at a small angle for 2 to 3 miles on either side of the irregular fold axis and then dip at much greater angles. Dips on the southeast side increase to about 65 degrees and those on the northeast limb change abruptly to between 75 and 80 degrees. Thus, the fold is rather broad and flat-topped.

The Nabesche fault curves around the nose and over the anticline about 6 miles south of the head of Nabesche River, thereby superimposing a slice of strata of both Silurian and Devonian ages over the fold.[1] The strata overlying this fault are in turn overlain farther south by strata above the still more westerly Mount Burden fault that exposes beds of Ordovician age near the fold axis and beds of Silurian age on either limb. Just east of the anticlinal axis Mount Burden is composed mainly of Silurian beds overlying the Mount Burden fault.

The structure of the northern end of the Bernard anticline is probably much more complex than is shown on the accompanying map. Present data indicate that the fold plunges gradually to the northwest, and north of Horn Creek is again obscured by overriding thrust fault slices.

Other Folds

There are numerous anticlines and synclines within the Paleozoic strata in the northern part of the map-area. Also, in that part of the Mountains east of Mount Burden and Advance Mountain and underlain by the Nabesche and Mount Brewster faults the upper Paleozoic and Triassic beds are tightly folded. Normally these anticlines and synclines are long and narrow with steeply dipping limbs. None of them, however, are comparable in size to the Bernard anticline.

Within the region underlain by the Misinchinka Group structural data are meagre. Several folds and faults are known to occur locally and others may be present. None of these were traced laterally for any distance and, therefore, are not shown on the map. The presence of small recumbent folds in a few places suggests considerable structural complexity within these strata.

FOOTHILLS

That part of the map-area designated as the Foothills is bounded on the west by the Mount Brewster fault and on the east by Butler Ridge, Hackney Hills, and other ridges along strike to the north. Pink Mountain, though isolated and occurring east of this line of ridges, is structurally also a part of the Foothills. Several southwest - dipping thrust faults occur, but these are generally more widely spaced than in the Mountains

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1 See footnote under the heading 'Nabesche fault'.

and in most cases have resulted from the breaking of anticlines. None of these faults crosses the entire map-area from one border to the other, and stratigraphic displacement is normally measured only in tens or hundreds of feet. Many faults begin or terminate in compressed, asymmetrical anticlines.

The folds generally consist of a succession of narrow, tightly-folded anticlines (most of which are faulted near their axes) separated by broad synclines having gently inclined limbs. Asymmetrical anticlines with steeply dipping northeast flanks are conspicuous in the southern part of the map-area north and south of Peace River. In some cases the asymmetry is reversed as in the Pardonet anticline and the small anticline just east of Adams Creek. The Change of dip between the relatively flat crest and the steep limb of the folds is normally very abrupt, producing flat-topped folds.

Exceptions to tightly folded anticlines occur in that region underlain mainly by Triassic strata and extending from just south of the upper reaches of Chowade River to just north of Laurier Pass. In this area both anticlines and synclines are open folds with gently dipping limbs. Some folds, particularly in the northern part of the map-area, change along strike from simple anticlines to anticlinoria composed of several smaller folds, but these composite structures are less common than the individual anticlines and synclines.

A characteristic of most folds within the Foothills is a general southward plunge that is particularly marked from about 56° 20'N to beyond the southern border of the map-area. A few of the faults and folds have been named and are described on the following pages.

FAULTS

Pardonet Fault

This is the most westerly fault within the Foothills. Its northern extremity is assumed to be just south of the head of Chowade River; from there it extends southeasterly beyond the southern border of the map-area. South of Peace River Triassic rocks are in fault contact with Lower Cretaceous strata, but at the surface throughout most of its length this fault appears to involve only beds of Triassic age. What is assumed to be a splay of the Pardonet fault displaces Triassic beds on Pardonet Hill on the south side of the river. The stratigraphic separation south of Peace River is estimated to be 2,000 feet. North of Peace River the displacement may be a little less than this amount.

Carbon Fault

The Carbon fault appears to have its northern beginning in an anticline just north of Cypress Creek and east of the Fiddes syncline. From there it extends southeasterly on the east side of the Fiddes and Schooler Creek synclines and passes just east of Jones Peak north of Peace River and just east of Carbon Peak south of the river.

North of Graham River Triassic strata have been thrust over beds of Jurassic and Early Cretaceous ages. Between Graham and Peace Rivers Triassic beds are, for the most part, in contact with Triassic beds. At two places, however, thin bands of both Mississippian and Permian strata are exposed along the hanging-wall side. South of Peace River Triassic and then Jurassic strata successively overlie Lower Cretaceous beds within the map-area owing to the southerly plunge of all structures.

The stratigraphic separation along the Carbon fault appears to be between 1,000 and 1,500 feet.

Mount Gething Fault Zone

This structural zone seems to be near the crest of an anticline along most of its length. It is a composite of one or more faults, elements of which can be traced from the southern border of the map-area through Mount Gething and northwesterly as far as Cypress Creek. Over most of this distance Triassic strata have been thrust over beds of Early Cretaceous age, but near the southern border of the area Cretaceous beds are faulted against Cretaceous beds. The total displacement on all faults is not known. As shown on the structure cross-sections accompanying this report, no fault is thought to have a displacement of more than 1,500 feet.

Butler Ridge Fault Zone

This is another zone composed of several faults extending northwest from Butler Ridge at least as far as Blue Grave Creek. North of this the existence of the zone could not be proved, though an assumed fault is shown on the map separating the Minnes and Bullhead Groups from the overlying Fort St. John Group. Near the south end of Butler Ridge these faults pass into anticlines.

FOLDS

Nabesche Syncline

The Nabesche syncline is the most westerly syncline of the Foothills in the southern part of the map-area. It is an open fold about 3 miles wide extending southward from 56° 17'N to beyond the southern border of the map-area. The strata on the southwest limb dip at about 25 degrees, but are as high as 70 degrees on the northeast limb along the valley of Pardonet Creek (see structure cross-section G-H). That part of the syncline north of Peace River forms a ridge that has been called Black Bear Ridge[1] and on which are exposed strata of the Jurassic Fernie Formation and the Lower Cretaceous Minnes Group.

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[1] The Black Bear Ridge of McLearn (1950, 1960), is that formed by the Pardonet anticline on the north side of Peace River and adjacent to the Nabesche syncline on the east side.

Pardonet Anticline

This fold, which includes Pardonet Hill, is bounded on the west by the Nabesche syncline and on the east by the Pardonet fault. The anticline extends north from south of the map-area to about 8 miles north of Peace River, where it is cut off by the Pardonet fault. The fold is asymmetrical with a nearly flat crest. Beds on the west flank dip steeply to the west whereas those on the east flank dip east at a low angle. Only Triassic strata are exposed over its entire length.

Unnamed Composite Fold

Just east of the Pardonet fault and west of the Schooler syncline a series of small anticlines and synclines form a generally anticlinal structure that extends northward from the southern border of the map-area to just north of 56° 45'N. No name has been given to this composite structure although it is a prominent feature on the accompanying geological map.

The numerous folds comprising it are en echelon in part and no single anticline or syncline could be traced throughout the length of the structure. Strata of Mississippian and Permian ages are exposed at the culmination of the structure near Emerslund Lakes and for about 15 miles north and south of the lakes. Beyond these points Triassic strata occur at the surface.

Schooler Creek Syncline

The next important fold to the east in the southern part of the area is the Schooler Creek syncline. This fold extends east of south from 7 miles south of the mouth of Needham Creek to beyond the southern border of the map-area. South of Peace River it forms the Carbon Creek Basin (Mathews, 1947). The fold is 2 to 2 1/4 miles wide north of Peace River valley, but widens to nearly 9 miles south of the river. The syncline is shallow relative to its width with dips from 10 to 40 degrees. Steeper dips occur near the Carbon Creek fault at its eastern edge.

Because of its southerly plunge the syncline deepens to the south so that although Triassic strata are exposed along the axis north of Peace River, progressively younger beds fill most of the basin south of the river.

The Schooler Creek syncline is shown on the accompanying map to terminate just south of Needham Creek. The Fiddes syncline, in the northern half of the map-area, is shown to end near Christina Falls on Graham River. There seems little doubt that together these folds form a synclinal region from north to south across the map-area, but the axes of the two appear to be en echelon and separated by an anticline for a few miles south of the mouth of Needham Creek.

Adams Syncline

This broad fold with gently dipping limbs lies between the Carbon and Gething faulted anticlines. South of Peace River it is about 5 miles wide and exposes strata of the Minnes and Bullhead Groups over its entire width; north of Peace River the rocks within the syncline are mainly of Triassic age. The fold loses its identity to the north before reaching Graham River.

Dunlevy Syncline

The Dunlevy syncline is a broad, shallow fold between the Gething structure on the west and Butler Ridge on the east. Its irregular axis can be traced from the south border of the map-area to Blue Grave Creek where the fold dies out in the Butler Ridge fault zone. The southern part of the syncline appears structurally simple, but toward the north the west limb is complicated by several small folds and the east limb is cut by a minor thrust fault. Along most of its length strata of the Bullhead Group outcrop along the axis with older Cretaceous strata occurring along the flanks.

Butler Ridge Anticlinorium

This complex structure consists of several faulted anticlines separated by synclines. It extends north from the southern border of the map-area to Blue Grave Creek (Beach and Spivak, 1944). Between Blue Grave Creek and Halfway River the Butler Ridge structure and the Gething structural zone together form one complex zone of folds and faults at the eastern edge of the Foothills and bounded on the west by the Chowade syncline.

Chowade Syncline

The Chowade syncline is a long, relatively narrow fold extending north for more than 48 miles from south of Graham River to north of Cypress Creek. Along most of its length this syncline is quite regular with strata on either flank dipping at about 40 degrees. For a few miles north of Graham River the axis becomes somewhat irregular and beds on the east limb dip as much as 60 degrees west whereas those on the west limb decrease to about 20 degrees east. The fold is canoe-shaped, and exposes strata of the Buckinghorse Formation for 22 miles along its axis. Along the flanks and to the north and south beds of the underlying Minnes and Bullhead Groups outcrop; still farther south Jurassic and then Triassic strata are exposed at the surface.

Cypress Anticline

This long, narrow fold occurs west of the Chowade syncline and extends southward from the northern border of the map-area to 14 miles south of Graham River where it disappears below a branch of the Carbon fault and merges with that structural zone. Along most of its length beds of Triassic age are exposed in the central part of the fold with beds of Jurassic and Cretaceous ages occurring farther out on the flanks. Between Cypress Creek and Chowade River only Cretaceous beds are exposed; this may indicate a structural low on the fold in this region. The fold is symmetrical with strata on both flanks dipping at about 45 degrees.

Christina Syncline

The Christina syncline occurs between the Carbon fault on the west and the Cypress anticline on the east. This structure begins just north of Graham River and extends to the north as a single fold to a point just south of Cypress Creek. From there to the northern border of the map-area it is complicated by several smaller folds on the west flank. Only strata of the Minnes and Bullhead Groups outcrop within this syncline.

Fiddes Syncline

The Fiddes syncline is west of the Carbon fault and extends southward from the northern border of the map-area to 14 miles south of Graham River. This fold is about 6 miles wide near Halfway River and narrows to the south. It has a total length of about 44 miles. Lower Cretaceous rocks are exposed along the axis as far as Chowade River, then Triassic strata to its southern end. The beds dip at between 55 and 65 degrees along the flanks, but their inclination decreases to about 30 degrees near the axis. The Fiddes syncline is the northern part of the Schooler Creek synclinal zone.

Other Folds

In the northern part of the map-area several other folds occur west of the Fiddes syncline. None of these are of great length and none have been named.

INTERIOR PLAINS

The Interior Plains part of the map-area extends eastward from Butler Ridge, Hackney Hills, and other ridges along strike to the north. Structural deformation is considerably less there than within the Foothills physiographic division and decreases from west to east.

FAULTS

Subsurface evidence indicates the presence of thrust faults within this part of the map-area, but the positions of their surface traces have not been located so far.

