CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES, FORESTS AND SCIENTIFIC SERVICES

GEOLOGICAL SURVEY OF CANADA

PAPER 47-25

MOON CREEK MAP-AREA, ALBERTA

(REPORT AND MAP)

BY

E. J. W. IRISH

OTTAWA

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(Summary Account)

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Illustration

Preliminary Map -- Moon Creek, Alberta --- In envelope

MOON CREEK MAP-AREA, ALBERTA

INTRODUCTION

Location

Moon Creek map-area, comprising 184 square miles, is situated in the Foothills belt of west-central Alberta, north of Athabaska River, between latitudes 53° 30' and 53° 45' and longitudes 118° 15' and 118° 30'. The nearest railway is the transcontinental line of the Canadian National, which follows the valley of Athabaska River about 25 miles south of the Moon Creek area. Entrance, a village on the railway about 190 miles west of Edmonton, provides the nearest store, post office, and telegraph service for the extensive region to the north and northwest.

Accessibility

The village of Entrance is the outfitting point for a large region extending north and northwest and including the Smoky River territory, which for many years has been visited by coal prospectors, hunting parties, and, more recently, by exploratory geological parties representing oil companies.

Entrance may be reached by Canadian National Railway or by a branch road that connects with the Edmonton-Jasper highway 2 miles to the south. No roads existed until recently throughout the extensive territory north of Entrance and Athabaska River, but travel is facilitated by good pack trails, which are maintained by rangers of the Alberta Forest Service.

Until the summer of 1947, Moon Creek map-area was accessible only by two main forestry trails. The more easterly route, known as the Lower Trail, extends northwest from Entrance, following the eastern edge of the Foothills. This trail crosses the extreme northeast corner of the map-area about 40 miles from Entrance. The more westerly route, known as the Upper or Mountain Trail, branches from the Lower Trail about a mile north of Wildhay River (about 20 miles from Entrance), and follows the river westward. The Mountain Trail crosses the extreme southwest corner of the map-area about 40 miles from Entrance. The central part of the area can be reached from the Lower Trail at the Little Berland ranger cabin by following a good pack trail up Little Berland River for several miles. Originally, a good trail, the Evans Creek Trail, extended from the Moberly ranger cabin on the Lower Trail, up Moberly Creek, and down Evans Creek to Little Berland River. However, since fire swept through the area, this trail has not been cleaned out on the Little Berland side of the divide. It is possible, however, to travel by this route. The northwest corner of the area may be reached by the Adams Creek trail, which leaves the Lower Trail on the north side of Berland River and then follows the river upstream to the Adams Creek forestry cabin and fire lookout.

The map-area contains some branch trails, which, though they are not cleared out for pack trails, are very helpful when travelling in this region. One of these extends from the Evans Creek trail up Little Berland River to a point between the two limestone ridges. Here it forks, one branch extending up a small creek to the northwest, over the divide, and then down a small tributary of Moon Creek to Moon Creek itself. The other branch extends southeast over a divide, and then follows the gravel bars down Mumm Creek to join the Mountain Trail on Wildhay River. Trappers' trails and game trails may be used in some parts of the area.

Early in the spring of 1946, a winter road was built to a promising oil structure on Muskeg River, and late in the summer of the same year construction of a gravel road was begun from Entrance. This road follows, in general, the old Lower Trail and crosses the northeast corner of Moon Creek area. During the summer of 1947, parts of this road were impassable for ordinary cars and small trucks because of deep mud holes, but when construction is completed it will be possible to drive from Entrance to the drilling site of the Muskeg well, a distance of 74 miles.

Horses are, however, still the principal means of transportation both of men and supplies. Most of the larger valleys are open enough to permit travel with pack-horses even where no cut trails exist.

Previous Work

Little geological work had been done in the Foothills region between Athabaska and Smoky Rivers prior to 1939. The only published geological information on the map-area is contained in reports by J. MacVicar (1917, 1920, 1924), who made a reconnaissance survey of the region north of the Grand Trunk Pacific Railway (now the Canadian National Railway). In 1924, James McEvoy examined the Smoky River coalfield, Alberta, for the Dominion Fuel Board. More recently, the Foothills region north of Athabaska River has been, and is being, actively prospected for petroleum, and the present report is part of a broad scheme to provide geological maps and reports of that part of the Foothills belt.

Acknowledgments

The present report is based on field work commenced during the summer of 1946 and completed during the summer of 1947. In 1946 the writer was ably assisted by D.A. Pounder, R.L. McIntosh, and J.K. Eccles, and in 1947 by E. Hall, H.G. Gammell, and G.C. Wells. He is indebted for many courtesies to members of the Alberta Forest Branch and to Mr. S.H. Clark and Mr. Rufe Neighbor of Entrance.

Fossils collected from the area were identified by W.A. Bell, F.H. McLearn, and R.A.C. Brown of the Geological Survey.

PHYSICAL FEATURES

Topography

Moon Creek map-area includes both mountains and foothills, and these form a series of northwesterly trending ridges with intervening valleys. Two mountain ridges cross from the southeast corner to the western boundary and divide the area into three topographic units. About one-half of the area lies northeast of these ridges, and a little more than one-quarter to the southwest.

Typical foothills occupy the northeastern division, which is underlain, for the most part, by strata of Cretaceous age. The ridges here are generally rounded, and where not burned are timbered to the top. Valleys between the ridges are relatively wide, with gentle slopes. The approximate eastern edge of the Foothills belt crosses the extreme northeast part of the map-area, the transition from foothills to plains being marked by gentle northeast dips and little relief. Structural deformation and relief increase progressively southwestward to where the foothills merge with the mountain ridges.

The mountain division is a zone about 5 miles wide, extending northwesterly across the area from the southeast corner, and consisting of two parallel thrust blocks forming two ridges of Palaeozoic strata separated by Cretaceous beds. For purposes of description, the most easterly of these ridges will be referred to as the Hoff fault block, and the more westerly as the Nilson fault block. Both fault blocks are characterized by very rugged topography with steep, precipitous slopes on the northeast and more gentle dip slopes to the southwest. Relief here is about 3,000 feet, with an average elevation for the mountains of 7,000 feet, though some peaks have elevations of more than 8,500 feet.

The third division is that area lying southwest of the mountain ridges just described, and northeast of the Rocky Mountains proper. Elevations within it are about 1,000 feet lower than those of the bordering ranges on either side, and when viewed from these higher elevations it appears as a basin-like depression. The area is about 5 miles wide, and is traversed by well-defined ridges parallel with the mountain blocks. Most of these ridges rise to, or above, timber-line, but some are lower and are timbered to the top. The area is underlain by Lower and Upper Mesozoic strata.

Drainage

The principal streams draining Moon Creek map-area are Berland River, Little Berland River, Moon Creek, and Wildhay River.

All creeks in the southern one-third of the map-area drain into Wildhay River, which has its source on the east side of the front range of the Rocky Mountains, and flows southeast at first and then more easterly where it crosses Moon Creek map-area. The valley is fairly wide even in the gaps through the two mountain ridges, and gravel flats are extensive. Mumm Creek, Seep Creek, Carson Creek, Fault Creek, and Thoreau Creek drain the southern third of Moon Creek area, and empty into Wildhay River. Of these, Mumm Creek is the only one whose course appears to be controlled by the rock structure. This stream flows southeasterly between the two thrust blocks of Palaeozoic limestone. The general direction of the other creeks is more southerly, cutting the structure at a small angle.

