CANADA

DEPARTMENT

OF

MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 52-26

GRANDE CACHE MAP-AREA, ALBERTA

(REPORT AND MAP)

By

R. Thorsteinson

OTTAWA

1952

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(Summary Account)

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GRANDE CACHE MAP-AREA, ALBERTA

INTRODUCTION

Location and Name

Grande Cache map-area lies in the west-central part of the Alberta Foothills, and is traversed diagonally by Smoky River. It comprises an area of approximately 196 square miles between latitudes 53°45' and 54°00' and longitudes 119°00' and 119°15'. The nearest railway is the transcontinental line of the Canadian National, which follows Athabasca River some 65 miles to the southeast, entering the Yellowhead Pass at Entrance, a village about 190 miles west of Edmonton.

The name "Grande Cache" was given to a cache of food and supplies maintained by early traders of the Hudson's Bay Company about the middle of the nineteenth century. This cache was located in the centre of the map-area near the site of the present day Indian village.

Accessibility

Entrance provides the nearest post office, telegraph, and outfitting point for hunting and exploratory parties. It may be reached by rail or by a road that connects it with the Edmonton-Jasper highway 2 miles to the south.

Until 1946 no motor roads existed in the extensive territory to the north of Entrance and Athabasca River, but in the spring of that year such a road was constructed by oil companies engaged in drilling on Muskeg River 76 miles north of Entrance and 10 miles east of the Grande Cache map-area. This road followed a forestry trail known as the Lower trail, which followed the outer edge of the Foothills. From the site of the Muskeg No. 1 well, the trail continues along Muskeg River and then down Grande Cache Valley to the Indian village of the same name.

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The Muskeg No. 1 well was financed jointly by the Gulf, Imperial, McColl-Frontenac, and Socony-Vacuum companies under a compact known as the Northern Foothills Agreement. Unfortunately the well proved dry and was abandoned in November 1948. Hope that this road would be permanently maintained is now in doubt.

Another route, known as the Upper or Mountain trail, connects Entrance with the Grande Cache area over a distance of about 100 miles. This trail branches from the Lower trail about a mile north of Wild Hay River, follows that stream to Rock Lake and thence overland across the upper reaches of Big Berland and Muskeg Rivers to Sulphur River. The Upper trail then follows the latter valley to its junction with the Lower trail at the Indian village of Grande Cache.

The Grande Cache area is about the same distance from the town of Grande Prairie, on the Northern Alberta Railway, as from Entrance. A forestry trail known as the Gustavs Flats trail leaves the Indian village of Grande Cache, fords Smoky River about 6 miles to the northwest at Gustavs Flats, and there joins the Smoky River trail, which leads down the northwestern banks of the Smoky to Grande Prairie. This trail is reported to be poorly maintained.

The area contains a few branch trails, but these are not cleared for pack-trains and much of the area apart from the main trails is difficult of access.

Horses and pack-trains are the chief mode of transportation for both men and supplies. Light sea planes have landed on Grande Cache Lake, which is about 1¼ miles long and ½ mile wide.

Previous Work

J. M. MacVicar (1917, 1920, 1924)[1] examined the coal occurrences between Brule and Smoky River. His work is the only published geological report that includes a discussion of the stratigraphy of the Grande Cache area. In 1924, James McEvoy (1925) examined the Smoky River coalfields for the Dominion Fuel Board. His report is largely given to economic considerations and adds little to previous geological work of MacVicar's. In 1928, B. R. MacKay (1929) made a brief visit to the northeast corner of the Grande Cache area in his survey of the coalfields of the Jasper Park area.

[1] Dates in parentheses are those of References at the end of this report.

Acknowledgments

This report is based on field work begun in the summer of 1948 and completed in 1949. During the field season of 1948 the writer was assisted by R. B. McLeod, D. H. Shouldice, and A. L. Flood, and in 1949 by Colin Stearn and J. Ambler. All these assistants performed their duties in an able manner. The writer is also indebted to Messrs. S. H. Clark, Carl Luger, and Mr. and Mrs. Robert McGee, all of Entrance, for many courtesies extended to him and members of his party.