FOLDS

Within that part of the Interior Plains included in Halfway River map-area several anticlines and synclines have been mapped. In most cases these are very gentle, open folds with the strata on both limbs normally inclined at between 5 and 15 degrees. Dips up to 35 degrees occur locally. These folds appear to be en echelon in character, no one fold persisting for any great distance. At the northern border of the map-area their axes strike roughly north-south, but farther south the trend becomes more south-easterly. The position of the axes could be located only approximately because of the lack of outcrops and the small inclination of the beds.

Close to the western margin of the Plains other folds are suspected but could not be mapped with data available at this time.

SUMMARY AND COMMENTS

In Halfway River map-area the most ouststanding structural features within the mountains are the Bernard anticline and the folded thrust faults above it. The relationships between these structures indicate that folding took place mainly after the formation of the faults because both strata and faults appear to be folded toegether. Little or no movement on the faults seems likely to have taken place after the anticline had reached its present size. The Bernard anticline may be related to the underlying Brewster thrust and also to other subsidiary faults that have not reached the surface.

Two features are characteristic of the Foothills in the southern half of the map-area: (1) the concentration of high dips in narrow anticlinal belts; (2) the general southerly plunge of these folds. Also, in most cases the narrow, compressed anticlines are commonly broken by high-angle thrust faults near the axes along part or all of their lengths. Another feature of the Foothills in this region is the presence of the flat-topped or so-called 'Box' anticlines mentioned previously. Beach and Spivak (1944) and Mathews (1947) noted that on such anticlines much of the folding is concentric rather than similar. In the northern half of the map-area these distinguishing features are less conspicuous. Wide, shallow synclines occur but the intervening anticlinal regions are more complex. Many of the anticlines change northward into broad anticlinoria by the addition of subsidiary folds on one or both flanks.

Gentle warping is typical of the Plains part of the map-area; faults occur but cannot be mapped on the surface at this time.

ECONOMIC GEOLOGY

OIL AND NATURAL GAS

Natural gas is, at present, the most important natural resource in Halfway River map-area. The locations of wells drilled to date by various oil companies are shown on the accompanying geological map. Additional information on individual wells is available in the British Columbia Department of Mines Schedule of Wells Drilled (1963).

The earliest test holes for oil and gas were drilled by the British Columbia Government in 1922. Five holes were located rather close together on Farrell Creek about 24 miles northwest of Hudson Hope, and a sixth 12 miles farther south on Beryl Prairie. According to Dresser (1921, 1922) the Farrell Creek wells are on the Farrell Creek anticline or dome. Beach and Spivak (1944) noted that these wells penetrated the Hasler, Gates, and Moosebar Formations (Buckinghorse Formation of this report) and about 800 feet of the Gething Formation. Small amounts of gas were obtained, and in 1957 the writer noted that gas from No. 1 hole was still bubbling through the water near the north side of the creek.

The Interior Plains division of Halfway River map-area lies within that part of northeastern British Columbia that has been and is still being actively investigated for oil and gas. Natural gas is produced from numerous wells, though oil in economic quantities has not been found. Established gas fields are the Highway, Gundy Creek, Blueberry West, and Kobes Townsend. The wells in the Highway and Kobes Townsend fields produce from Mississippian, Triassic, and Lower Cretaceous formations, whereas those in the Gundy Creek and Blueberry West fields produce only from Mississippian and Triassic strata.

Between the eastern edge of the Foothills and the established gas fields a large number of exploratory wells have been drilled. Many of these encountered gas, and exploration is continuing in this region (see Appendix I). A few wells have been drilled within the eastern marginal zone of the Foothills without encountering commercial quantities of oil or gas. Triassic strata are exposed in the cores of many of the anticlines but thrust faults are normally present. Mississippian rocks underlie most of the Foothills region, and although many anticlines in the Foothills are probably underlain by thrust faults, the Mississippian strata may occur in closed structures.

COAL

Large deposits of good quality bituminous coal are found in northeastern British Columbia in the Gething Formation of Early Cretaceous age. Within Halfway River map-area the deposits are found at the following localities: upper part of Peace River Canyon area, Dunlevy Creek - Cust Creek - Butler Ridge area, and the Carbon Creek area. Coal seams are numerous in the southern part of the map-area, but to the north the number and thickness of seams decreases rapidly.

Coal was produced for some years at several small mines near Butler Ridge and Portage Mountain. No coal is now being mined within Halfway River map-area. Thin coal seams and lenses occur also in the Dunvegan Formation of Late Cretaceous age, but these are too small to be commercially important.

Peace River Canyon Coal Area

The Peace River Canyon coal area of McLearn (McLearn and Kindle, 1950) extends from the foot of Peace River Canyon and includes neighboring ground on both sides of Peace River. The presence of coal seams along the walls of the canyon was first noted by Alexander MacKenzie in 1793. The first leases were acquired in the area by Neil Gething and associates in 1908; in 1912 C. F. J. Galloway reported on this coal field for the British Columbia Department of Mines. In 1922 F. H. McLearn examined the area and his report (1923) describes the occurrences in detail. Further investigations of the coal resources were made by F. H. McLearn and E. J. W. Irish in 1943. A complete description of all seams in the area, including their rank and thickness, is given by McLearn and Kindle (1950).

Only the western part of this coal area near the head of Peace River Canyon is within Halfway River map-area and the seams there are toward the base of the Gething Formation. One seam, the Murray seam, was mined for a short time; it is located about 2 miles below the head of the canyon on the east side in a thick, black shale zone.

It was uncovered in 1943 in a trench excavated on the edge of the high east canyon wall (McLearn and Irish, 1944). The seam was 5 feet thick in the discovery trench and had a 1.5-foot bed of clay ironstone near the middle.

In 1944, Peace River Coal Mines Ltd. began mining operations near the discovery trench. According to McLearn and Kindle (1950) 748 tons of coal were mined in that year, and by the end of 1947 total production was 7,935 tons mined and sold. Mining operations continued for several years but were finally suspended for economic reasons.[1] All coal mined from the Peace River Canyon area was sold locally in Hudson Hope, Fort St. John, and Fort Nelson. Transportation to all points from the mines was by truck.

Dunlevy Creek - Cust Creek - Butler Ridge Coal Area

Coal seams occur on both Dunlevy and Cust Creeks and their eastern branches, but none are thick enough to mine.

At the south end of a spur of Butler Ridge two thin seams lie close to the base of the Gething Formation or within the Cadomin - Gething transition beds; the structure is anticlinal. Coal outcrops were first discovered on the southwest limb of the anticline about 22 miles west of Hudson Hope and a mile north of Peace River about 480 feet above river level. The property was acquired by Mr. George Packwood in 1940 and mining was begun the same year. In 1948 new mine workings were opened on what is considered to be the same seam located on the other limb of the anticline and about half a mile east of the original workings.

The lower (No. 1) seam at the original workings ranged in thickness between 20 and 30 inches, the lower 10 inches were sheared and crushed. It is overlain by hard, massive sandstone and underlain by silty shale. The upper (No. 2) seam is between 15 and 16 feet above No. 1 and is about 30 inches thick. The seam mined on the east limb of the fold is roughly 5 feet thick.

Coal was mined for several years and hauled by truck to Fort St. John and other points on the Alaska Highway over a poor road for a distance of 83 miles. The property is now owned by Reschke Coal, Ltd., but no coal is being mined.

Several coal seams are known on the east side of Butler Ridge. Beach and Spivak (1944) recorded one such seam, less than 3 feet thick, that could be traced for nearly 1,200 feet along the middle branch of Ruddy Creek. Thin coal seams outcrop as far north as Halfway River, but none of mineable thickness are known. Hage (1944) reported a coal seam more than 5 feet thick at the base of the Lower Cretaceous strata on Pink Mountain. This location is north of Halfway River and just beyond the northern boundary of the map-area.

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[1] The abandoned mine was destroyed during construction of the high dam of the British Columbia Hyro and Power Authority.

Carbon Creek Coal Area

This area lies on the south side of Peace River about 20 miles west of the Peace River Canyon. The seams outcropping along Carbon Creek and its tributaries within this map-area are in the northern part of the Carbon Creek coal basin (Mathews, 1947). Coal was first discovered on Carbon Creek in 1911 by Messrs. Cowper Rochfort, David Barr, and George McAllister. The coal was examined for the British Columbia Department of Mines in 1923 by J. D. Galloway, but the first comprehensive report and map of this coal area was by W. H. Mathews in 1947.

The coal-bearing strata occur in a synclinal basin about 9 miles wide and extending 20 miles south from Peace River. In the northern part of the basin the structure is simple and the seams dip gently. The seams are exposed mainly along Carbon Creek or the lower parts of its tributaries. Since most of the coal seams are in the upper part of the coal-bearing beds near the axis of the syncline, they are thought to be within a thousand feet of the surface in most places and thus favourably situated for development. The largest number of seams are exposed in the central part of the basin just south of Halfway River map-area. According to McLearn and Kindle (1950) at least ten seams in the basin are locally more than 4 feet thick, and at least five are between 3 and 4 feet thick.

One of the lowest of the thicker seams is exposed on a small creek entering Carbon Creek from the west about 5 miles above Peace River. This outcrop is approximately a quarter mile west of Carbon Creek and about 1,000 feet above the base of the coal-bearing strata. Mathews (1947) gave its thickness as 2 feet 11 inches.

Four coal seams are believed to be present near the junction of Carbon Creek and Seven Mile Creek at the southern border of this map-area. Other exposures occur between 1 mile and 3 miles above the mouth of Seven Mile Creek. A description and analysis of each is given by Mathews (1947).

The rank of most of the coal within Halfway River map-area is considered to be medium-volatile bituminous based on the classification of the Committee of the American Society of Testing Materials (see Stansfield, 1937, p. 6). McLearn and Kindle (1950, p. 183) stated "The calorific value is high, being more than 13,000 B. T. U.'s per pound for many seams, even in surface samples, and the calorific value of nearly all coal samples computed on an ash-free basis exceeds 14,000 B. T. U.'s per pound".

At present the demand for this coal is small except for local domestic use, but large reserves of high-grade, bituminous coal are probably available when required.

GOLD

Placer Deposits

Placer gold was discovered on the Finlay and Parsnip Rivers as early as 1861 (McConnell, 1896), but little is known of the earlier days of Placer mining on Peace River. According to MacGregor (1952) 2,000 miners were panning the bars between Hudson Hope and Fort St. John in the 1870's. Undoubtedly many men on their way to the gold fields in Yukon Territory remained to try their luck along Peace River, and to this day the bars are worked by individuals from time to time (see McLearn and Kindle, 1950; Taylor, 1962). The Annual Report of the Minister of Mines of British Columbia for 1947 gives the total production of placer gold for Peace River division during the period 1900 to 1947 as 4,116 ounces valued at $94,977.

The gold is found on the bars or river flats of Peace River. For many years the Omineca and Cariboo Mountains have been recognized as the major source of the gold. Because the gold particles are so small they lie in or just below the gravels and sands forming the upstream ends of the bars during high-water stages of the river. A few more massive deposits of old channel gravels now overlain by flood plain sands and silts are said to contain low values throughout thicknesses of about 25 feet. The size of the gold particles decreases to the east down the river.

Branham Flats, located on the north side of Peace River about 25 miles above the Peace River Canyon, was first worked for placer gold by 'Dad' Branham about 1912 and later by several individuals and groups including Woods and Taylor and the Ingenika Company. In 1918 Branham Flats was tested with steam drills (O'Neill and Gunning, 1934), and in 1922 the Peace River Gold Dredging Company Limited moved a dragline to the flat. The operations in 1922-23 were not profitable. In 1942 Jack Reschke of Hudson Hope took a home-made, trestle-mounted, hand-operated, two-winch dragline by boat to the lower Parsnip River. There he and his wife and nine-year-old son worked for three months and took out 120 ounces of dust. 'Hudson Hope Mines' moved a dragline, conveyor belt, and washer to Branham Flats in 1959. To this date (1963), however, the plant has not been put into operation (Pl. II, A).

Load Gold Deposits

As early as 1899 mineral claims were staked on some of the quartzite and associated white quartz on the north-facing slope of Mount Selwyn about 8 miles east of Finlay Forks on the south side of Peace River. The rocks form a part of the succession that may be of Cambrian age, but which in this report and on the accompanying geological map are included in the Misinchinka Group.