Little Berland River, which drains the middle third of the area, has its source in a cirque between the two limestone blocks, and flows northeasterly at right angles to the strike. The river is not large, being about 20 feet wide, but its gradient is steep and it has carved a deep narrow gap through the Hoff fault block. The valley widens as it leaves the mountains, and for some miles flows through thick gravel deposits of its own making. For 3 miles below the point where the river leaves the mountains, bedrock is concealed by a thick mantle of gravel, which is added to each year during the spring high water. At low water, in the latter part of the summer, this part of the river is dry, a feature not restricted, however, to Little Berland River, as many streams in this district become dry when the flow of water is not sufficient to saturate the thick gravel deposits.

The northern third of the area is drained mainly by Moon Creek and its tributaries, though some creeks in the northwest corner flow northward into Berland River. Moon Creek is a stream about equal to Little Berland River in size. Its source is near the southwestern side of the mountain zone, so that it cuts normal to the strike through most of the western and all of the eastern fault blocks. Like the Little Berland, it has cut a deep, narrow, precipitous valley through the mountains. Moon Creek flows approximately northeast, parallel with Little Berland River, between which is another long, northeasterly flowing creek known as the north fork of Little Berland River or Fox Creek.

The tributaries of Moon Creek and Little Berland River enter the main streams from the north and south, cutting across the northwesterly trending structures at various angles.

Berland River, also flowing northeast, crosses the northwest corner of the map-area. In Moon Creek area, it is about 100 feet wide, and is larger than all the other streams except Wildhay River. It flows in a wide, flat-bottomed valley, and drains the northwest corner of the map-area.

The valleys of Little Berland River, Moon Creek, Wildhay River, and Berland River, though usually timbered, include considerable open grass land, much of which is swampy. Most of the tributary creeks flow through muskeg or swamp in part of their courses. Timber-line is about 6,000 feet above sea-level, and most of the hills below this elevation are timbered to the top. The southern exposures of some of the hills are bare of forest, and are grassed to the top. The forest consists of spruce and lesser amounts of balsam fir, pine, aspen, and birch. Fire has burned over large areas, and these are now covered by a thick tangle of logs and second growth jack pine. Wild flowers are varied and numerous.

Game is plentiful throughout the district. Moose, elk, caribou, deer, sheep, goat, and bear are common. Small fur-bearing animals are numerous, and much trapping is done throughout the district. Fish are usually plentiful in most of the larger streams. These include rainbow trout, Dolly Varden trout, Arctic trout or grayling, and Rocky Mountain whitefish.

GENERAL GEOLOGY

General Statement

The map-area is underlain by marine and non-marine sedimentary strata, ranging in age from Devonian to Paleocene, that were deposited near the eastern margin of the Cordilleran geosyncline. These strata have been greatly deformed by northwesterly trending folds, and by great thrust faults striking about parallel with the axes of the folds. As a result, the formations are, in general, exposed in long, relatively narrow, northwesterly trending bands. Two thrust fault blocks that form the mountain belt bring to the surface Devonian rocks, which are the oldest exposed in the area. Carboniferous, Triassic, and Jurassic strata are also exposed on these ridges, whereas to the northeast and southwest the exposed formations become increasingly younger.

Bedrock is well exposed in the mountains and on some of the higher ridges, but elsewhere outcrops are found chiefly in stream beds and on the tops of ridges. The positions of contacts and structures in much of the map-area can, therefore, only be inferred from limited outcrop data, and probably many more faults and minor folds are present in the foothills part of the area than are indicated on the map.

Table of Formations

Period or epoch	Formation or group, and approximate thickness (feet)	Subdivision and approximate thickness (feet)	Lithology
Paleocene	4,000 +		Sandstone, shale, conglomerate (non-marine)

Upper Cretaceous	Brazeau 6,000 ±		Sandstone, shale, conglomerate (non-marine)
		Solomon member 100	Sandstone (marine)
	Wapiabi 1,500 ±		Shale, shaly sandstone (marine)
	Bighorn 240		Quartzitic sandstone, shale, sandy shale (marine and non-marine)
	Blackstone 1,800 ±		Shale, minor siltstone (marine)
	Dunvegan 190 ±		Sandstone, shale, and sandy shale (marine and non-marine)
	Fort St. John 400 ±		Shale and sandy shale (marine)
	Luscar 2,000 ±		Sandstone, shale, conglomerate, coal (non-marine)
Lower Cretaceous	Cadomin 30-100		Conglomerate
	Nikanassin 900		Quartzitic sandstone and shale (marine and non-marine)
Jurassic	Fernie 900		Shale and quartzitic sandstone (marine)
Triassic	Spray River 1,130	Whitehorse member 130	Limestone and dolomite (marine)
		1,000	Quartzitic sandstone and siltstone (marine)

Carboniferous (Mississippian)	Rundle 600-680		Limestone and dolomite (marine)
	Banff 470-600		Argillaceous limestone, limestone and calcareous shale (marine)
Devonian	Boule 1,500		Limestone and dolomite (marine)
	Perdrix 400		Limestone and calcareous shale (marine)

Devonian

Perdrix Formation

The Perdrix formation, as defined by Lang in his memoir on Entrance and Brûlé map-areas, is the oldest exposed in the Moon Creek area. It consists of thin-bedded, grey to brownish grey, light buff weathering, calcareous shales, with some interbedded thin limestone and dolomite beds. These beds are exposed along the base of the scarp of the Nelson fault block from the head of Little Berland River northwest to and beyond the boundary of the map-area. The best exposure occurs on the ridge near the west boundary of Moon Creek map-area. The thickness of exposed strata of the Perdrix formation ranges from a few feet or less, near the middle of the map-area, to about 400 feet near the western border. At the base of the scarp just north of Moon Creek, the lowest strata consist of about 300 feet of dark grey to brown, brown weathering, calcareous shale. These are overlain by 100 feet of thin-bedded (1 to 3 feet thick), mottled, nodular, black limestone with minor interbeds of dark grey calcareous shale. Both rock types contain abundant fossils.

Boule Formation

The succeeding Boule formation, as defined by Lang (1947) for Brûlé map-area, is the uppermost unit of Devonian age exposed in the Moon Creek area. It occurs as a band along the fault scarp of the Nelson fault block from about the middle of the area to the west boundary. Two other small exposures occur where the anticlinal fold of the Hoff fault block has been cut through by small, southwest-flowing branches of Mumm Creek, near the east boundary of the map-area.

The Boule formation consists of about 1,500 feet of limestone and dolomite. The formation can be divided roughly into two divisions based on the thickness of the beds. The lower 400 feet is made up of limestone and dolomite beds from 1 foot to 10 feet thick, with minor thin interbeds of calcareous shale. The upper 1,100 feet is thick bedded to massive.

The two divisions are similar lithologically, consisting of dark grey to black, light grey weathering limestone and dolomite. Most of the beds contain small, irregularly shaped masses of chert, and some are slightly porous. No definite fossil beds were noted, but fossils are rare throughout the formation. Precipitous cliffs are typical of Boule strata.