Invertebrate fossils collected in the area were identified by F. H. McLearn and J. A. Jeletzky, and the plant fossils were identified by W. A. Bell. The writer is particularly indebted to Dr. McLearn, from whom he received much useful advice before leaving for the field.

GENERAL CHARACTER OF THE REGION

Topography

The Grande Cache map-area is situated approximately in the centre of the west-central Foothills. The markedly different resistance to erosion offered by the various bedrock formations, together with their thicknesses and structure, has been the controlling factor in determining the nature of the topography. Thus, a series of ridges and intervening valleys is traceable across the area and generally marks the outcrop position of hard or softer sedimentary strata respectively.

The area is physiographically divisible into two parts: (1) the northern, roughly three-quarters comprises the typical wooded ridge and valley systems of the Foothills; and (2) the southern quarter where greatly thickened and resistant Lower Cretaceous sandstones of the Nikanassin formation dominate the outcrop pattern and produce a castellated topography rising into a series of high mountains. These mountains topographically simulate the front range of the Rocky Mountains and their slopes are in many places devoid of trees, even to elevations below timberline, which in this latitude may be generally placed at 6,500 feet above sea-level.

The surface of the area has a maximum topographic relief of about 4,600 feet. The lowest elevation, about 3,150 feet above sea-level, is on Muskeg River, where this stream traverses the northeast boundary of the area. The highest point is the summit of Mount Russell, approximately 7,750 feet, in the south-central part of the map-area.

Drainage

The region is drained by the swiftly flowing Smoky, Muskeg, and Sulphur Rivers and their tributaries. These rivers, especially the Smoky, present great obstacles to travel in times of flood.

Grande Cache Valley is occupied by muskeg and by a series of lakes, of which the largest are Peavine, Grande Cache, and Victor. The valley appears to have been the preglacial channel of Sulphur River, carrying its waters at that time to confluence with the Muskeg. With the disappearance of glacial ice, the damming effect of a terminal moraine in the vicinity of the Indian village caused Sulphur River to turn through 180 degrees and join the Smoky to the southwest.

STRATIGRAPHY

General Statement

All the rocks exposed within Grande Cache map-area are sedimentary in origin and range in age from Jurassic to Upper Cretaceous. Both continental and marine facies are represented in an exposed aggregate section approximately 9,300 feet thick. The strata have been folded and thrust faulted in a northwesterly direction.

Bedrock is well exposed throughout most of the area, particularly in canyons and streams or along the many steep cliffs.

Table of Formations

Period or epoch	Formation or group, and approximate thickness in feet	Faunal zones	Lithology
Pleistocene and Recent			Till and gravel, largely confined to valleys and major streams
Upper Cretaceous	Kaskapau (Blackstone) 1,300 +	Dunveganoceras Zone	Dark grey shale and bands of ironstone concretions (marine)
	Dunvegan 325 ±		Sandstone, shale, and thin coal seams (marine to non-marine)
?			
Lower Cretaceous	'Fort St. John' 450-500	Neogastroplites Zone	Dark grey shale and ironstone concretions (marine)
	Blairmore group: Luscar and Mountain Park 2,200 ±		Sandstone, siltstone shale, conglomerate, and coal (non-marine and brackish)
	Blairmore group: Cadomin 120 ±		Pebble- and cobble-conglomerate (non-marine)
	Nikanassin 4,000 ±		Quartzitic sandstone, sandstone, siltstone, and carbonaceous shale (non-marine and marine)
Jurassic	Fernie 1,000 +		Dark grey shale and siltstone; interbedded quartzitic sandstone (marine)

Jurassic

Fernie Group

The uppermost 1,000 feet of the Fernie group, the oldest rocks exposed in the area, are exposed along two of the major structures in the southwest quarter of the map-area, namely, the Knife Mountain anticline and the Mount Russell thrust fault. These strata are composed chiefly of dark grey shales, with minor dark grey siltstone and interbedded buff to grey weathering quartzitic sandstone. The latter beds are rarely more than a foot thick, and are confined to the upper 200 feet of the group.