According to McLearn and Kindle (1950) the Peace River Mining and Milling Company, Limited carried out surface work on nine Crown-granted claims. Twelve tons of rock were treated in a small test mill, but no gold was recovered. In 1923 J. D. Galloway visited the claims and reported (1924) that quartz veinlets form a negligible percentage of the whole. The owners, however, claimed that gold values of from $2.00 to $4.00 per ton occurred generally throughout the quartzite without relation to the veinlets. Five samples collected for the British Columbia Department of Mines by Douglas Lay in 1928 yielded no trace of gold. Sampling was done in 1933 by J. G. MacGregor for Gold Mountain Mines Syndicate, and in 1935 by the Consolidated Mining and Smelting Company, Limited. An amalgamation test of a 70-pound bulk sample showed that it contained only a trace of gold.

BOG IRON

Several deposits of bog iron are situated along the valley of Cameron River from its head to its confluence with Halfway River. These are isolated, small, more or less circular masses composed of relatively pure iron oxide near the centre of each mass, but grading into iron-stained gravels or clay toward their outer margins. These deposits are presumed to have had their origin from a central spring: the water contained iron in solution which was precipitated as iron oxide after reaching the surface. In the deposits seen by the writer the water from the springs has apparently ceased to flow and the iron oxide has dried and hardened.

BUILDING STONE

The Rocky Mountains part of Halfway River map-area contains an abundant supply of limestone and dolomite, some of which may be suitable as building stone.

GRAVEL AND SAND

Large supplies of gravel for road building are available along the river terraces and bars. Terminal moraines, such as that filling the pre-Pleistocene channel of Peace River, should also be considered when large quantities of gravel and sand are required.

PORTLAND CEMENT

M.Y. Williams (1934) pointed out that the raw materials and fuel for the manufacture of Portland cement are in close proximity in the map-area. Limestone is available on Peace River about 15 miles above the mouth of Nabesche River, and suitable shale occurs 2 miles up Nabesche River from its mouth. Coal occurs on Carbon Creek about 12 miles from the Nabesche River.

HYDRO ELECTRIC POWER

Peace River has long been considered as a possible source of hydro-electric power. In 1957 the first studies of the feasibility of hydro development on Peace River were begun, and between 1957 and 1959 eleven possible dam sites along the river were examined by drilling. Of these, the Portage Mountain site near the abandoned Peace River Coal mine was chosen for the proposed high dam. Dolmage and Campbell (1963) stated "........ the location of the axis of the dam, the powerhouse and the many ancillary works have largely been governed by geological features".

The site chosen has the advantages of (1) a relatively short distance between bedrock buttresses on either side of the river, (2) lack of a thick sand and gravel fill in the preglacial bed of the river, (3) bedrock composed of very competent, thickbedded sandstone of the upper part of the Minnes Group and the Cadomin Formation under the highest part of the dam, and of the Gething Formation above the 2,000-foot elevation.

The Peace River Coal mine workings are to be back-filled with gravel and will be utilized as a foundation drain under the dam. The gravel fill for the dam will come from morainal material forming two hills at the east end of the Rocky Mountain Portage (Charlie Lake map-area).

The three 50-foot-diameter diversion tunnels on the west side of the valley, each 2,600 feet long, have now (1963) been completed, and construction of the dam itself is imminent.

The reservoir behind the completed dam or dams will form a very large lake extending from the dam site 70 miles back through the foothills and mountains and for many miles up both the Finlay and Parsnip valleys within the Rocky Mountain Trench. The maximum water level of this lake is to lie at an elevation of 2,320 feet (Dolmage and Campbell, 1963). Above this elevation the water would spill from the reservoir at the south end into the Fraser River at Prince George. At that level the geological and topographical features below the 2,300 - foot contour, which are shown on the accompanying map, will not be seen.

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APPENDIX I

List of drilled wells

Plains Wells

Well No	Name	Location	Ground elevation (feet)	Total depth (feet)	Result	Deepest strata penetrated	
						Age	Depth below ground level
2	Pacific Town (A-1)	1/4 unit C, unit 69, block J, 94B/16	3,101	7,406	Completed gas well from Mississippian strata	Mississippian	6,858
3	Phillips Petroleum Blair "A" No. 1	1/4 unit C, unit 85, block E, 94B/16	3,282	8,700	Abandoned, dry	Mississippian	7,620
4	Phillips Petroleum Town "A" No. 2	1/4 unit C, unit 16, block J, 94B/16	2,925	7,406	Abandoned, dry	Mississippian	6,836
5	Sinclair Pacific Robertson Creek	1/4 unit D, unit 39, block J, 94B/15	3,365	9,141	Abandoned, dry	Mississippian (Rundle)	8,732
6	French Petroleum Company - Richfield Daiber	1/4 unit C, unit 98, block D, 94B/16	3,532	5,413	Abandoned, dry	Triassic	5,182
7	French Petroleum Company - Richfield Daiber No. 1	1/4 unit C, unit 76, block D, 94B/16	2,893	5,700	Gas from Triassic	Triassic	4,237
8	French Petroleum Company - Richfield Daiber	1/4 unit C, unit 56, block D, 94B/16	3,195	4,899	Gas from Triassic	Triassic	4,695
9	Phillips Petroleum Daiber "A" 1	1/4 unit A, unit 45, block D, 94B/16	2,962	11,504	Abandoned, dry	Devonian	10,135
10	Texaco N.F.A. Cameron River (1)	1/4 unit B, unit 49, block L, 94B/9	2,921	5,124	Completed gas well from Triassic	Triassic	4,892

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<u>Plains Wells</u>

Well No	Name	Location	Ground elevation (feet)	Total depth (feet)	Result	Deepest strata penetrated	
						Age	Depth below ground level
11	Hudson Bay Cypress Creek	1/4 unit A, unit 28, block F, 94B/15	3,235	9,135	Gas from Triassic	Pennsylvanian-Mississippian (Stoddart Formation)	9,067
12	Hudson Bay Cypress Creek	1/4 unit A, unit 87, block C, 94B/15	3,751	4,940	Gas from Triassic	Triassic	4,570
13	Hudson Bay Cypress Creek	1/4 unit A, unit 86, block C, 94B/15	3,735	12,110	Abandoned, gas shows	Debolt Formation (Mississippian)	11,290
14	Hudson Bay Cypress Creek	1/4 unit A, unit 65, block C, 94B/15	3,391	4,635	Gas from Triassic	Triassic	4,342
15	Hudson Bay Chowade	1/4 unit B, unit 18, block J, 94B/10	3,067	5,598	Abandoned, dry	Triassic	5,330
16	Texaco N. F. A. - Cameron	1/4 unit D, unit 43,	2,723	9,472	Gas from Triassic	Golata Formation (Mississippian)	9,200
17	Sinclair <u>et al.</u>, Graham (B-5-1)	1/4 unit C, unit 53, block D, 94B/9	2,487	8,957	Suspended	Banff? Formation (Mississippian)	8,778

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Plains Wells

Well No	Name	Location	Ground elevation (feet)	Total depth (feet)	Result	Deepest strata penetrated: Age	Deepest strata penetrated: Depth below ground level
19	Imperial Calvan Altares	1/4 unit C, unit 14, block H, 94B/8	2,524	3,095	Abandoned, dry	Gething Formation (Lower Cretaceous)	3,075
20	Imperial Calvan Altares	1/4 unit A, unit 83, block A, 94B/8	2,660	6,848	Completed gas well from Bluesky (Lower Cretaceous)	Triassic	6,123
21	Imperial Pacific Altares	1/4 unit C, unit 42, block A, 94B/8	2,530	3,863	Abandoned, dry	Cadomin Formation (Lower Cretaceous)	3,524
24	Hudson Bay Cypress Creek	1/4 unit C, unit 38, block F, 94B/15	3,163	4,760	Abandoned, dry	Triassic	4,315
25	Texaco Texan Blair	1/4 unit D, unit 71, block I, 94B/15	3,453	7,080	Abandoned, dry		
26	Texaco N. F. A. Townsend	1/4 unit A, unit 8, block J, 94B/9	? K. B. elev. 2,597	7,773	Abandoned, dry	Debolt Formation (Mississippian)	7,429

Foothills Wells

Well No	Name	Location	Ground elevation (feet)	Total depth (feet)	Result	Deepest strata penetrated	
						Age	Depth below ground level
1	Hudson Bay Headstone Creek	1/4 unit D, unit 87, block I, 94B/14	3,617	11,698	Abandoned, dry	Devonian (Elk Point Formation)	11,500
18	Placid - Federal	1/4 unit C, unit 29, block E, 94B/8	4,625	9,696	Abandoned, dry	Debolt Formation (Mississippian)	8,943
22	French Petroleum Company	1/4 unit C, unit 23, block G, 94B/1	3,039	7,796	Abandoned, dry	Triassic	5,806
23	Fargo Oils Butler Ridge No. 1	1/4 unit A, unit 7, block G, 94B/1	2,639	1,481	Abandoned, dry	Entire hole in the Bullhead Group	

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APPENDIX II

Measured Stratigraphic Sections

Section 1. Western end of Advance Mountain; lat. 56° 03'N, long. 123° 28'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	SILURIAN		
16	Dolomite, fine to medium grained, grey to brown-grey, weathering dull grey; some beds sandy or silty; beds 2 to 6 feet thick; a bed 90 feet above base of unit contains: Catenipora sp., Favosites sp. cf. F. favosus (Goldfuss), Entellophyllum? sp. and Fletcheria? sp. (GSC loc. 39957)	350	2,580
15	Dolomite, fine to medium grained, grey to brown-grey, weathering grey and buff; unit contains a 10-foot-thick bed of dolomitic sandstone at top and bottom	90	2,230
14	Dolomite, fine to medium grained, grey to brownish, weathering dull grey to brown; beds 2 to 5 feet thick; much of unit is silty or sandy	500	2,140
13	Sandstone, dolomitic and dolomite, sandy; dolomite, grey, weathering grey to light grey; beds 2 to 4 feet thick; sandstone, fine grained; dolomite is fine to medium grained	160	1,640
12	Dolomite, fine to medium grained, grey to brownish grey, weathering grey and buff; beds 3 to 5 feet thick; some sandy or silty beds	360	1,480
	ORDOVICIAN		
11	Sandstone, fine to medium grained, grey to light grey, weathering grey and light grey, dolomitic; beds 4 to 6 feet thick	90	1,120
10	Dolomite, fine to medium grained, grey to light grey, weathering grey to buff; at 50 and 190 feet above base of unit are dolomite breccias each 10 to 15 feet thick; beds between 2 and 4 feet thick; at 170		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10 (cont'd.)	feet above base of unit a 3-foot-thick bed contains: Streptelasma sp., Resserella sp., and Bumastus sp. (GSC loc. 39933)	400	1,030
9	Sandstone, medium grained, dolomitic, grey, weathering grey; beds 1 foot to 2 feet thick	20	630
8	Dolomite, grey, weathering grey and buff; some beds silty; beds 3 to 5 feet thick	50	610
7	Limestone, fine to medium grained, grey to dark grey, weathering grey-buff; beds 1 foot to 3 feet thick	30	560
6	Dolomite, fine to medium grained, grey, weathering buff-grey; beds 2 to 4 feet thick; about 80 feet in middle of this unit is covered	230	530
5	Limestone, dense to fine grained, grey to brownish grey, weathering buff; beds 3 inches to 2 feet thick; some argillaceous beds	20	300
4	Dolomite, medium grained, dark grey, weathering grey and buff; average thickness of beds about 6 feet	90	280
3	Sandstone, fine grained, quartzitic, grey, weathering grey and light buff; beds 2 to 4 feet thick; some beds dolomitic	60	190
2	Dolomite, fine to medium grained, dark grey, weathering brownish; beds 6 feet thick and massive	30	130
1	Limestone, fine to medium grained, dark grey, weathering grey to brownish; beds 6 inches to 2 feet thick	100	100