Mississippian

Banff Formation

The Banff formation, of Mississippian age, conformably overlies the Boule limestone and dolomite. It is exposed in both mountain blocks. In the Hoff fault block, Banff strata are exposed in three small areas by the erosion of two anticlines; where this fault block crosses the eastern border of the map-area it exposes a complete section of Banff strata underlain by Devonian and overlain by the Rundle formation. Toward the northwest the Banff is exposed in two other areas in the core of a second fold.

In the Nelson fault block, strata of Banff age are brought to the surface by two thrust faults. The larger band is exposed above the Devonian strata in the main fault block, and extends along the ridge about two-thirds of the way across the map-area from the west boundary. A smaller band, about 3 miles long, is exposed along a smaller thrust to the southwest. Good sections of the formation occur in both bands. The only other exposures are in a small area in the core of an anticline near the headwaters of Seep Creek, where only the upper 100 feet of the formation is exposed.

The Banff formation consists of relatively thin-bedded, grey to black, argillaceous limestone, calcareous shale, and thin interbeds of grey limestone. The whole formation weathers light brown or buff, and forms gentle slopes of shaly to platy debris. The formation is softer than either the underlying Devonian limestone or the overlying Rundle strata. Its shaly character and buff weathering make its upper and lower contacts quite distinct.

At the southeast end of the Hoff fault block, the Banff formation is 600 feet thick, but sections at the northwest end of the Nelson fault block range between 470 and 530 feet in thickness.

The following section was measured on the ridge on the west side of Moon Creek near its source:

Top of Section

Feet

Overlying beds, Rundle formation

Shaly limestone, dark grey, weathering buff-grey and reddish brown; thin-bedded ---------- 9

Limestone, dark grey; weathering dark grey; in beds from 3 inches to 3 feet thick; thin ribbons of grey chert near top ------- 35

Limestone, crinoidal; light grey, weathering light grey; beds from 1 inch to 1 foot thick; brachiopods in 2-foot zones near base ---------- 24

Limestone, nodular; dark grey, hard; weathering light grey; in beds from 1 inch to 3 inches; interbedded with soft, grey-buff, shaly limestone in beds from 1 inch to 2 feet -------- 50

Limestone, light grey, coarse-grained, weathering brownish; beds from 1 inch to 1 foot; brachiopods in zone about 10 feet from top ---------- 50

Limestone, dark grey, fine-grained, buff-weathering; containing numerous chert nodules up to 3 inches in diameter; some nodules lined with quartz crystals; thin-bedded ---------- 46

	Feet
Limestone, coarse-grained, dark grey, buff-weathering, crinoidal; brachiopods	19
Limestone and shaly limestone, dark grey, fine-grained; some chert nodules in the upper limestone beds	45
Limestone, thin-bedded, dark grey, weathering brown; networks of calcite stringers	23
Limestone, dark grey, with chert nodules and large calcite crystals; beds 6 inches to 2 feet; much interbedded calcareous shale	28
Limestone, coarse-grained, dark grey, weathering grey and brown; beds from 6 inches to 1 foot; much white calcite present	20
Limestone, fine-grained, grey, containing chert nodules; beds from 1 foot to 2 feet in thickness	27
Shaly limestone, dark grey, weathering brown; a few thin, grey limestone beds; much white calcite present	18
Limestone, fine-grained, dark grey, with chert nodules; beds from 8 inches to 2 feet; weathers red-buff	34
Limestone and calcareous shale, fine-grained, black limestone interbedded with grey calcareous shale; beds between 1 foot and 4 feet thick; both types weather light buff; many small cavities in the limestone, some filled with pyrite	72
Total	500

Underlying beds, Boule formation

The Banff formation is extremely fossiliferous, especially in the upper 200 feet. The fossils are usually restricted to definite beds or horizons, and some of these beds, though only 3 or 4 feet thick, are composed almost entirely of shell remains. Some thin beds of limestone are coquinas of crinoid remains.

The following forms, identified by R.A.C. Brown of the Geological Survey, were collected from the Banff formation at various localities in the Moon Creek map-area:

Syringopora sp. indet.
Diphyphyllum colemanense Warren
Syringopora aculeata Girty

Bellerophon sp. indet.
cf. Euomphalus eurekensis Walcott
Euomphalus sp.
Straparollus cf. ophirensis

Chonetes sp.
Gypidula sp.
Conocardium sp.
Productella lata Warren

Camarothoechia sp.
C. cf. tuta Miller
C. chouteauensis Weller
C. allani Warren
Cyrtospirifer animascensis
Cyrtia standlyensis Shimer
Athyris angelica Hall
Schizophoria sp.
cf. Dielasma chouteauensis Weller
Brachythyris chouteauensis Weller
Martinia rostrata Girty
Spirifer explanadensis n.sp.
S. rutherfordi Warren
S. marionensis Shumard
Composita immatura Girty
C. athabaskensis Warren
Schellwienella ? sp.
Cliothyridina lata Shimer
Linoproductus ovatus Hall
Reticularia cf. cooperensis (Swallow)
Dictyoclostus cf. arcuatus (Hall)

Michelinia placenta White

Rundle Formation

The Rundle formation of limestone and dolomite overlies the Banff formation conformably. It is well exposed in several bands on both mountain ridges, the bands being repetitions due to thrust faulting.

In Moon Creek map-area the Rundle formation can be divided into three, usually distinct, units, based on the character of the beds. These three divisions are of about equal thickness, although small differences were noted in different sections. The total thickness of the formation is between 600 and 680 feet. The lower one-third consists of very hard, mostly thick-bedded to massive, light grey weathering limestone, with minor interbeds of shaly limestone, and, toward the top, some interbeds of dolomite. This is a resistant unit, about 200 feet thick, that forms craggy outcrops and steep cliffs.

Above the unit just described is about 200 to 235 feet of dolomite, with some limestone and thin shaly beds, in beds up to 3 feet thick. These strata are softer and thinner than those of the lower unit, weather dark grey to brown, and form more gentle slopes than the rock below.

The upper part of the Rundle, also about 200 feet thick, is predominently thick-bedded, ash-grey weathering, grey to brown dolomite. It contains numerous thin bands and nodular lenses of chert, and rounded masses of white, cleavable calcite. These are usually about 2 to 3 inches in diameter, but some as much as 4 feet in diameter were noted. This unit also forms steep cliffs, but not as bold as those formed by the more massive lower unit.