The contact of the Fernie with the overlying Nikanassin formation is conformable and comparatively abrupt, being marked by a transition zone of sandstone and siltstone through a thickness of about 50 feet.

No fossils were found in the strata ascribed to the Fernie, and its identification rests solely on its stratigraphic position and lithology.

Lower Cretaceous

Nikanassin Formation

Nikanassin beds are well exposed over a large part of the map-area. Particularly good exposures, in one place a complete section, are to be found in the southwest corner of the area on the flank of the Knife Mountain anticline. The approximate thickness of 4,000 feet, which represents the greatest thickness yet determined for this formation, has been determined graphically. E. J. W. Irish (1951) estimates a maximum thickness of 1,000 feet for this formation in the adjoining Pierre Greys Lakes map-area. Presumably these beds thicken rapidly westerly across the Grande Cache area.

The Nikanassin formation comprises a series of thin- to thick-bedded, dark to light grey, buff weathering, fine- to medium-grained, well-cemented sandstones and quartzitic sandstones, interbedded with thin carbonaceous shales and siltstones. In the lower 2,500 feet or so of this formation, and through a gradational interval of about 500 feet in the upper part, the interbedded, thin carbonaceous shales, siltstones, and sandstones become progressively less significant constituents in the sequence. Elsewhere quartzitic sandstone beds become the dominant constituent; these are rarely more than 4 feet thick in the upper 1,500 feet or so of the assemblage, but individual massive beds lower in the section may be as much as 30 feet thick and probably average 10 to 15 feet. Crossbedding is a dominant characteristic of the beds in the upper part of the formation, but is virtually lacking in the lower part.

An indeterminate species of Aucella was collected at a locality about 1,000 feet below the upper contact of the formation.

The following section of the upper part of the Nikanassin formation was measured at the exposure of this formation at the core of the Sterne Creek anticline on the north bank of Smoky River:

Overlying beds, Cadomin formation

Thickness Feet	
0-11.0	Covered
11.0-14.0	Siltstone, dark grey, crumbly weathering
14.0-17.0	Sandstone, grey, fine-grained, in part carbonaceous, finely bedded
17.0-22.0	Siltstone, dark grey, crumbly weathering; interbedded with thinly bedded carbonaceous sandstone
22.0-27.0	Sandstone, brown, crossbedded, medium-grained, carbonaceous
27.0-39.0	Siltstone, grey, hard; with intercalated fine-grained sandstone beds

Thickness Feet	
39.0-65.6	Sandstone, buff, crossbedded, carbonaceous; with occasional interbedded silstone
65.6-121.2	Sandstone, grey to brown, crossbedded locally, interbedded with massive quartzitic sandstone beds ranging up to 3.5 feet in thickness
121.2-141.2	Siltstone and sandstone; dark grey, calcareous siltstone interbedded with fine-grained, tan-coloured, crossbedded sandstone containing much fragmentary plant remains
141.2-156.2	Siltstone, dark grey, hard; with minor, intercalated, light grey, fine-grained sandstone
156.2-171.7	Siltstone, dark grey, hard, containing large ironstone concretions and numerous plant remains
171.7-204.7	Sandstone and siltstone; grey, crossbedded sandstone interbedded with dark grey siltstone, each in beds approximately 1 foot thick.
204.7-208.1	Siltstone, dark grey, hard
208.1-222.7	Sandstone, grey, fine-grained, crossbedded, weathers buff, thinly bedded at top, becoming more thickly bedded towards base
222.7-225.3	Siltstone, dark grey, hard, carbonaceous
225.3-227.5	Sandstone, light grey to buff, minutely crossbedded, carbonaceous, very hard, massive
227.5-230.7	Siltstone, dark grey, crumbly weathering
230.7-233.5	Sandstone, grey, fine-grained, crossbedded, carbonaceous, buff weathering
233.5-236.5	Siltstone, dark grey
236.5-243.7	Sandstone, buff, thinly bedded, carbonaceous, buff weathering
243.7-261.7	Sandstone, dark grey, highly carbonaceous, thinly bedded, grading into siltstone
261.7-264.0	Sandstone, buff to grey, quartzitic, minutely crossbedded
264.0-271.0	Siltstone and sandstone; lenses of grey siltstone in crossbedded, fine-grained, buff sandstone containing carbonaceous fragments
271.0-275.9	Sandstone, dark grey, fine-grained, quartzitic, massive