Section 2. On ridge west of the head of Needham Creek; lat. 56° 28'N, long. 123° 42'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	SILURIAN		
26	Dolomite, dense to finely crystalline, light and dark grey, weathering light grey and dark grey; most beds silty or sandy; beds platy and 1 inch to 1 foot thick	240	3,287
25	Sandstone, quartzitic, medium grained, grey weathering light grey; with interbedded sandy dolomite; beds 2 inches to 1 foot thick	15	3,047
24	Dolomite, dense to finely crystalline, light and dark grey, weathering brownish grey and dark grey; silty to sandy; beds 1/4 inch to 4 inches thick; a massive bed 10 feet thick at 55 feet above base of unit contains: Halysites or Cystihalysites sp. Favosites cf. F. favosus (Goldfuss), Favosites spp. 2, ?Thamnopora, ?Coenites, Striatopora (GSC loc. 46914)	97	3,032
	ORDOVICIAN		
23	Sandstone, quartzitic, coarse grained, light grey, weathering light grey; beds 6 inches to 2 feet thick; slightly calcareous	105	2,935
22	Limestone, dense, dark grey, weathering buff; beds papery to platy	100	2,830
21	Dolomite, finely crystalline, dark grey, weathering dark grey; platy	75	2,730
20	Shale, silty, dark grey, weathering light grey to buff; papery; slightly calcareous	20	2,655
19	Covered	30	2,635
18	Dolomite, finely crystalline, light grey, weathering light grey, platy, silty; 5-foot-thick bed of crinoidal limestone at 25 feet		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
18 (cont'd.)	above base of unit, 20-foot covered zone at 70 feet above base	170	2,605
17	Mostly covered; dolomite outcrops at 330, 600, and 701 feet above base of unit	880	2,435
16	Quartzite, fine grained, light grey, weathering light grey, massive	10	1,555
15	Dolomite, light to dark grey, weathering light grey to buff; beds 1/2 inch to 2 feet thick; some silty beds; lower 40 feet of unit contains dark grey chert nodules up to 1 foot long	280	1,545
14	Limestone, shaly, light to dark grey, weathering brownish grey; beds 6 inches thick with shaly partings	300	1,265
13	Limestone, dense to microcrystalline, dark grey to black, weathering brownish grey; some beds silty; beds 1/2 inch to 6 inches thick; some shaly zones	310	965
12	Shale, dolomitic, grey, weathering buff; thin bedded to papery	10	655
11	Covered	60	645
10	Dolomite, fine grained, dark grey, weathering dark grey; beds 6 inches to 3 feet thick	150	585
9	Dolomite, fine grained, steel grey, weathering light grey; beds 6 inches to 3 feet	100	435
8	Dolomite, fine to coarse grained, purplish to reddish, weathering purplish grey; sandy; thick massive beds	100	335
7	Lamprophyre, dark grey, weathering buff to brown; medium crystalline	15	235
6	Dolomite, greenish grey to green, slightly phyllitic	20	220

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Dolomite, medium grained, dark grey, weathering rusty red; some greenish beds; some beds brecciated; beds 2 to 4 feet thick	60	200
4	Covered	20	140
3	Dolomite, fine grained, brown, weathering brown; small exposure on talus slope; contains hesperorthid brachiopod (GSC loc. 46926)	10	120
2	Covered	40	110
1	Dolomite, fine grained, grey to steel grey, weathering dull grey to buff; silicified and cut by thin quartz veinlets	70	70

Section 3. One mile south of Mount Robb; lat. 56° 50'N, long. 123° 48' to 123° 49'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	<u>SILURIAN</u>		
18	Shale, dark grey, weathering grey; contains diplograptid graptolites (GSC loc. 51266)	20	2,230
17	Sandstone, fine grained, quartzitic, grey to brown-grey, weathering grey to brown; beds 2 to 3 feet thick; several thin shaly partings	150	2,210
	<u>ORDOVICIAN</u>		
16	Siltstone, dark grey, weathering grey; beds 3 to 5 inches thick; interbedded with shale and silty shale, dark grey, weathering grey and buff; beds at base of unit contain diplograptid graptolite and ?<u>Dicranograptus</u> sp. (GSC loc. 51264)	270	2,060

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
15	Limestone, dark grey, weathering buff; beds 4 inches to 2 feet thick	20	1,790
14	Covered	350	1,770
13	Limestone, dense to fine grained, dark grey, weathering grey; in 20- to 40-foot units; shale, grey to dark grey, weathering grey to buff in 10- to 15-foot units	160	1,420
12	Sandstone and shale interbedded; sandstone, grey, weathering light grey, quartzitic, fine grained; occurs in 20-foot units; shale, grey to dark grey, weathering grey to buff in 10- to 15-foot units	90	1,260
11	Dolomite, dense to finely crystalline, grey to dark grey, weathering grey to buff; silicified, slightly calcareous; beds 6 inches to 3 feet thick	300	1,170
10	Dolomite, dense to fine grained, grey to dark grey, weathering light grey; some silty beds; beds 1 foot to 3 feet thick; beds at base of unit contain low-spired gastropods that are probably of Ordovician age (GSC loc. 51261)	200	870
9	Limestone, fine grained, grey to dark grey, weathering buff to grey; beds 6 inches to 2 feet thick; dolomitic	20	670
8	Dolomite, finely crystalline, grey to dark grey, weathering light grey; beds 6 inches to 4 feet thick; some calcareous beds	80	650
7	Limestone, dense, dark grey, weathering buff; beds 3 inches to 2 feet thick	30	570
6	Dolomite, finely crystalline to dense, dark grey, weathering grey and buff; beds 1 foot to 3 feet thick	170	540

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Dolomite, fine grained, dark grey, weathering dark grey; beds 1 inch to 3 feet thick; unit contains several pisolitic beds	80	370
4	Dolomite, dense to finely crystalline, grey to dark grey, weathering grey; beds 6 inches to 3 feet thick	50	290
3	Limestone, grey to brownish grey, weathering grey and buff; platy; beds 3 inches to 10 inches thick; silty	80	240
2	Limestone, grey, weathering grey, silty; shale, dark grey, weathering grey	70	160
1	Dolomite, finely crystalline, grey to dark grey, weathering light grey; beds 1 foot to 2 feet thick	90	90

Section 4. Near head of Beattie Creek; lat. 56° 12'N, long. 123° 47'W.

ORDOVICIAN

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
15	Dolomite, finely crystalline, dark grey, weathering grey and brown, silty, finely laminated; thin bedded in part; beds 100 feet above base of unit contain: ?Austinella sp. and ?Glyptorthis sp. (GSC loc. 46851)	130	1,045
14	Siltstone, dolomitic, grey, weathering light grey; finely laminated; beds from 1/2 inch to 2 inches thick	75	915
13	Limestone, finely crystalline, light grey, weathering light grey; phyllitic	100	840
12	Dolomite, finely crystalline, light grey, weathering light grey; massive beds as much as 6 feet thick	50	740

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
11	Siltstone, dark grey to black, weathering dark grey; finely laminated; talus platy	60	690
10	Dolomite, finely crystalline, dark grey, weathering dark grey; thin bedded, silty	110	630
9	Dolomite, finely crystalline, light grey, weathering light grey; massive beds as much as 6 feet thick	100	520
8	Limestone, dark grey, weathering grey and buff (patchy or streaky), phyllitic	60	420
7	Dolomite, coarsely crystalline, light grey, weathering light grey	30	360
6	Covered	30	330
5	Limestone, micrograined or microcrystalline, dark grey, weathering light grey; slightly shaly with phyllitic partings	40	300
4	Shale, black, weathering buff to rusty, slightly calcareous at top of unit but non-calcareous at base; 110 feet above base is a 10-foot-thick bed of limestone	140	260
3	Limestone, microcrystalline, dark grey, weathering dark grey and buff in streaks; massive with phyllitic partings	30	120
2	Shale, black, weathering buff to rusty red; papery to very thin bedded; slightly limy	40	90
1	Limestone, finely crystalline, dark grey, weathering buff to grey; slightly silty; phyllitic	50	50

Section 5. North-south divide just north of Wedge Peak; lat. 56° 06'N, long. 123° 28'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	SILURIAN		
7	Dolomite, finely crystalline, dark grey, weathering grey-buff; beds 1 foot to 3 feet thick; platy to blocky; beds 60 feet above base of unit contain: *Streptelasma* sp., *Catenipora* sp., *Favosites* sp., *Coenites* cf. *C. laminatus* (Hall), *Hesperorthis* sp., "*Homoeospira*" sp. (GSC loc. 46905)	120	1,580
	ORDOVICIAN		
6	Dolomite, fine to medium crystalline, grey to dark grey, weathering grey, light grey, and buff; beds 2 to 6 feet thick; beds are silty between 380 and 430 feet and between 200 and 280 feet from base of unit; gastropods occur about 180 feet above base of unit; (GSC loc. 46866); at 70 feet above base cf. *Palaeophyllum* sp. (GSC loc. 46924) was collected	480	1,460
5	Dolomite, finely crystalline, light grey, weathering light grey to buff; lower 50 feet of unit is silty; bottom 5 feet of unit contains: *Streptelasma* cf. *S. prolongatum* Wilson; *Catenipora* spp., tabulate coral, favositid coral, (GSC loc. 46917)	140	980
4	Siltstone, dark grey, weathering dark grey	30	840
3	Limestone, finely crystalline, dark grey, weathering grey to buff; silty	30	810
2	Dolomite, finely crystalline, dark grey, weathering buff-grey; thick massive beds. Fossils at 220 feet above base of unit: gastropod, indeterminate solitary coral (GSC loc. 46890). Fossils at 110 feet above base of unit: *Dinorthis* sp., ?*Austinella* sp. (GSC loc. 46939)	380	780

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Limestone, dense to finely crystalline, dark grey, weathering buff-grey or dull grey; rough blocky fracture; beds 3 to 10 feet thick	400	400

Section 6. East of Mount Kenny; lat. 56° 57'N, long. 123° 45'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	UPPER DEVONIAN		
	Besa River Formation		
18	Shale, dark grey, weathering grey and buff; some calcareous; unit contains several 6-inch-thick limestone beds	230	4,080
	Probable Fault		
	MIDDLE DEVONIAN		
17	Dolomite, fine to medium crystalline, grey, weathering grey to light grey; very silty to sandy; beds 6 inches to 4 feet thick	260	3,850
16	Covered	50	3,590
15	Dolomite, fine to medium crystalline, grey, weathering grey to light grey; very silty to sandy; beds 6 inches to 4 feet thick	180	3,540
14	Covered	30	3,360
13	Dolomite, finely crystalline, grey to brownish grey, weathering dull grey or buff; beds 1 foot to 4 feet thick; 30 feet of sandy dolomite 700 feet above base; beds of dolomite breccia in middle 300 feet of the unit	800	3,330
12	Covered	30	2,530

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
11	Dolomite, fine to medium crystalline, grey to dark grey, weathering buff and grey; beds 2 to 4 feet thick; very silty except lower 150 feet of unit	720	2,500
	SILURIAN		
10	Sandstone, fine grained, grey, weathering grey to buff; dolomitic	60	1,780
9	Dolomite, dense to finely crystalline, grey weathering light grey; beds 2 to 8 feet thick; very silty or sandy	130	1,720
8	Sandstone, fine grained, grey, weathering brown	30	1,590
7	Dolomite, dense to finely crystalline, grey, weathering light grey; beds 1 foot to 4 feet thick; silty; some chert nodules; one 10-foot-thick bed of sandy dolomite at 110 feet above base of unit	190	1,560
6	Sandstone, fine grained, grey, weathering grey to buff; beds 2 to 10 feet thick	70	1,370
5	Dolomite, dense to finely crystalline, grey to grey-brown, weathering grey to light grey; beds 4 to 10 feet thick; black chert nodules in many beds throughout unit; some silty and siliceous beds	300	1,300
4	Dolomite, dense to finely crystalline, grey to buff, weathering grey to buff; beds as much as 6 feet thick; very siliceous; fossils 170 feet above base of unit: *Favosites* sp., ?*Syringopora* sp., *Glassia* sp., solitary coral (GSC loc. 51298)	430	1,000
3	Dolomite, fine to medium crystalline, grey weathering grey to light grey; beds 1 foot to 5 feet thick	170	570

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Limestone, dense to finely crystalline, dark grey, weathering grey to buff; beds 6 inches to 4 feet thick; some silty beds; some argillaceous beds	300	400
1	Dolomite, finely crystalline, dark grey, weathering grey; platy; beds 6 inches to 3 feet thick; interbedded with shale, dolomitic or calcareous, dark grey, buff weathering; fossils 70 feet above base of unit: cf. <u>Pentamerus</u> sp., <u>Favosites</u> sp., <u>Cystihalysites</u> sp., heliolitid coral (GSC loc. 51302)	100	100

Section 7. West of mouth of Horn Creek; lat. 56° 37'N, 123° 32'W.