The following section of the Rundle formation was measured on the ridge between the headwaters of Carson and Moon Creeks:

Top of Section Feet

4 Overlying beds, Spray River formation

Upper Division

Dolomite, thick-bedded to massive, dark grey, light grey weathering; beds average 3 feet in thickness; much white calcite in small cavities and as stringers ----------50

	Feet
Dolomite, very fine-grained, grey, buff weathering	4
Dolomite, massive, grey, grey weathering; numerous lenses and nodules of dark grey chert; a few, thin, shaly weathering beds	21
Limestone, dolomitic; dark grey, and dark grey weathering; contains large and small nodules of white calcite; corals and brachiopods present	11
Dolomite, fine-grained, light grey, light grey weathering	11
Dolomite, very hard, fine-grained, dark grey, buff to brown weathering; small, calcite-filled cavities extremely numerous; weathered rock presents a honeycomb appearance	63
Dolomite, calcareous; thin-bedded (1 foot), fine-grained, dark grey, cream weathering, shaly; numerous small cavities filled with calcite and some with pyrite	18
Dolomite, fine-grained, dark grey, brown weathering; many small calcite-filled cavities	15
Dolomite, interbedded dark and light grey, with some calcareous shale beds up to 1 foot thick; many small calcite-filled cavities	21

Middle division

	Feet
Dolomite and shaly dolomite, thin-bedded (up to 3 feet), fine- to medium-grained, brownish grey dolomite, interbedded with thin limestone beds and beds of argillaceous limestone and dolomite; mostly buff to brown weathering; some beds porous; many masses of white calcite up to 1 foot in diameter	195

Lower division

Limestone, extremely fine-grained, dark brownish grey weathering; many patches and stringers of white calcite	6
Limestone, fine-grained, dolomitic, grey, buff-grey weathering; networks of white calcite stringers	7
Dolomite, fine-grained, grey, shaly, blocky, and buff-grey weathering	10
Limestone, massive, grey, ash-grey weathering, fine-grained; speckled with calcite crystals in places; some pyrite	10
Dolomite, fine-grained, light grey, light grey weathering	6
Limestone, thin-bedded, brownish grey and grey, grey weathering-	21
Dolomite, brittle, fine-grained, grey, buff weathering	6
Limestone, dark grey, fine-grained, light grey weathering	24

Limestone, fine-grained, grey, light grey weathering; speckled with minute calcite-filled cavities; very porous when weathered	10
Limestone, dolomitic, very fine-grained, brownish grey, brownish grey weathering; minute calcite-filled cavities; porous; some fossil remains	12
Limestone, hard, grey, ash-grey weathering; weathers slaty; thin fossil zone containing brachiopods and crinoid remains	7
Dolomitic shale, soft, dark grey, buff weathering	2
Limestone, fine-to medium-grained, light to dark grey, grey weathering, thin-bedded	26
Limestone, thick-bedded, hard, very fine-grained, grey, light grey weathering; large calcite-filled vugs; 2-foot zone at the top containing brachiopods and crinoid remains	30
Limestone, soft, grey to brown, brownish weathering, in part crinoidal with some bryozoans and brachiopods	4
Limestone, hard, thick-bedded, to massive, grey, light grey weathering, fine-grained	25
Limestone, hard, fine-grained, thick-bedded to massive, grey, light grey weathering; numerous bands and irregular masses of dark grey chert	50
Underlying beds, Banff formation	
Total	665

Fossils are not plentiful in the Rundle formation. Two, and perhaps three, thin coquina zones occur. These are composed of crinoid parts, but usually include some bryozoa, brachiopods, and gastropods. Scattered brachiopods and gastropods occur in some beds in the 200 feet of thin-bedded dolomite in the middle of the formation. Crinoid remains are common. Few fossils except corals occur in the upper part of the Rundle, but these are prolific in some beds.

The following is a list of forms collected from the Rundle formation in Moon Creek map-area and identified by R.A.C. Brown of the Geological Survey:

Lower part of Rundle

Rhipidomella cf. diminutina Rowley
Productus aff. minnewankensis Shimer
Dictyoclostus sp.
Camarotoechia cf. allani Warren
Syringothyris sp.
Brachythyris suborbicularis (Hall)
Spirifer sp.
S. minnewankensis Shimer
Composita sp.
Schellwienella sp.
Cliothyridina lata Shimer
Proetus sp.

Upper part of Rundle

Eumetria verneuiliana (Hall)
cf. *Composita sulcata* Weller

Horizon uncertain

Triplophyllum minnewankensis Shimer
Syringopora aculeata Girty
cf. *Diphyphyllum mutable* Kelly

Triassic

Spray River Formation

In nearly all localities where the Rundle-Spray River contact is exposed, a rusty weathering, basal conglomerate from 2 inches to 2 feet thick, and composed of subangular pebbles of limestone similar to the Rundle, rests disconformably on the Rundle formation. The pebbles usually range in size between ½ inch and 2 inches, but occasional pebbles are as much as 5 inches in diameter.

This disconformity is not conspicuous, but is of great significance because it must represent much of Carboniferous, all of Permian, and possible Lower Triassic time.

The conglomerate grades upward into a succession of hard, grey, very thin-bedded, slabby, reddish brown weathering siltstone and sandstone. The assemblage becomes calcareous toward the top. Where weathered, the reddish brown colour and thin, slabby nature of the silstone are distinctive.

These beds occupy large areas of both of the mountain blocks. The long narrow bands are the result of faulting, folding, and the steep attitude of the beds. No complete section was measured, but a composite section gave a thickness of about 1,000 feet, a figure that agrees well with the stratigraphic interval obtained from structure-sections.

Whitehorse Member. Overlying the siltstone and forming the top of the Triassic strata in Moon Creek map-area, is the Whitehorse limestone member. It is an excellent horizon marker both because of its lithology and because of its conspicuous cream-white colour when weathered, and for this reason has been mapped separately. Its distribution in the map-area coincides with that of the subjacent siltstone member, long narrow bands and small patches occurring in both mountain blocks.

The Whitehorse member consists of between 80 and 150 feet of grey to chalky white, buff to cream weathering limestone. The lower 20 feet or so is usually transitional into the underlying, buff weathering, silty limestone. Some beds are hard and brittle, whereas others are soft and porous. Small cavity fillings of white calcite are very common, and when weathered give a 'honeycomb' appearance to the beds. In some localities, thin beds of intraformational limestone breccia occur toward the top of the member, and in one locality 10 feet of black, calcareous shale lies between the siltstone and the Whitehorse limestone.

Composite Section of Spray River Formation

Overlying beds, Fernie formation

Whitehorse Limestone Member	Feet
Limestone, grey to white, cream weathering, hard and soft; some porous beds; some limestone breccia -----	100
Limestone, silty, grey, buff weathering ----------	20

Siltstone Member

	Feet
Siltstone, thick- and thin-bedded, grey, red-brown weathering, hard; upper 50 feet calcareous with a few beds of silty limestone	100
Covered	300
Siltstone and sandstone, thin-bedded, hard, grey, red-brown weathering, platy; minor interbeds of hard sandstone up to 2 feet thick	100
Siltstone, thin-bedded, hard, grey, red-brown weathering	500
Limestone conglomerate	0.33
Total	1,120.33

Underlying beds, Rundle formation.

Fossils occur in the siltstone toward the top of that member. Impressions of small ammonoids are quite numerous, but are so poorly preserved that identification is impossible. Some small brachipods and pelecypods occur in limestone beds in the upper part of the siltstone sequence. These are usually tightly packed together into a thin zone and are very poorly preserved. A few ammonoids occur in the lower part of the Whitehorse member. Here again preservation is poor, the fossils being entirely replaced by white calcite. Two localities yielded a few identifiable forms, and these were assigned a Middle Triassic age by F.H. McLearn. No fossils have been collected from the base of the formation. It is possible, therefore, that some of the lower part may be of Lower Triassic age.