Thickness Feet	
275.9-283.3	Sandstone, brown, fine-grained, minutely crossbedded, carbonaceous, thinly bedded, buff weathering
283.3-301.3	Siltstone, grey; containing lenaes of crossbedded, fine-grained, carbonaceous sandstone
301.3-302.0	Sandstone, dark grey, fine-grained, thinly bedded, carbonaceous, buff weathering
302.0-303.4	Sandstone, light brown, minutely crossbedded, quartzitic, carbonaceous, yellow to orange weathering
303.4-313.0	Siltstone, light to dark grey
313.0-313.5	Sandstone, dark grey, thinly bedded, crossbedded, carbonaceous
313.5-315.9	Siltstone, dark grey, crumbly weathering
315.9-316.4	Sandstone, light yellow, thinly bedded, crossbedded, carbonaceous
316.4-322.1	Siltstone, dark grey, crumbly weathering
322.1-330.4	Sandstone, light brown, fine-grained, minutely crossbedded, carbonaceous; minor interbeds of grey siltstone
330.4-365.4	Siltstone and sandstone; crumbly weathering dark grey siltstone interbedded with minutely crossbedded, fine-grained, carbonaceous, rusty weathering sandstone
365.4-368.4	Sandstone, dark grey, medium-grained, crossbedded, hard; siltstone partings
368.4-369.4	Sandstone, light brown, fine-grained, crossbedded, carbonaceous
369.4-384.0	Sandstone, dark grey, medium-grained, crossbedded, quartzitic
384.0-393.6	Sandstone, buff, fine-grained, quartzitic; minor siltstone interbeds; plant fragments
393.6-423.1	Siltstone and sandstone; intergrading and interfingering, dark grey siltstone and fine-grained, grey, carbonaceous sandstone
423.1-423.7	Sandstone, light brown, crossbedded, carbonaceous
423.7-474.7	Siltstone and sandstone, alternating in beds about 1 foot thick; sandstone, grey to buff, fine- to medium-grained; siltstone, dark grey and crumbly weathering, carbonaceous

Thickness Feet	
474.7-477.7	Sandstone, dark grey, grey weathering, fine-grained, hard, dense
477.7-492.7	Siltstone, dark grey, thinly bedded, hard; contains fragments of plants stems
492.7-494.2	Sandstone, grey, quartzitic; carbonaceous bedding planes
494.2-500.7	Sandstone, light brown, fine-grained, crossbedded, massive
500.7-521.5	Sandstone and siltstone alternating in beds about 1 foot thick; sandstone, light brown, fine-grained, crossbedded; siltstone, dark grey to grey, hard
512.5-532.0	Siltstone, black, arenaceous, fissile
532.0-533.0	Sandstone, light brown, medium-grained, crossbedded; carbonaceous bedding planes
533.0-542.0	Siltstone, dark grey, arenaceous, crumbly weathering
542.0-560.8	Sandstone and siltstone alternating in thin beds about 3 feet thick; sandstone, dark grey with carbonaceous fragments; siltstone, black, fissile, containing poorly preserved plant remains
560.8-574.4	Siltstone, black, hard, crumbly weathering; mumerous ironstone concretions
574.4-596.9	Siltstone, dark grey, hard, fissile; contains numerous thin beds of very fine-grained dark grey sandstone
596.9-607.7	Sandstone, dark grey, fine-grained, in thin and irregular beds
607.7-643.7	Siltstone, dark grey, arenaceous, hard; contains minor, fine-grained, carbonaceous sandstone
643.7-646.3	Sandstone, dark grey, fine-grained, thinly bedded, rusty weathering
646.3-669.3	Sandstone, dark grey, fine-grained, crossbedded, weathers brown
669.3-674.6	Siltstone, dark grey to grey, hard, arenaceous, thinly bedded
674.6-703.6	Sandstone, fine-grained, greyish brown, crossbedded, uniformly carbonaceous