UPPER DEVONIAN

Besa River Formation

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Shale, dark grey, weathering grey to brown; thin bedded to fissile	200	2,750
12	Limestone, grey to brown-grey, weathering grey to buff; contains shaly partings as much as 6 inches thick; fossils from upper beds: <u>Basilicorhynchus</u> <u>basilicum</u> Crickmay, <u>Cyrtospirifer</u> cf. <u>C.</u> <u>mimetes</u> (Crickmay), <u>Athyris</u> sp. (GSC loc. 42627)	70	2,550
11	Shale, dark grey, weathering grey to brown; thin bedded	250	2,480
10	Limestone, argillaceous, brown-grey, weathering buff; interbedded with shale, dark grey, calcareous	60	2,230
9	Shale, dark grey, weathering grey to buff; thin bedded to papery; several thin (2- to 6-inch) limestone beds in lower 100 feet of unit	220	2,170

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Shale, dark grey, calcareous	30	1,950
	<u>MIDDLE DEVONIAN</u>		
7	Limestone, dense to finely crystalline, grey, weathering grey to brown; beds 2 to 4 feet thick; silty in part	90	1,920
6	Dolomite, dense to medium crystalline, dark grey, weathering grey to buff; beds 1 foot to 10 feet thick; some sandy or silty zones; several brecciated beds near middle of unit; some calcareous beds; a 10-foot-thick bed of limestone 40 feet above base of unit contains: <u>Spinatrypa</u> sp., <u>Thamnopora</u> sp., <u>Australophyllum</u>? cf. <u>A.</u> ?<u>thomasae</u> (Hill and Jones), large crinoid ossicles (GSC loc. 51291)	400	1,830
5	Covered	110	1,430
4	Dolomite, finely crystalline, dark grey and grey, weathering dull grey and buff; beds 2 to 5 feet thick; one brecciated bed near middle of unit	160	1,320
3	Dolomite, sandy and sandstone, dolomitic; dolomite, grey, weathering grey, sandy interbedded with sandstone, grey, weathering grey to buff, dolomitic	370	1,160
2	Dolomite, dense to finely crystalline, grey, weathering light grey; siliceous; some beds silty or sandy; beds 2 to 6 feet thick	260	790
1	Dolomite, dense to finely crystalline, grey, weathering light grey; beds 2 to 6 feet thick; siliceous; some beds silty or sandy	530	530

Section 8. Near head of Nabesche River; lat. 56° 21'N, long. 123° 30'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	UPPER DEVONIAN		
	Besa River Formation		
14	Shale, grey and dark grey, weathering grey to buff; much of unit is covered	500	4,375
13	Limestone, finely crystalline, grey to brown, weathering buff and dull grey; with some interbedded calcareous shale	80	3,875
12	Covered	40	3,795
11	Shale, dark grey, weathering grey to buff, fissile to platy; a few thin (6-inch) argillaceous limestone beds	260	3,755
10	Covered	60	3,495
	MIDDLE DEVONIAN		
9	Dolomite, very calcareous and limestone; grey, weathering grey to buff; beds 1 foot to 4 feet thick; bed 30 feet above base contains: Cladopora sp. and undet. brachiopods (GSC loc. 46848)	50	3,435
8	Limestone, dense to finely crystalline, dark grey, weathering grey to buff; beds 2 to 4 feet thick	70	3,385
7	Dolomite, finely crystalline, grey to brown-grey, weathering grey and buff; beds 6 inches to 3 feet thick; unit contains some interbedded limestone, dark grey, weathering buff; lower 100 feet contains several breccia beds	310	3,315
6	Shale, and dolomitic shale; grey, weathering buff; platy	15	3,005

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Dolomite, fine to medium crystalline; several beds coarsely crystalline; grey and dark grey, weathering dull grey, grey, and buff; unit generally silty; between 700 and 800 feet above base sandstone beds as much as 10 feet thick are interbedded; fossils at 50 feet below top of unit: Cladopora sp., Stringocephalus? sp. (GSC loc. 46843)	1,100	2,990
	SILURIAN		
4	Dolomite, dense to finely crystalline, grey, weathering grey; beds 1 foot to 4 feet thick; lower 100 feet contains some breccia beds; upper 100 feet very sandy or silty with several thin sandstone beds; most beds silicified	570	1,890
3	Covered	30	1,320
2	Dolomite, fine to medium crystalline, grey to grey-brown, weathering light grey; beds 2 to 6 feet thick; unit is sandy or silty; a 30-foot thickness is covered 590 feet above base of unit	940	1,290
1	Dolomite, finely crystalline, grey to dark grey, weathering grey and light grey; very sandy; some interbedded dolomitic sandstone; lower beds contain poorly preserved Halysites	350	350

Section 9. 8 miles northeast of Mount Burden; lat. 56° 17'N, long. 123° 24'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	MISSISSIPPIAN		
	Prophet Formation		
14	Limestone, cherty and calcareous chert; interlensed; limestone, crystalline, grey, weathering grey to light grey; chert, light grey to brown, weathering grey; beds 2 to 6 feet thick	100	3,720
13	Limestone, finely crystalline, grey, weathering grey; beds 6 inches to 3 feet thick; interbedded with calcareous shale, and thin (6-inch) chert and siltstone beds	280	3,620
12	Shale, grey to dark grey, weathering grey to buff; platy to fissile; some is calcareous	310	3,340
11	Chert, bedded, dark brownish grey, weathering grey; interbedded with calcareous shale and argillaceous limestone; chert and limestone beds 6 inches to 2 feet thick	290	3,030
	UPPER DEVONIAN		
	Besa River Formation		
10	Mainly covered; talus and small exposures indicate underlying limestone, shale, and thin dark chert beds	320	2,740
9	Limestone, dense to finely crystalline, grey, and grey-brown, weathering buff; beds 6 inches to 3 feet thick; some argillaceous limestone; unit contains some interbedded shale; basal beds contain: Atrypa? sp., Metriophyllum sp. A. of Smith, Disphyllum sp. (GSC loc. 46884); 30 feet above this stratigraphically are: Atrypa or Spinatrypa sp.		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9 (cont'd.)	Charactophyllum? sp., Thamnopora sp. (GSC loc. 46945)	120	2,420
8	Shale, grey and brown, weathering grey to buff; fissile to platy	560	2,300
7	Limestone, finely crystalline, grey and grey-brown, weathering buff; beds 6 inches to 3 feet thick; unit contains a little interbedded calcareous shale	50	1,740
6	Shale, fissile to platy, dark grey, weathering grey and brown; unit contains 2- to 3-inch thick interbedded limestone beds near middle	300	1,690
	MIDDLE DEVONIAN		
5	Shale, dark grey, weathering grey and buff; interbedded grey and brown limestone beds up to a foot thick	110	1,390
4	Limestone, dense to medium crystalline, dark grey to grey-brown, weathering light grey and buff; beds 6 inches to 3 feet thick; some beds argillaceous; some interbedded calcareous shale in lower 250 feet; fossils at 180 feet above base of unit: Cladopora sp., Spinatrypa sp., and Schizophoria sp. (GSC loc. 46853)	550	1,280
3	Covered	90	730
2	Dolomite, fine to medium crystalline, grey, weathering grey and buff; beds 2 to 4 feet thick; much of unit is silty or sandy; breccia beds occur between 200 and 300 feet above base	550	640
1	Limestone, dense to finely crystalline, dark grey to brown, weathering grey; beds 6 inches to 3 feet thick	90	90

Section 10. North side of Peace River valley (composite section); lat, 56° 02'N, long. 123° 18'W and 123° 34'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	UPPER DEVONIAN		
	Besa River Formation		
5	Shale, dark grey, weathering buff; platy to fissile	40	1,360
4	Limestone, dense to finely crystalline, grey, weathering buff; interbedded with shale and calcareous shale	70	1,320
	MIDDLE DEVONIAN		
3	Limestone, dense to finely crystalline; some coarsely crystalline and crinoidal beds; grey, weathering grey and buff; some argillaceous limestone; some calcareous shale partings	520	1,250
2	Limestone, dense to finely crystalline, grey, dark grey, and brown, weathering grey, dull grey, and buff; much of unit is argillaceous; sandstone, grey, brown-weathering, occurs 30 feet above base; fossils at 220 feet above base: *Favosites* sp., *Schizophoria* sp., *Atrypa* cf. *A. arctica* (Warren), *Spinatrypa* cf. *S. lata* (Warren), *Warrenella* cf. *W. franklini* (Meek), (GSC loc. 39949). Fossils at 340 feet above base: ?*Coenites* sp., *Schuchertella* sp., *Atrypa* sp., *Spinatrypa* sp. (GSC loc. 39950). Fossils at 580 feet above base: *Hexagonaria* sp. A., *Disphyllum* sp. cf. *D. goldfussi* Geinitz, *Spinatrypa* cf. *S. andersonensis* (Warren) (GSC loc. 39948)	620	730
1	Dolomite, fine grained or finely crystalline, grey, weathering light grey; beds 2 to 4 feet thick; unit is sandy or silty	110	110

Section 11. West side of Ospika River; lat. 56° 38'N, long. 123° 58'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	UPPER DEVONIAN		
	Besa River Formation		
1	Shale, thin bedded to fissile, grey to dark grey, weathering grey, buff, and red-brown; shale is hard and siliceous in places: some thin beds of silty shale; limestone pods or lenses as much as 3 feet thick and 15 feet long occur between 100 and 300 feet above base; at 200 feet above base a limestone lense contains: Alveolites? sp. and Coenites sp. (GSC loc. 51322)	800	800

Section 12. North of Lady Laurier Lake; lat. 56° 43'N, long. 123° 43'W.

	UPPER DEVONIAN		
14	Siltstone, dark grey, weathering grey, calcareous; 20-foot-thick sandstone unit at base	110	1,744
13	Covered	15	1,634
	MIDDLE DEVONIAN		
12	Dolomite, dense to finely crystalline, grey, weathering grey; beds 6 inches to 3 feet thick	60	1,619
11	Limestone with interbedded calcareous shale	60	1,559
10	Mainly covered; talus of cherty limestone and calcareous shale	190	1,499

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Limestone, dense to finely crystalline, grey to dark grey, weathering light grey to buff	50	1,309
8	Covered	50	1,259
7	Limestone, dense to finely crystalline, grey, to dark grey, weathering light grey to buff; beds 2 to 4 feet thick; beds in middle of unit contain: Coenites sp., Thamnopora sp., Favosites sp. D. (GSC loc. 51316)	50	1,209
6	Siltstone, blocky to shaly, dark grey, weathering grey; at 340 feet above base is 20 feet of sandstone, grey, weathering buff, calcareous	430	1,159
5	Shale, fissile, calcareous, dark grey, weathering grey to buff; with interbedded limestone beds as much as 4 feet thick	130	729
4	Dolomite, finely crystalline, grey, weathering grey; beds 1 foot to 4 feet thick	60	599
3	Siltstone and shale, dark grey, weathering grey	59	539
2	Siltstone, dark grey, weathering dark grey; shaly debris; slightly calcareous; some shale, silty; 10-foot-thick bed of limestone 34 feet above base contains: Hexagonaria sp. cf. Argutastrea arguta Crickmay, Syringopora sp. (GSC loc. 51306)	370	480
1	Siltstone, dark grey, weathering dark grey; shaly debris; slightly calcareous; 10-foot thickness of dolomite at base of unit	110	110

Section 13. East-west ridge 2 miles south of Wicked Lake; lat. 56° 13'N, long. 123°33'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	UPPER DEVONIAN		
	Besa River Formation		
8	Shale, dark grey to grey, weathering buff to grey; thin bedded to fissile; some papery; 30 to 40 feet of calcareous shale occurs 40 feet above base of unit	730	2,120
7	Shale, dark grey, weathering buff to brown; some calcareous shale; several thin (2- to 6-inch) limestone beds occur throughout the unit	90	1,390
	MIDDLE DEVONIAN		
6	Limestone, dense to medium crystalline, grey and brown-grey, weathering grey and buff; beds 2 to 4 feet thick; unit contains some dark chert in beds near base of unit; poorly preserved brachiopods occur in the lower 150 feet of unit	350	1,300
5	Limestone, dense to finely crystalline; some coarsely crystalline crinoidal beds; dark grey to grey, weathering grey and grey-brown; beds 4 inches to 2 feet thick; fossils collected 50 feet above base of unit: Alveolites? sp., Atrypa sp. (GSC loc. 46828)	270	950
4	Covered; talus shows limestone and argillaceous limestone	100	680
3	Limestone, dense to finely crystalline, dark grey to brown-grey, weathering grey and buff; beds 6 inches to 4 feet thick	200	580

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Dolomite, fine to medium crystalline, grey, to dark grey, weathering grey and light grey; beds 6 inches to 2 feet thick; 110 feet above base of unit dolomite contains: *Thamnopora* sp. (GSC loc. 46838)	300	380
	SILURIAN		
1	Dolomite, fine grained or finely crystalline, grey, weathering very light grey; silty; beds 2 to 4 feet thick	80	80

Section 14. Near head of Chowade River; lat. 56° 42'N, long. 123° 27'W.