The following genera were collected from the lower part of the Whitehorse member:

Beyrichites sp.
Gymnotoceras sp.
Trigonodus sp.
Sturia sp.

The following genera were collected from a limestone bed in the upper part of the siltstone member:

Myophoria cf. laevigata
Leda sp.
Spiriferina sp.
Coenothyris sp.

Jurassic

Fernie Group

The Fernie group, consisting of about 900 feet of black shale and interbedded sandstone, overlies the Whitehorse member of the Spray River formation. Because of the softness of the shale, good exposures of the lower contact are rare. In the few places in Moon Creek map-area where the contact was observed, it appeared to be conformable.

Rocks of the Fernie group form long, narrow bands, usually faulted, on the southwest sides of the two mountain blocks. Smaller areas of Fernie beds occur on the northeast side of the Hoff fault block, and in the core of the anticline that crosses Berland River at the west boundary of the map-area.

The lower part of the group consists of black, fissile shale. Near the lower contact are some beds of limy black shale and others that are extremely hard, fine grained, black, platy, and siliceous. Numerous concretionary, yellow weathering, ironstone bands are present in the lower 300 feet of shale.

Upward in the formation the shale becomes interbedded with more sandstone, and at the top hard grey sandstone is the predominant rock type. The Fernie is gradational into the overlying Nikanassin formation, and for purposes of field mapping the contact has been placed at the base of the first 20-foot bed of massive, quartzitic sandstone.

The following section was measured at the head of Moon Creek:

	Feet
Overlying beds, Nikanassin formation	
Sandstone and shale, grey, hard, siliceous, interbedded with black shale in beds up to 4 feet -------	16
Sandstone, grey, hard, buff weathering; numerous thin, silty shale partings ----------	11
Shale, predominantly silty, with many ribbons of grey sandstone 4 inches thick ----------	43
Sandstone, grey, hard, grey-brown weathering; thin partings of grey, silty shale ----------	4
Shale, dark grey to black, with thin ribbons of grey sandstone ----------	12
Sandstone, grey to brown, light brown weathering, with thin interbeds of dark grey shale ----------	38
Shale, dark grey to black, with numerous interbeds of hard, grey sandstone from 6 inches to 6 feet thick -	27
Shale, dark grey to black, silty; occasional thin (3-inch) sandstone ribbons at the base; grey sandstone in beds up to 3 feet thick forms about 50 per cent of the strata at the top ----------	415
Shale, black, fissile, with numerous concretionary beds of yellow weathering ironstone from 2 inches to 1 foot thick ----------	259
Shale, black, fissile, with a 15-foot zone at the base containing black, calcareous shale and some beds of a black, hard, fine-grained, siliceous rock. These beds contain belemnites---------	75
Total ---	900
Underlying beds, Whitehorse member of the Spray River formation	

Fossils collected from the Fernie strata in the map-area are as follows:

Belemnites sp.
Aucella sp.

Lower Cretaceous

Nikanassin Formation

The Nikanassin formation conformably overlies the Fernie group. It occupies extensive areas in Moon Creek map-area to the northeast and southwest of the two mountain blocks, and also between them. Much of it is repeated by thrust faulting. An excellent, complete section of the formation, 904 feet thick, is exposed where Berland River cuts through the anticline near the west boundary of the area.

The strata consist of marine and non-marine, hard, grey, light buff weathering sandstone with some interbedded shale. The lower part is composed of thick-bedded, medium-grained, quartzitic sandstone, with minor interbeds of black clay shale and soft brown sandstone. Buff and brownish sandstone, grey silty shale, and thin coaly beds predominate in the upper part of the formation.

The following section was measured on Berland River near the west border of Moon Creek map-area:

Overlying beds, Cadomin formation	Feet
Sandstone, brownish and grey sandstone, weathering light brown, with interbedded grey shale; two 3-foot ironstone beds at 20 and 74 feet below the top	148
Sandstone, grey, hard, quartzitic, dark grey weathering --	17
Sandstone and shale, grey, buff weathering sandstone with interbedded greenish, silty shale ----------	52
Sandstone, hard, thin-bedded; grey, brown weathering -----	58
Shale, dark grey, with interbedded sandstone bands up to 2 feet thick ----------	27
Sandstone, hard, grey, thick-bedded, light brown weathering, medium-grained; with minor thin grey shale partings ----------	159
Shale and sandstone, interbedded brownish grey, grey-buff weathering sandstone and grey-green shale in beds about 6 feet thick ----------	58
Sandstone, thick-bedded to massive, grey, buff weathering, with minor thin shale partings ----------	253
Shale, grey, silty ----------	4
Sandstone, hard, brown, yellow weathering -- ----------	2
Shale, black, fissile ----------	6
Sandstone, thin-bedded, grey, quartzitic, grey weathering -	46
Shale, dark grey to black, silty ----------	5
Sandstone, thin-bedded, grey-brown, dark grey to brown weathering ----------	49
Sandstone, light grey, grey weathering, hard, quartzitic, massive ----------	20
Total ------	904

Underlying beds, Fernie group

No fossils were collected from the Nikanassin formation in Moon Creek map-area.

Cadomin Formation

The Cadomin formation lies stratigraphically above the Nikanassin. It occurs as long, narrow, sinuous bands, and as small fragments in the area of Lower Cretaceous rocks southwest of the Nelson fault block, northeast of the Hoff fault block, and between the two mountain blocks. Most of the exposures are due to repetition by faulting and folding.

The Cadomin formation is a hard, closely packed, and well cemented conglomerate. It outcrops boldly, and is an excellent horizon marker. The pebbles are generally from $\frac{1}{2}$ inch to 3 inches in diameter, and consist chiefly of black, green, grey, brown, and red chert, and pink, green, and white quartzite. The rock fractures across the pebbles rather than around them. The thickness of the formation ranges between 30 and 100 feet, and in a few places the conglomerate includes lenses of hard, quartzitic, grey sandstone.

In the 100 feet of beds immediately above the Cadomin, are conglomerate beds and lenses composed of finer pebbles, but of the same chert and quartzite. These are included in the lower part of the succeeding formation rather than with the Cadomin.

Luscar and (?) Mountain Park Formations

The Luscar formation conformably overlies the Cadomin conglomerate. The largest area of Luscar strata occupies a northwest-trending belt on the northeast side of the Hoff fault block. This belt is about $2\frac{1}{2}$ miles wide, and extends from the east to the west boundary of the map-area. Within it small areas of Nikanassin and Cadomin rocks have been exposed by faulting and folding. Small areas of the overlying Fort St. John shale may also be present, but lack of good exposures prevented confirmation of this, and it was considered advisable to map all strata as Luscar except those known definitely to be of another formation.

Another narrow strip of Luscar beds lies between the two mountain ridges, and extends almost from the southeast corner to the west border of the map-area. Luscar strata also underlie about one-half of the area to the southwest of the Nelson fault block, but their distribution there is patchy because of faulting.

The formation consists of non-marine, fine- to medium-grained, thin-bedded, greyish green and buff weathering, grey, brown, and greenish sandstone; grey, greenish grey, and black shale; coal seams from 6 inchese to 50 feet thick; and scattered thin ironstone bands in black shale. Some of the shale is silty, and some is very carbonaceous.