Thickness Feet	
703.6-709.6	Siltstone, dark grey, fissile; grading into thinly bedded, grey, fine-grained sandstone
709.6-711.3	Sandstone, brown, thinly bedded, brown weathering; with carbonaceous bedding planes
711.3-731.6	Sandstone, dark brown, fine-grained, uniformly carbonaceous, thick to thin irregularly bedded, grey weathering; minor siltstone
731.6-778.6	Siltstone, dark grey, arenaceous, fissile, in beds 2 to 3 feet thick; intercalated sandstone beds a few inches thick; carbonaceous matter along the bedding planes
778.6-782.2	Sandstone, dark brown, carbonaceous, especially along bedding planes, thickly bedded, yellow weathering
782.2-827.7	Siltstone and sandstone interbedded in beds about 1 foot thick; sandstone, brown, uniformly carbonaceous, fine-grained, massive; worm burrows?
827.7-842.0	Sandstone, dark brown, fine-grained, carbonaceous
842.0-872.9	Siltstone and sandstone interbedded in beds about 1 foot thick; siltstone, black, fissile and arenaceous; sandstone, fine- to medium-grained, dark and carbonaceous, brown weathering; crossbedded sandstone beds occur as lenses
872.6-877.2	Sandstone, brown, fine-grained; massive carbonaceous matter concentrated along bedding planes
877.2-910.5	Sandstone, brown, fine-grained, crossbedded, weathering yellow into thin beds; carbonaceous matter along bedding planes; minor amounts of siltstone interbeds a few inches thick
910.5-919.0	Siltstone, dark grey, crumbly; with thin, yellow, carbonaceous, crossbedded sandstone interbeds
919.0-948.5	Sandstone, fine-grained, argillaceous, carbonaceous, crossbedded, yellow weathering; with interbeds of fissile siltstone about 5 feet thick
948.5-953.9	Siltstone, dark grey, fissile; contains minor streaks of sandstone
953.9-955.4	Sandstone, light brown, fine-grained, crossbedded
955.4-959.4	Sandstone and siltstone in alternating beds; sandstone, fine-grained, tan weathering, carbonaceous; siltstone, dark grey, fissile

Thickness Feet	
959.4-1,015.4	Sandstone, fine-grained, argillaceous, highly crossbedded; carbonaceous bedding planes; light brown to dark grey, thin siltstone interbeds
1,015.4-1,018.0	Siltstone and sandstone, carbonaceous; in alternate, equal beds about an inch thick
1,018.0-1,051.0	Sandstone, fine-grained, crossbedded, weathering yellowish brown; in some places with carbonaceous bedding planes; siltstone partings
1,051.0-1.109.0	Sandstone and siltstone; sandstone, dark brown, fine-grained, with carbonaceous bedding planes in beds about 1 foot thick; siltstone dark grey, crumbly, in beds of same thickness.
1,109.0-1,111.0	Siltstone, black; with minor sandstone partings
1,111.0-1,117.6	Sandstone, medium-grained, grey, massive, tan weathering
1,117.6-1,120.7	Sandstone, brown or black, fine-grained, massive, hard; with carbonaceous bedding planes
1,120.7-1,128.5	Sandstone, silty, crossbedded, light brown; carbonaceous bedding planes
1,128.5-1,163.5	Sandstone, dark grey, fine-grained, carbonaceous; massive to thin-bedded, hard, siltstone partings of little horizontal extent; ripple-marked
1,163.5-1,167.2	Siltstone, black, fissile, arenaceous; minor interbeds of dark sandstone
1,167.2-1,169.0	Sandstone, dark grey, fine-grained, hard with carbonaceous fragments
1,169.0-1,197.4	Sandstone, brown to dark grey, fine-grained, crossbedded; with many carbonaceous bedding planes; intercalated siltstone beds a few inches thick
1,197.4-1,199.0	Siltstone, sandstone, and shale, interbedded, dark grey
1,199.0-1,214.0	Sandstone, dark brown, fine-grained, crossbedded; with carbonaceous bedding planes; siltstone partings about 3 inches thick
1,214.0-1,214.8	Siltstone, arenaceous, dark grey to black, fissile