	TRIASSIC		
22	Siltstone, fine grained, dark grey, weathering grey to buff, calcareous	70	1,135
	Disconformity		
	PERMIAN		
	Fantasque Formation		
21	Chert, grey to dark grey, wavy bedding; weathering dull grey to brown; beds 6 inches to 3 feet thick	40	1,065

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Disconformity		
	MISSISSIPPIAN-PENNSYLVANIAN(?)-PERMIAN		
	Kiskatinaw - Taylor Flat Formation		
20	Limestone, sandstone and shale interbedded; limestone and sandy limestone predominates; limestone is finely to coarsely crystalline, grey, weathering buff-grey; sandstone is fine grained, grey, weathering brown; shale is grey	250	1,025
19	Covered	35	775
18	Limestone, dense to fine grained, grey, weathering grey-buff; beds 2 to 3 feet thick	20	740
17	Covered	10	720
16	Sandstone, fine grained, grey, weathering buff	10	710
15	Covered	25	700
14	Sandstone, fine grained, grey, weathering brown; some calcareous beds 2 to 4 feet thick	50	675
13	Covered	30	625
12	Sandstone, medium grained, grey, weathering grey, calcareous; interbedded with limestone, sandy, grey-brown, weathering buff	60	595
11	Shale, grey, weathering grey; fissile	15	535
10	Covered	60	520
9	Sandstone, medium grained, grey, weathering light grey to buff; some interbedded grey shale	30	460

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Covered	30	430
7	Sandstone, fine to medium grained, grey, weathering light grey to buff; beds 2 to 4 feet thick; some beds calcareous; one bed of sandy limestone near middle of unit	60	400
6	Covered	30	340
5	Sandstone, fine to medium grained, grey, weathering grey; beds 2 to 3 feet thick	40	310
4	Covered	20	270
	<u>MISSISSIPPIAN</u>		
	<u>Golata Formation</u>		
3	Shale, dark grey, weathering grey to buff; interbedded with siltstone, dark grey, weathering grey; unit contains bands of ironstone nodules as much as 3 inches in diameter; some calcareous shale in lower 50 feet of unit	150	250
2	Shale, dark grey, weathering grey; platy to fissile	30	100
	<u>Prophet Formation</u>		
1	Limestone and chert; limestone, finely crystalline, grey, weathering grey, cherty; interlensed with chert, light grey; beds 1 foot to 5 feet thick	70	70

Section 15. Head of west fork of Emerslund Creek; lat. 56° 22'N, long. 123° 15'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	MISSISSIPPIAN - PENNSYLVANIAN(?) - PERMIAN		
	Kiskatinaw - Taylor Flat Formation		
9	Sandstone, fine to medium grained, grey, weathering buff and grey; some beds calcareous, minor amounts of interbedded grey sandy limestone; limestone near middle of unit contains: Schellwienella sp. ?, Squamularia sp. ?, Punctospirifer sp., Spirifer sp., lophophyllid coral (GSC loc. 47013)	80	780
8	Covered	100	700
7	Sandstone, fine to medium grained, grey, weathering buff; some beds calcareous; minor amounts of interbedded grey limestone and dark grey shale	110	600
6	Covered	40	490
5	Sandstone, fine grained, grey, weathering grey to buff; calcareous; beds 2 to 3 feet thick; a few beds of sandy limestone near the middle of the unit	60	450
	MISSISSIPPIAN		
	Golata Formation		
4	Covered	30	390
3	Shale, grey to dark grey, weathering grey; platy to fissile; some calcareous zones; a few ironstone concretions; shaly limestone near top of unit contains: Orthotetes sp., Echinoconchus sp., Spirifer sp., Reticularia cf. R. pseudolineata (Hall),		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3 (cont'd.)	Schellwienella sp., Setigerites altonensis (Norwood and Pratten), Ekvasophyllum cf. E. turbineum Parks (GSC loc. 46865)	70	360
2	Shale and siltstone; shale, dark grey, weathering grey to buff; platy to fissile; siltstone, dark grey, weathering dark grey; some 4- to 6-inch-thick concretionary ironstone bands	200	290
	Prophet Formation		
1	Limestone and chert; limestone, finely crystalline to coarsely crystalline, grey, weathering grey; cherty; with interlensed chert, light grey, weathering dull grey; beds 1 foot to 5 feet thick; the following fossils occur 60 feet above base of unit: Syringopora sp., Lithostrotion (Siphonodendron) whitneyi of Meek (GSC loc. 46870)	90	90

Section 16. Northwest ridge of Mount Brewster; lat. 56°13'N, long. 123°17'W.

MISSISSIPPIAN - PENNSYLVANIAN (?) - PERMIAN

Kiskatinaw - Taylor Flat Formation

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Limestone, dense to finely crystalline, grey, weathering grey; interbedded with sandstone, fine grained, grey, weathering buff; near middle of unit limestone contains: Lophophyllidium sp. ?, spiriferid brachiopod (GSC loc. 46875)	60	780
8	Covered	30	720

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Sandstone, fine grained, grey, weathering buff; beds 2 to 3 feet thick	20	690
6	Shale, fissile to platy, dark grey, weathering grey-buff; some silty shale; some thin limestone beds throughout unit	160	670
5	Limestone, dense to finely crystalline, grey-brown, weathering grey to buff; beds 6 inches to 3 feet thick	70	510
4	Sandstone, fine grained, grey, weathering buff to brown; calcareous; some interbedded grey shale	130	440
3	Covered	30	310
2	Shale, platy to fissile, dark grey, weathering grey to buff; interbedded with sandstone, fine grained, grey, weathering buff; proportion of sandstone increases upward stratigraphically in the unit	150	280
	MISSISSIPPIAN		
	Golata Formation		
1	Shale, platy to fissile, dark grey, weathering grey to buff; some interbedded dark grey, siltstone	130	130

Section 17. East ridge of Mount Greene; lat. 56° 05'N, long. 123° 14'W.

MISSISSIPPIAN - PENNSYLVANIAN(?) - PERMIAN

Kiskatinaw - Taylor Flat Formation

5	Sandstone and shale; sandstone, fine grained, grey, weathering buff and grey; beds 2 to		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5 (cont'd.)	4 feet thick interbedded with shale, dark grey, weathering grey-buff	120	595
4	Limestone, finely to coarsely crystalline, grey, weathering grey-buff; beds 6 inches to 2 feet thick; contains <u>Choristites</u> sp. ? <u>Spirifer</u> sp. (GSC loc. 46882)	15	475
	<u>MISSISSIPPIAN</u>		
	<u>Golata Formation</u>		
3	Shale and siltstone; shale, platy to fissile, grey to dark grey, weathering grey-buff; siltstone, platy, dark grey, weathering grey; some calcareous shale zones; a few thin (3- to 6-inch-thick) fine-grained sandstone beds in lower part of unit	400	480
2	Covered	30	60
	<u>Prophet Formation</u>		
1	Limestone and chert; limestone, finely to coarsely crystalline, grey, weathering grey, cherty; interlensed with chert, light grey, weathering grey-buff; beds 1 foot to 5 feet thick; upper beds of unit contain: <u>Ekvasophyllum inclinatum</u> Parks, <u>Syringopora</u> sp. (GSC loc. 46858)	30	30

Section 18. Head of northeast-flowing branch of Graham River; lat. 56° 18'N, long. 122° 04'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	PERMIAN		
	Fantasque Formation		
4	Chert, bedded, dark grey, weathering grey	50	145
	Disconformity		
	MISSISSIPPIAN - PENNSYLVANIAN(?) - PERMIAN		
	Kiskatinaw - Taylor Flat Formation		
3	Limestone, finely crystalline, grey-brown, weathering grey to buff; argillaceous and silty; beds 6 inches to 2 feet thick; some thin shale partings; lowermost bed of unit contains: *Linoproductus* sp., *Dielasma* sp., *Spirifer* sp., *Waagenoconcha* sp. (GSC loc. 42513)	60	95
2	Covered	20	35
1	Limestone, finely crystalline, grey-brown, weathering buff; argillaceous; beds 1 foot to 2 feet thick	15	15

Section 19. Ridge 2 miles south of Needham Creek; lat. 56° 28'N, long. 123° 15'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	TRIASSIC		
	Pardonet Formation		
18	Siltstone, fine grained, dark grey, weathering grey-buff; beds 6 inches to 2 feet thick; middle of unit contains 60 feet of light grey calcareous sandstone	210	2,740
17	Shale, grey, weathering grey; interbedded with limestone, soft, argillaceous	70	2,530
16	Covered	90	2,460
15	Siltstone, fine grained, dark grey, weathering grey-buff; calcareous; grades to silty limestone in places	80	2,370
14	Covered	100	2,290
13	Siltstone, fine grained, dark grey, weathering grey-buff, calcareous; grades to silty limestone in places	30	2,190
12	Covered	30	2,160
11	Limestone, finely to coarsely crystalline, dark grey, weathering grey; silty; beds 6 inches to 3 feet thick; lower bed of unit contains: Monotis subcircularis Gabb (GSC loc. 47020)	30	2,130
10	Sandstone, fine grained, grey, weathering grey; thin bedded; calcareous	30	2,100
9	Limestone, crystalline, dark grey to grey, weathering grey and buff; contains: Monotis alaskana Smith, Pseudosirenites sp., Helictites sp., Parajuvavites sp., Alloclionites cf. A. woodwardi Mojsisovics, Steinmannites sp. (GSC loc. 46998)	20	2,070

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Limestone, crystalline, grey to dark grey, weathering grey to buff; silty; interbedded with dark grey, calcareous siltstone	50	2,050
7	Limestone, finely to coarsely crystalline, grey to dark grey, weathering grey and buff; silty; beds 6 inches to 2 feet thick	60	2,000
6	Siltstone, and limestone; siltstone, fine grained, calcareous, dark grey, weathering buff; beds 6 inches to 2 feet thick; interbedded with unit of limestone up to 15 feet thick; limestone, grey, weathering grey; silty; finely crystalline to coarsely crystalline and crinoidal; rare thin beds of fine-grained, grey, calcareous sandstone	140	1,940
	Liard Formation		
5	Covered	150	1,800
4	Sandstone, fine to medium grained, grey, weathering grey to buff; beds 2 to 10 feet thick; calcareous; interbedded with siltstone, dark grey, weathering grey to buff, calcareous; lower half of unit contains some crystalline, dark grey, buff-weathering limestone beds; proportion of sandstone increases stratigraphically upward	1,060	1,650
3	Limestone, fine to medium crystalline, dark grey, weathering buff, silty; beds 1 foot to 2 feet thick; basal beds of unit contain Spiriferina cf. S. borealis Whiteaves, Asklepioceras sp., Paratrachyceras sutherlandi McLearn, Nathorstites mcconnelli (Whiteaves) (GSC loc. 46960)	50	590
2	Siltstone, fine grained, dark grey, weathering grey to buff, calcareous; beds 6 inches to 3 feet; middle of unit contains some interbedded sandstone, fine grained, grey to dark grey, weathering grey, calcareous	320	540