In the lower 150 feet of the formation are several conglomerate beds or lenses up to 6 feet thick, consisting of pebbles similar to those of the Cadomin formation. In the Moon Creek map-area, however, the pebbles in these beds average about one-half inch in diameter, yielding a much finer conglomerate than the typical Cadomin.

Because of limited exposures and the intensive faulting and folding of the Luscar, no satisfactory estimate of the thickness of the formation was obtained, but the interval between the upper and lower limits of the formation, as obtained from compiled structure-sections, is roughly 2,000 feet.

Sandstone beds of the upper part of the Luscar may represent the Mountain Park formation, but separation of the two formations has not been attempted.

Plant fossils are fairly abundant in the Luscar strata, but the non-marine fauna is scarce. Plant fossils collected in Moon Creek map-area have been identified by W.A. Bell of the Geological Survey as follows:

Ferns

Sphenopteris latiloba Fontaine
Cladophlebis oerstedi (Heer) Seward
Cladophlebis parva Fontaine

Cycadeoids

Elatides curvifolia (Dunker)
Elatides dickoniana (Heer)
Elatocladus sewardi nom. nov.
Elatocladus (Sequoia?) smittiana (Heer)
Elatocladus sp. cf. Cephalotaxopsis brevifolia Fontaine

Incertae sedis

Sagenopteris mclearni Berry
Zamiopsis n.sp.

These species are typical of the Luscar formation, which is considered to be of Aptian (upper Lower Cretaceous) age.

Fort St. John Group

Lying conformably between the Luscar and Dunvegan formations is about 400 feet of black, fissile shale and sandy shale similar to that of the Blackstone formation. No fossils were found in this shale, but its stratigraphic position below the Dunvegan sandstone suggests that it represents a thin southwesterly extension of the Fort St. John group of Peace River district, which consists of several, dominantly marine formations.

Nowehere was a complete section of this shale seen, but poor exposures occur on Little Berland River and on Moon Creek, and probably indicate the presence of a narrow belt of Fort St. John shale extending across the map-area. Above this belt, on Moon Creek, are two other areas of black shale similar lithologically to the Blackstone. The shale is greatly contorted and sheared, and no recongnizable fossils were obtained from it, but as it appears to rest conformably on the Luscar (?) it has been mapped as Fort St. John.

The only other recognizable exposure of the Fort St. John group occurs between the two mountain blocks, between the headwaters of Moon Creek and Little Berland River. Here again the shale is exceedingly contorted.

Upper Cretaceous

Dunvegan Formation

The Dunvegan formation conformably overlies the Fort St. John shale. It extends as a narrow band of nearly vertical strata from southeast to northwest across the map-area. Exposures are poor. On Little Berland River the Dunvegan is faulted and distorted, and on Moon Creek only the upper 50 feet of the formation is exposed. Another small exposure was observed between the two mountain ridges, between the headwaters of Moon Creek and Little Berland River.

In Moon Creek map-area the Dunvegan formation consists of two thick-bedded bands of hard, grey, quartzitic sandstone about 50 feet thick separated by 90 feet of interbedded, softer, grey sandstone, dark grey, nodular, fine-grained sandstone, and grey shale. Impressions of wood and carbonized wood fragments were seen in some beds. The total exposed thickness is, therefore, 190 feet, but because the lower contact is faulted, the true thickness of the formation is probably greater.

The section exposed on Little Berland River is as follows:

Overlying beds, Blackstone formation	Feet
Sandstone, hard, quartzitic, slabby, grey-green, grey weathering	50
Sandstone, silty, brown, light brown weathering	10
Shale, soft, dark grey, grey weathering	8
Sandstone and silty shale, grey, greenish weathering, interbedded with dark grey silty shale	32
Sandstone, hard, quartzitic, grey, grey weathering	4
Shale, grey; nodular and clayey in part, with interbeds of hard, grey sandstone; carbonized wood fragments	20
Sandstone, fine-grained, hard, silty; containing a 1-foot ostrea coquina	16
Sandstone, quartzitic, hard, grey-green, slabby, grey weathering	50
Total	190

Underlying beds, Fort St. John (?) shale (fault contact)

Fossils are not numerous in the Dunvegan formation, but in the Little Berland River exposure there is, 135 feet from the top of the section, a 1-foot crushed coquina bed composed predominantly of a small species of ostrea, but including the following forms:

Brachydontes multilinigera
Corbula ? n.sp.
Ostrea sp.
Compeloma or Viviparus sp.

A specimen of Inoceramus rutherfordi Warren was obtained from the Dunvegan exposure in front of the Hoff thrust block between Little Berland River and Moon Creek; a poorly preserved leaf found here at approximately the same horizon was identified as Magnolia.

Blackstone Formation

The Dunvegan formation is overlain by a succession of thin-bedded, black, silty shales and black, fissile shales. These are referred to the Blackstone formation, in consonance with the nomenclature of southern Alberta. It should be understood, however, that south of Athabaska River the Blackstone formation includes all strata between the Luscar (or Mountain Park) and overlying Bighorn formations, whereas in Moon Creek area the interval between the Luscar (or Mountain Park) and Bighorn formations is

occupied by the Fort St. John group, the Dunvegan formation, and the "Blackstone" formation. Thus, the beds classed here as "Blackstone" cannot be regarded as exact equivalents of the Blackstone formation farther south. On the other hand, the "Blackstone" of Moon Creek map-area does not appear to be the equivalent of the Kaskapau formation of the Peace River district, as the Badheart sandstone overlying the Kaskapau shale is believed, from fossil evidence, to be slightly younger than the Bighorn formation.

The largest area underlain by Blackstone strata in Moon Creek area is a belt about one-quarter mile wide extending northwesterly from the east to west border of the map-area just northeast of the large area of Luscar strata. A small area of Blackstone shale is also exposed between the two mountain blocks. In addition, two small areas of black, fissile shale in the southwest corner of the map-area have been mapped as Blackstone, though it is possible that these may be Fort St. John.

The Blackstone formation consists almost entirely of black, fissile, marine shale, with minor interbeds of yellow weathering, concretionary, discontinuous ironstone beds up to 1½ feet thick. Toward the top of the formation are a few, thin, fine-grained, grey, hard, sandstone beds and at least one bed of silty limestone. A 6-foot bed of hard, grey, quartzitic sandstone lies about 100 feet stratigraphically below the top of the formation.

The formation is everywhere poorly exposed, and is intricately folded and faulted. No undisturbed exposure of the Blackstone was observed, and consequently no complete section could be measured. The stratigraphic interval between the top of the Luscar and the base of the Bighorn formation ranges between 1,500 and 1,800 feet.

The only fossil collected from the Blackstone in Moon Creek map-area was Inoceramus labiatus. Specimens of this species were found near the middle of the formation and are poorly preserved.

Bighorn Formation

The Bighorn formation occupies a narrow belt of nearly vertical beds extending from southeast to northwest across the Moon Creek area. It is best exposed on Little Berland River, where the formation is about 240 feet thick, consisting of two bands of hard, thick-bedded sandstone each about 60 feet thick and similar to the sandstone of the Dunvegan formation, separated by 120 feet of softer sandstone and shale. The thick sandstone members usually form conspicuous ridges.