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Toad Formation		
1	Siltstone, fine grained, dark grey, weathering grey and buff, calcareous; beds from 2 feet thick to massive unit 15 feet thick	220	220

Section 20. Ridge 4 miles north of head of Schooler Creek; lat. 56° 20'N, long. 122° 55'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	TRIASSIC		
	Pardonet Formation		
18	Sandstone, fine to medium grained, grey, weathering light grey to buff; beds 1 foot to 4 feet thick	150	2,310
17	Limestone, finely to coarsely crystalline, grey to light grey, weathering grey to buff; silty; beds 1 foot to 3 feet thick; base of unit contains: Halobia sp. (GSC loc. 46991); top bed of unit contains: Monotis cf. M. ochotica Keyserling, Proclydonautilus natosini McLearn (GSC loc. 46992)	40	2,160
16	Siltstone, fine grained, dark grey, weathering grey, platy, calcareous	30	2,120
15	Limestone, finely to coarsely crystalline, grey to dark grey, weathering grey; silty; beds 1 foot to 3 feet thick; a bed 70 feet above base of unit contains: Malayites sp., Sirenites nabeschi McLearn, Gonionotites sp. indet., Gryphea sp. (GSC loc. 47005)	170	2,090

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
14	Sandstone, fine grained, grey, weathering grey and buff, calcareous; 40 feet of very sandy grey limestone in middle of unit	120	1,920
13	Dolomite, dense to finely crystalline, grey, weathering light grey; beds 2 to 4 feet thick	220	1,800
	Liard Formation		
12	Sandstone, fine grained, grey, weathering buff; calcareous; beds 2 to 3 feet thick	60	1,580
11	Covered	60	1,520
10	Limestone, finely crystalline, dark grey, weathering grey-buff; silty; beds 6 inches to 2 feet thick; beds near middle of unit contain: Spiriferina cf. S. borealis Whiteaves, terebratulid indet. (GSC loc. 46982)	30	1,460
9	Mainly covered; small exposures of grey, fine grained sandstone	240	1,430
8	Sandstone, fine to medium grained, grey, weathering buff; beds 1 foot to 6 feet thick	70	1,190
7	Covered	100	1,120
6	Sandstone, fine grained, grey to dark grey, weathering grey to buff; beds 1 foot to 4 feet thick; some interbedded, dark grey, calcareous siltstone; beds 140 feet above base of unit contain: terbratulids indet. (GSC loc. 47012)	440	1,020
5	Mainly covered; small outcrops show siltstone, fine grained, dark grey, weathering buff, calcareous; interbedded with sandstone, dark grey, weathering grey	300	580

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	<u>Toad Formation</u>		
4	Covered	170	280
3	Siltstone, fine grained, hard, dark grey, weathering grey-buff, calcareous, massive	30	110
2	Covered	60	80
1	Shale, flaky, dark grey, weathering grey	20	20

Section 21. Black Bear Ridge; lat. 56° 06'N, long. 123° 05'W.

	<u>JURASSIC OR LOWER CRETACEOUS</u>		
	<u>Minnes Group</u>		
6	Sandstone and shaly sandstone; grey to brown, grey weathering, fine grained	50	1,190
	<u>JURASSIC</u>		
	<u>Fernie Group</u>		
5	Shale, silty shale, siltstone and sandstone interbedded; sandstone, fine grained, fine to medium grained, grey, weathering buff; proportion of sandstone increases stratigraphically upward in unit	190	1,140
4	Shale, silty, grey, weathering grey to buff; interbedded with siltstone, dark grey, weathering grey; 2- to 6-inch-thick concretionary ironstone beds common; a few thin sandstone beds near top of unit	640	950

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Shale, grey to dark grey, weathering buff to brown, papery	170	310
2	Shale, dark grey to black, weathering grey, calcareous, fissile; some interbedded dark grey limestone beds as much as 4 inches thick	110	140
	TRIASSIC		
	Pardonet Formation		
1	Limestone, finely crystalline, grey, grey weathering; beds 6 inches to 3 feet thick	30	30

Section 22. Pink Mountain; lat. 56° 01'N, long. 122° 53'W.

JURASSIC OR LOWER CRETACEOUS

Minnes Group

4	Sandstone and shaly sandstone; grey to brown, weathering grey, fine grained; base of unit consists of a thickness of interlensed conglomerate and sandstone as much as 7 feet thick; conglomerate composed of chert pebbles as much as 3 inches in diameter	30	220

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Disconformity		
	JURASSIC		
	Fernie Group		
3	Shale, dark grey, weathering grey and buff, fissile to papery; upper beds silty	100	190
2	Shale, dark grey to black, weathering grey, fissile to platy, calcareous	60	90
	Disconformity		
	TRIASSIC		
	Pardonet Formation		
1	Limestone, finely crystalline, grey, weathering grey; beds 6 inches to 3 feet thick	30	30

Section 23. French Petroleum Company Richfield Brenot Creek No. 1 well; lat. 56° 07'N, long. 122° 09'W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	JURASSIC OR LOWER CRETACEOUS		
	Minnes Group		
6	Sandstone and shaly sandstone; grey to brown, weathering grey to buff, fine grained	40	610

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	JURASSIC		
	Fernie Group		
5	Shale, silty shale, siltstone and sandstone interbedded; sandstone, fine to medium grained, grey, buff weathering; proportion of sandstone increases upward stratigraphically in section	160	570
4	Shale and silty shale, thin bedded to fissile, dark grey weathering grey; some interbedded dark grey siltstone; unit contains some thin concretionary ironstone bands	240	410
3	Shale, dark grey, weathering buff, papery	40	170
2	Shale, dark grey to black, weathering grey, fissile to platy, calcareous; several 4- to 6-inch-thick dark grey limestone beds in lower part of unit	100	130
	Disconformity		
	TRIASSIC		
	Pardonet Formation		
1	Limestone, finely crystalline, grey, weathering grey; beds 6 inches to 3 feet thick	30	30

PLATES I - IX

PLATE I A GSC photo 119873

Village of Hudson Hope, British Columbia, on the north bank of Peace River at the east end of Peace River Canyon. View looking southeast.

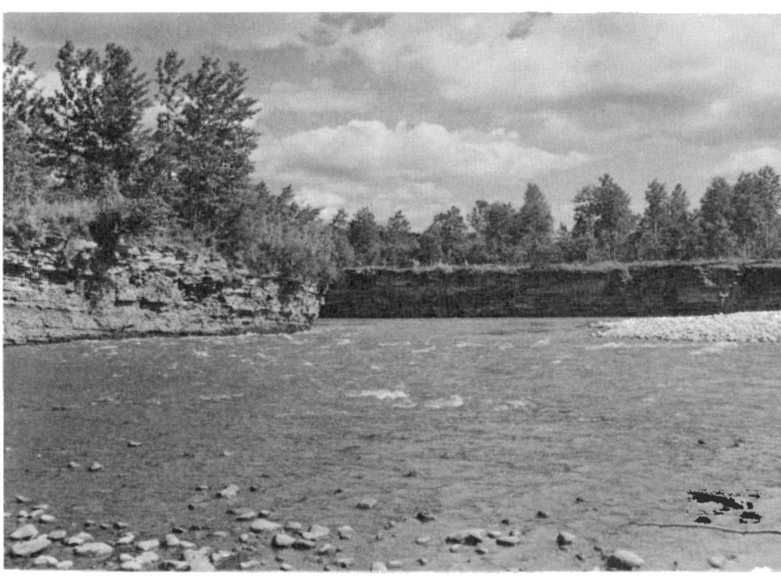

PLATE I B GSC photo 119868

Lowermost sandstone of the Sikanni Formation at confluence of Graham and Halfway Rivers. View looking east down Graham River.

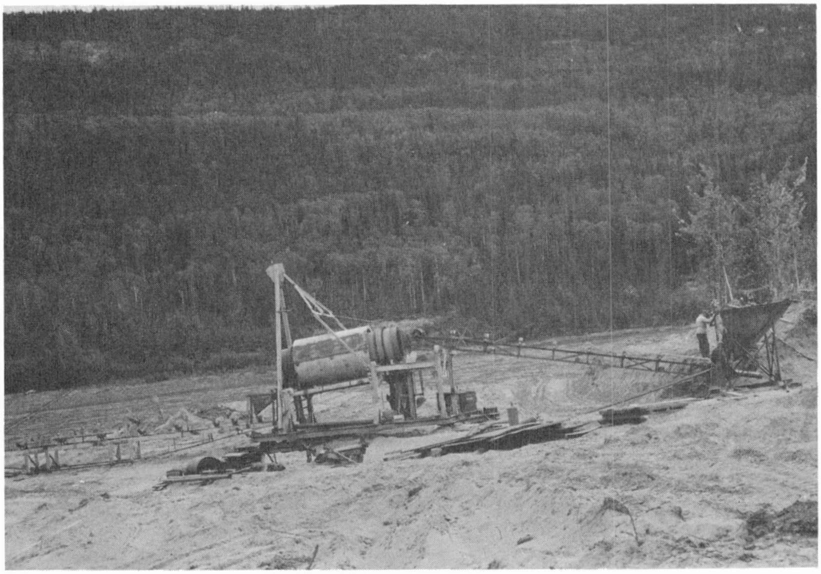

PLATE II A GSC photo 119893

Placer gold mining equipment on Branham Flat, Peace River.

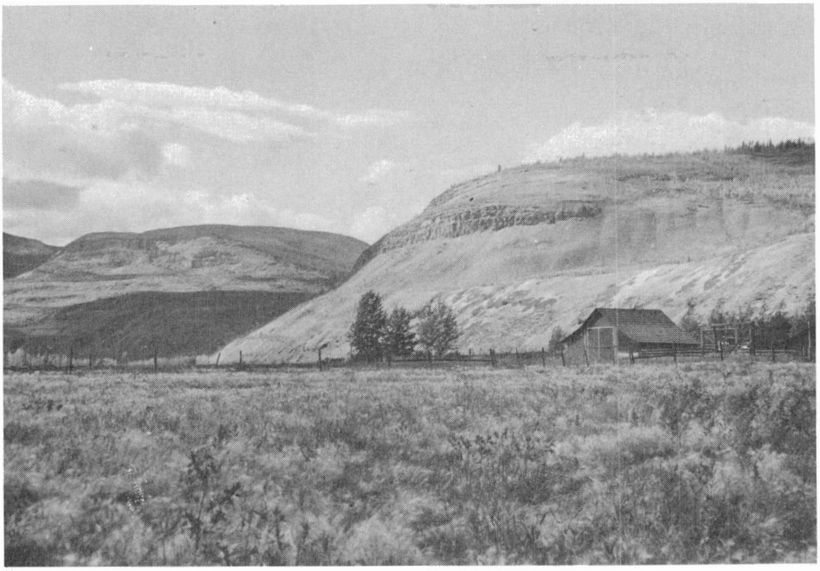

PLATE II B GSC photo 119892

Triassic "Grey Beds" outcropping on hillside at Gold Bar on north side of Peace River. View looking northwest; part of the Beattie ranch in foreground.

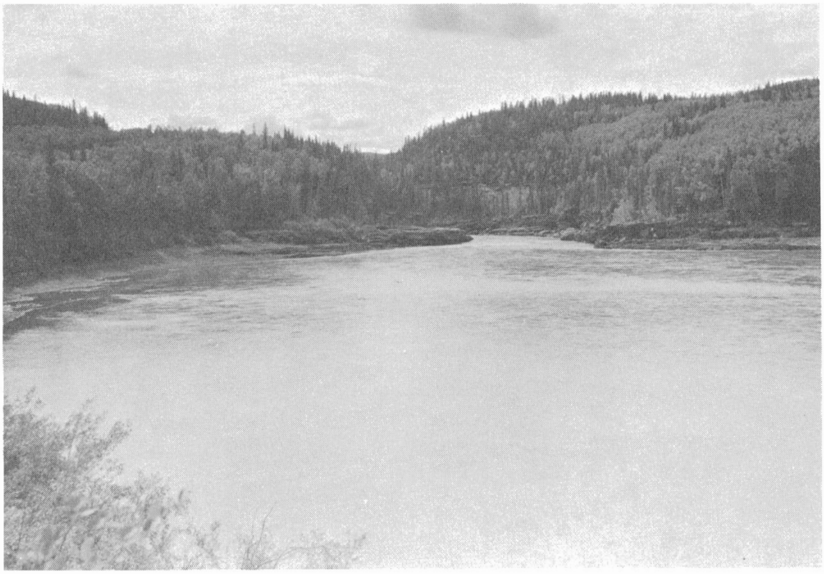

PLATE III A GSC photo 119898

Entrance to Peace River Canyon (west end). View looking southeast.

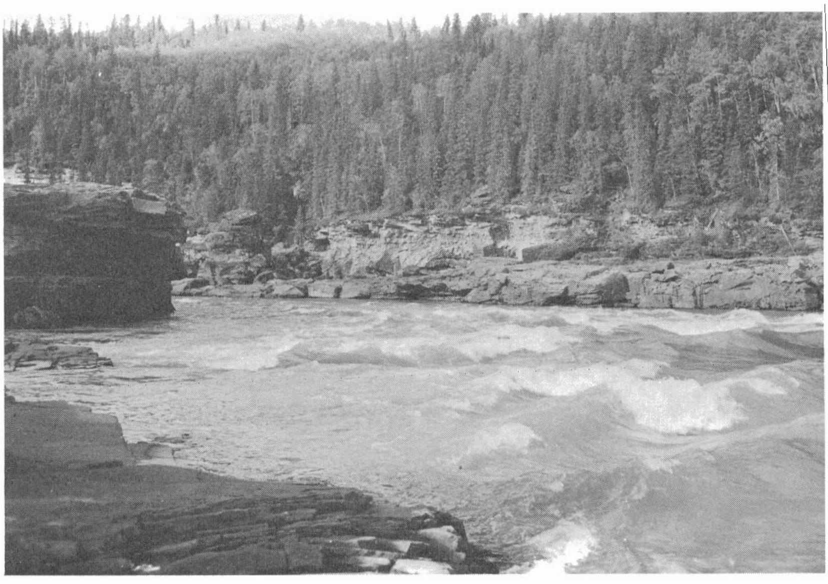

PLATE III B GSC photo 119896

Turbulent water at the narrow entrance to Peace River Canyon. View looking southeast; low water stage.

PLATE IV A GSC photo 119879

Peace River valley looking west from half a mile upstream from the mouth of Bernard Creek. Note general U-shape of valley.

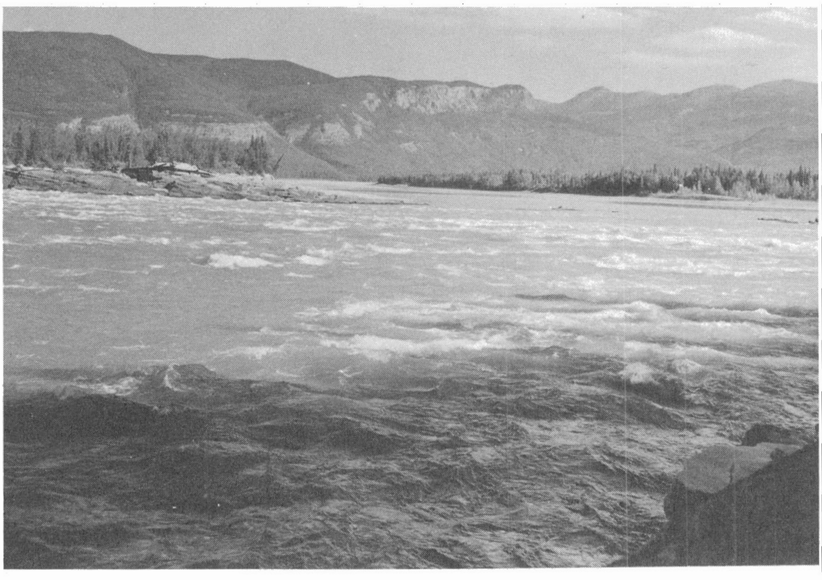

PLATE IV B GSC photo 119891

Finlay Rapids, Peace River. View looking north down Peace River.

PLATE V A GSC photo 119887

North side of Mount Selwyn looking southeast from the mouth of Wicked River.

PLATE V B GSC photo 119886

Plaque to the memory of Count Nicholas Ignatieff on a quartzite boulder on the north side of Peace River at the mouth of Wicked River. Ignatieff, Warden of Hart House, University of Toronto, spend the summer months at this locality on Peace River where he maintained a small experimental seed plot.

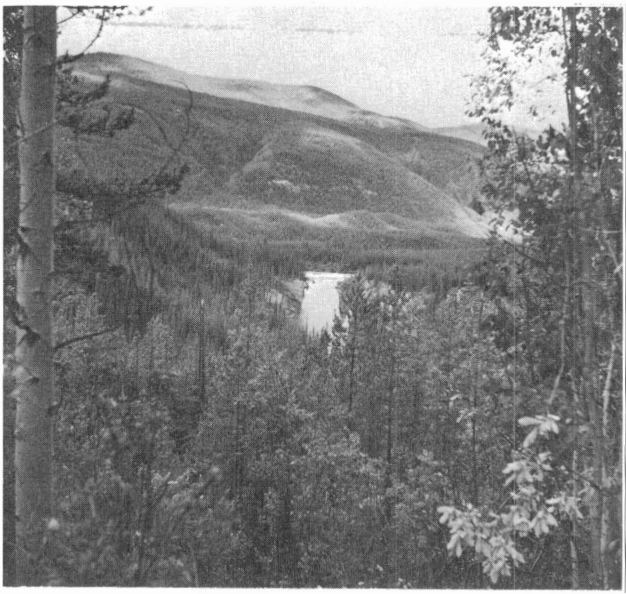

PLATE VI A GSC photo 119932

Upper part of Christina Falls on Graham River.

PLATE VI B GSC photo 119936

"Grey Beds" outcropping in canyon just below Christina Falls on Graham River.

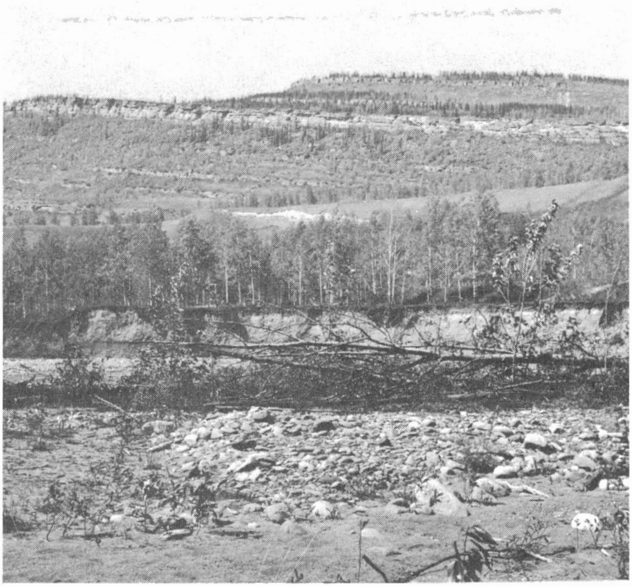

PLATE VII A GSC photo 119899

Flat-lying strata of Minnes Group and lower part of Bullhead Group near the mouth of Dunlevy Creek. View looking northeast.

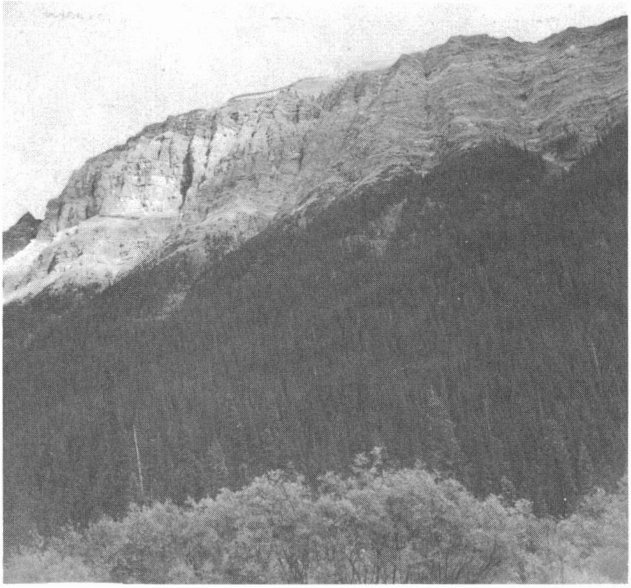

PLATE VII B GSC photo 119958

Cliff formed by the Mississippian carbonate and chert strata of the Prophet Formation just south of Needham Creek. View looking north.

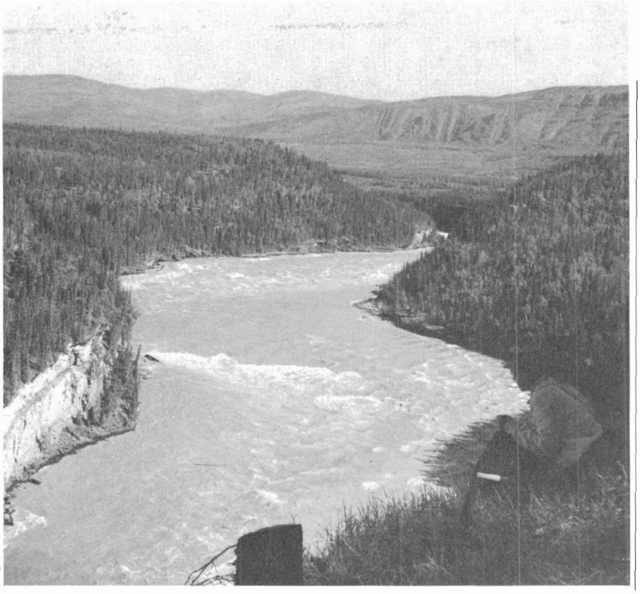

PLATE VIII A GSC photo 116815

Peace River Canyon from just downstream from abandoned Peace River coal mine near proposed dam site. View looking northwest up the river.

PLATE VIII B GSC photo 116814

Peace River Canyon downstream from abandoned Peace River coal mine. Beds of the Gething Formation form the canyon wall.

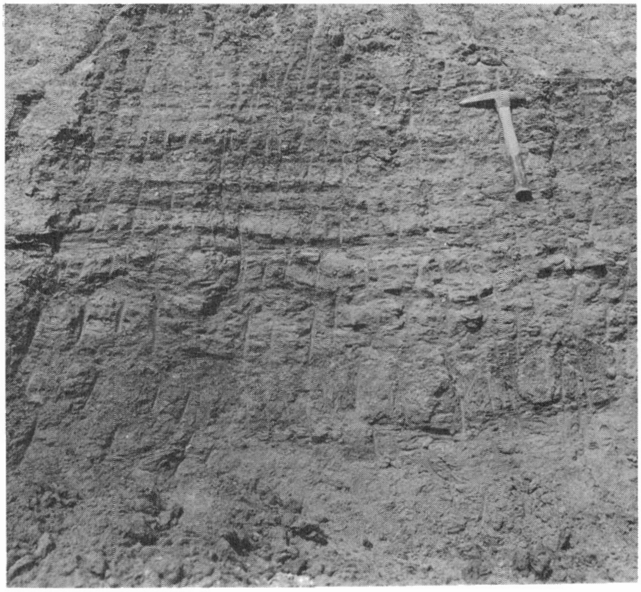

PLATE IX A GSC photo 139677

Varved glacial lake clays and silts on north side of Peace River west of the head of Peace River Canyon.

PLATE IX B GSC photo 116819

Terrace remnants at several levels on north side of Peace River about 4 miles downstream from the mouth of Schooler Creek. Hills are formed by west-dipping "Grey Beds" of Triassic age.