The lower sandstone member consists of hard, greenish grey, grey weathering, fine-grained, slabby sandstone. Above the sandstone are 120 feet of interbedded, grey, lumpy, clay-like shale; grey, silty shale; soft, greyish siltstone; and thin beds of light grey, quartzitic, medium-grained sandstone. Near the top of this middle member is a 2-inch seam of coaly material and a 6- to 10-inch bed of conglomerate. The upper, 60-foot sandstone member consists of fine- to medium-grained, slabby, hard, greenish grey sandstone.

Crossbedding is exhibited by both of the massive sandstone members. The higher strata of the upper sandstone carry Cardium pauperculum, but no other fossils were found in the formation.

The section measured on Little Berland River is as follows:

	Feet
Overlying beds, Wapiabi formation	
Sandstone, greenish grey, hard, slabby, quartzitic, fine grained; Cardium pauperculum near top ---	61

	Feet
Sandstone, buff-brown, thin-bedded, fine-grained -------	20
Conglomerate, pebbles up to 2 inches in diameter -------	0.8
Sandstone, dark grey, silty, grey weathering ----------	6
Coal, soft, dirty ----------	0.2
Shale, dark grey, soft ----------	4
Sandstone, light grey, fine-grained, quartzitic --------	3
Sandstone, grey-brown, light brown weathering, medium grained, with grey shale partings ----------	50
Shale, grey, hard ----------	7
Shale, greenish grey, clay-like, lumpy ----------	10
Sandstone, grey, grey weathering, hard, quartzitic -----	8
Sandstone and shale, soft, brownish grey, medium-grained sandstone with interbedded, grey, silty shale -	11
Sandstone, greenish grey, grey weathering, hard, slabby, quartzitic ----------	58
Total ----------	239

Underlying beds[1], Blackstone formation

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[1] In the adjoining Moberly Creek area to the east, Lang (1947, p.12) included, provisionally, with the Bighorn a 3-foot sandstone bed 163 feet below the basal, heavy sandstone of the above section.

Wapiabi Formation

The Wapiabi formation underlies two nearly parallel zones extending from southeast to northwest in the Foothills northeast of the two mountain blocks. It overlies the Bighorn formation conformably, and consists mainly of black marine shale.

The best exposures of the Wapiabi are on Little Berland River. There the lower contact with the Bighorn sandstone is distinct, the lower few feet of the Wapiabi consisting of fine-grained, greenish, glauconitic sandstone in thin beds. Above this is about 700 to 800 feet of black fissile shale containing yellow weathering ironstone as continuous and discontinuous bands from 1 inch to 2 feet thick, and as irregularly shaped, individual concretions. Above this zone is about 500 feet of interbedded fissile shale, silty shale, and sandstone in beds from 1 to 2 inches thick, which lend a ribboned appearance to this zone. The uppermost part of the Wapiabi consists of 300 feet of thin-bedded, greenish grey, medium-grained sandstone. The total apparent thickness of the formation at this exposure is, consequently, about 1,500 feet, a figure that checks well with the stratigraphic interval as scaled from structure-sections. The true thickness is, however, not known, because all exposures of the Wapiabi show considerable deformation.

The Wapiabi is generally considered to consist of a lower, Scaphites ventricosus zone and an upper, Baculites ovatus zone. No fossils were found in the upper part of the formation in the Moon Creek area, but from the lower part were collected numerous specimens of Scaphites ventricosus and some of Inoceramus lundbreckensis.

Brazeau Formation

The Brazeau formation, of late Upper Cretaceous age, overlies the Wapiabi, and occupies an extensive area in the north and northeast part of Moon Creek map-area.

The lower 100 feet of the Brazeau, consisting of a distinctive, slabby, buff-weathering, grey to greenish grey, hard sandstone, is a useful horizon marker, and is mapped separately as the Solomon sandstone. Fossils are rare in this member, but the following, collected from 50 feet above the base in an exposure on Moon Creek, were identified by F.H. McLearn:

Baculites sp.
"Dosiniopsis" sp.
Polinices ? and other gastropods

These would indicate that at least the lower part, if not all, of the Solomon member is marine.

The Solomon sandstone is overlain by 90 to 100 feet of softer, coarser grained, greenish sandstone and sandy shale containing a few scattered pebbles and poorly preserved plant remains. Overlying this zone are the typical and distinctive pebble beds of the Brazeau formation; the lower of these are true, massive, pebble-conglomerates, but above them, stratigraphically, the amount of conglomerate decreases until sandstone predominates, with only thin beds and lenses of conglomerate. The conglomerate consists of pebbles of chert and quartzite, one-half inch in diameter, rather widely spaced in a sandy matrix. The zone is about 1,000 feet thick, but has no sharp boundary, the conglomerate grading upward into sandstone. Both conglomerate and sandstone are commonly crossbedded.

The remainder of the formation consists of about 4,800 feet of interbedded sandstone and shale, with minor amounts of pebble-conglomerate, a few ash beds, and a few thin coal seams. The sandstone is generally crossbedded. Carbonized wood fragments, shale inclusions, and scattered pebbles are common. The inclusion of minute fragments of lignitic material gives some beds a 'salt and pepper' appearance. The shales are mainly grey and greenish grey, but include some black carbonaceous beds.

Most of the Brazeau strata in the map-area maintain moderate to low dips to the northeast, but within the area of these rocks is a zone of intense folding and faulting, designated separately on the map, and recognized from exposures on the larger streams. Due to paucity of rock outcrops in the interstream areas, no attempt has been made to work out the structural pattern.

Paleocene

No fossils were collected from the Upper Cretaceous, Brazeau formation in the Moon Creek map-area, and as no outcrops of the basal Paleocene (Entrance) conglomerate could be found, the position of the Cretaceous-Paleocene contact is uncertain, but is assumed to be approximately as shown along its northwesterly continuation from the adjoining Moberly Creek map-area. The outcrops seen in the northeastern corner of the area are mainly sandstone and sandy shales, not unlike some of the Brazeau but also similar to Paleocene plant-bearing beds encountered along strike to the southeast in the Moberly Creek area.

STRUCTURAL GEOLOGY

General

Moon Creek map-area is notable for: (1) the regularity of the strike of all structural features, which is about north 50 degrees west; and (2) the great number of strike thrust faults and the regularity of their traces on the surface, indicating that the faults are steeply inclined.

In the Foothills area to the northeast of the mountains, rock exposures are meagre, and it is extremely difficult to trace any faults that may be exposed. For this reason, few faults are shown in the area directly in front of the Hoff thrust block, which is underlain by Luscar strata. Similarly, the deformed Brazeau strata, previously referred to, are known from exposures on the main streams to be intensely faulted and sheared, but no attempt has been made to map the individual faults.

Faults

All faults in the map-area are considered to be strike faults, along which strata have been overthrust to the northeast. This assumption is known to be true in the mountainous region as the faults are not only readily traceable but many of the fault surfaces are partly exposed. In the Foothills and lower areas, where exposures are poor, the direction of dip of the faults may not be known, but as some of these faults can be shown to be thrusts with displacement to the northeast, it is probable that all of them are of the same type.

The two principal thrusts in the area are those that have brought to the surface the competent Palaeozoic limestone, which, due to its resistance to erosion, now forms the two mountainous belts. Within the two fault blocks are numerous minor thrusts that have piled thin rock slices on top of each other, giving repetitions of the same strata. It is probable that the surfaces of these lesser thrusts, most of which dip very steeply, join one or other of the two major thrust faults at depth.

Although thrust faulting was the main process of deformation, some folding took place either prior to or contemporaneous with the thrusting. Folding produced anticlines and synclines. Most of these appear to have been asymmetrical, with a steeper northeast limb, some of which were even overturned. The major thrusts were developed on the steep or overturned northeast limbs, although most of the minor thrusts probably occurred on the more gentle southwest limbs.

Folds

Anticlinal folds have been partly obscured by faulting, and synclinal structures in front of the thrust blocks have been intensely crumpled and partly overridden by the older strata.

The largest continuous fold is the Cabin Creek anticline, the southeasterly extension of which crosses nearly the entire map-area from southeast to northwest. This fold pitches to the southeast, and loses much of its identity in that direction. As a result of the vertical or overturned northeast limb of the structure, the Cretaceous formations younger than Luscar occur as long narrow belts extending northwesterly from the east border to the west border of the map-area.

A smaller anticline extends northwesterly across the map-area about 1½ miles northeast of the Cabin Creek structure. Wapiabi shales are exposed at the crest of the fold, and the meagre evidence obtained indicates that the southwest limb of the structure is the steeper one. The fold is faulted on the southwest flank, and this fault has been shown on the structure-sections as a thrust from the southwest, though no definite proof of this was obtained. Northeast of the fold the strata dip to the northeast at progressively lower angles.

The folded attitude of some of the faults on the Hoff fault block indicates that some folding or uplift of the area took place after the main period of faulting. Both the faulting and the folding required compressive forces acting from the southwest. No evidence of a subsequent period of tension was found.

In general, the marine shale formations such as the Fernie, Blackstone, and Wapiabi, together with the non-marine Luscar formation, were the incompetent members of the sedimentary sequence. Strata of these formations show intense crumpling and shearing wherever they are exposed. The more competent formations are faulted rather than folded.

ECONOMIC GEOLOGY

Coal

No coal was observed in the Brazeau or Paleocene strata in Moon Creek map-area. Northeast of the two mountain blocks only a few thin coal seams were observed, and all of these are in the Luscar formation. A 1-foot seam is exposed in the east bank of Little Berland River about one-quarter mile upstream from the Luscar-Fort St.John contact. A few seams up to 6 inches thick were noted in gullies at the head of Little Berland River, and on the divide between Little Berland River and Mumm Creek. Coal also occurs in a fault zone in the east bank of Moon Creek about a mile upstream from the Luscar-Fort St.John contact. Though no thick seams were seen in this part of the map-area, this may be due to paucity of exposures rather than to the absence of coal.

In the area underlain by Cretaceous strata southwest of the Palaeozoic fault blocks, the Luscar formation contains some thick seams; good coal has been known to exist in this district since 1916, and for a number of years after 1916 prospecting was active on the upper part of Wildhay River, Seep Creek, Carson Creek, and Thoreau Creek. A few seams were traced for short distances by trenching, but no coal was mined. Some diamond drilling was done on Thoreau Creek. Most of the old trenches and pits are now caved and overgrown with brush, but a few were reopened by the writer and the seams measured. All coal seams in this district have very steep dips.

Two seams on the east side of Carson Creek were located by trenches on the ridge east of the creek and traced part way down the hillside toward the stream. They should cross Carson Creek about 2,500 feet above its confluence with Wildhay River. The following section was measured on top of the ridge:

	Feet
Grey shale, hanging-wall	
Coal, weathered, powdery	7.2
Grey shale,	1.8
Bone	1.2
Coal, weathered, friable, containing small lenses of clay shale	22.0
Coaly shale, foot-wall	

These seams strike south 60 degrees east, and where measured dip to the northeast at 70 degrees. According to the sketch map accompanying the report of J. MacVicar (1923), these seams are on a claim then owned by J.P. Bickell. They are between 1,000 and 1,200 feet stratigraphically above the base of the Luscar formation.

In a low saddle of the ridge on the west side of Carson Creek another seam was exposed by trenching. This may be a continuation of the seams described above, as its stratigraphic position is similar. The approximate thickness of this seam is 35 feet. Silty shale occurs both above and below the coal. The seam strikes south 45 degrees east and dips at 65 degrees to the northeast.

A seam 2 feet thick is exposed in the south bank of Wildhay River opposite the mouth of Carson Creek.

On the south bank of Wildhay River opposite the mouth of Fault Creek a seam or seams had been previously exposed by a trench about 100 feet long. This trench is now overgrown with bush, but much coaly material had been removed. The seam could be followed to the southeast by means of old pits and trenches. No idea of the thickness was obtained, but the seam is apparently the northwest continuation of one of two that are exposed in a small creek just south of the map-area and to which MacVicar has assigned thicknesses of 18 and 24 feet.

In the west bank of Thoreau Creek, about three-quarters mile above its mouth, a thick seam is exposed. The seam strikes south 65 degrees east across the valley and has a dip of 82 degrees to the northeast. It lies about 1,000 feet above the base of the Luscar formation, and the section exposed is as follows:

Shale hanging-wall

	Feet
Coal	4
Shale	1
Coal	8
Coaly shale	6
Coal	25

Sandstone foot-wall

Northeast of the Thoreau Creek seam, on the ridge between Thoreau Creek and Fault Creek at an elevation of between 6,500 feet and 6,600 feet above sea-level, are two coal seams. The upper seam, lying about 1,200 feet above the base of the Luscar, consists of 27 feet of coal. Clay shale underlies the coal, and sandstone forms the roof. This seam strikes south 45 degrees east and stands vertically. A second seam lies about 400 feet lower in the formation, and is exposed in a pit higher on the hill. The thickness of this seam could not be measured. Adjacent strata strike south 45 degrees east and dip 80 degrees to the southwest.

Coal is exposed at numerous other localities outside of the map-area in the vicinity of Thoreau Creek and to the west, but accurate data on the correlation of the seams represented could not be obtained in the time available.

The coal area is one of intense folding and faulting, and the distance that a seam can be traced is controlled by the faulting. Where exposed, the coal was seen to be extremely weathered and powdery. In places movement within a seam was indicated by slickensiding and shearing.

Old analyses, given by MacVicar, rank the coal as high-grade bituminous. The area is relatively inaccessible so far as mining is concerned, but it would appear that a large tonnage is available.

Oil and Gas

No wells have been drilled for oil or gas within the map-area. At present, however, a well is being drilled at Muskeg River, about 15 miles northwest of Moon Creek map-area. If oil is found there in commercial quantity the possibilities of the northeast part of Moon Creek map-area will doubtless be considered. Attention may be given to the Cabin Creek anticline and the anticlinal fold to the northeast. Of these two folds, the northeasterly one is probably the more favourable, as the Rundle limestone is exposed in the Cabin Creek structure about 3½ miles northwest of Moon Creek map-area.

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