Thickness Feet	
1,214.8-1,225.8	Sandstone, dark brown, fine-grained, crossbedded; carbonaceous bedding planes; thinly bedded
1,225.8-1,226.6	Siltstone, arecaceous, dark grey to black, fissile
1,226.6-1,233.7	Sandstone, fine- to medium-grained, dark grey, crossbedded; with carbonaceous bedding planes
1,233.7-1,234.9	Siltstone, dark grey, arenaceous, fissile
1,234.9-1,241.7	Sandstone, fine-grained, dark brown, crossbedded; with carbonaceous bedding planes and fragments; some siltstone partings
1,241.7-1,242.6	Siltstone, arenaceous, dark grey, crossbedded
1,242.6-1,259.1	Sandstone, brown to grey, very fine-grained, crossbedded, massive, grey weathering
1,259.1-1,271.1	Covered interval
1,271.1-1,275.3	Sandstone, brown to grey, fine-grained, crossbedded; carbonaceous bedding planes
1,275.3-1,276.6	Siltstone, dark grey, fissile; with some black shale
1,276.6-1,280.0	Sandstone, grey, fine-grained, thin-bedded; carbonaceous bedding planes; brown weathering

Cadomin Formation

Outcrops of the Cadomin formation are numerous and well exposed in the area, and appear as long, sinuous bands paralleling the major structural features.

This formation consists of hard, massive conglomerate, which is extremely resistant to erosion and, in consequence, has a marked positive topographic expression. Where it outcrops it caps many of the high ridges in the area, and forms many persistent hogbacks, which are traceable along its entire outcrop length.

The pebbles in the conglomerate are well rounded, commonly ovoid or elliptical, and are closely packed; they consist chiefly of chert and quartzite in about equal proportions. The chert ranges in colour from black to green, red, milky white,

light yellow, and greyish white, the relative amounts of each varying from place to place. No rocks of igneous origin were observed. Cobbles up to 5 inches in diameter are not uncommon, but most of them average 3 to 4 inches. Chatter-marks were observed on some of the cobbles.

Beds and lenses of medium light grey, buff weathering sandstone occur locally interbedded with the conglomerate. In some places, notably where Smoky River crosses the Sterne Creek anticline, one such bed, 20 feet thick, is sufficiently persistent to divide the formation into two equal and separate conglomerate beds each about 60 feet thick.

The Cadomin formation averages about 120 feet in thickness, but a lateral variation is noticeable. In the west-central part of the map-area, where the headwaters of Adolphus Creek cross the southwest limb of the Sterne Creek anticline, a thickness of 221 feet was measured. This represents a maximum for the conglomerate in this area. There appears to be a tendency for the conglomerate to thicken from northeast to southwest.

The Cadomin overlies the Nikanassin formation with a pronounced disconformity. Cut and filled stream channels are common on the surface of the Nikanassin, and wherever the upper contact of the Nikanassin is exposed it is seen to be one of gentle relief, yet clearly eroded before the deposition of the Cadomin conglomerate.

Where Sulphur River transgresses the northwestern extension of Hayden Ridge and in the vicinity of the Cadomin slump-block south of Grande Cache Lake, there is evidence in the discordance in dip of the two formations to indicate that Nikanassin strata were deformed locally prior to the deposition of the Cadomin.

Luscar and Mountain Park Formations

It is uncertain whether the Luscar and Mountain Park formations are represented in toto in the Grande Cache area. At the type localities of these formations at Luscar and Mountain Park, Alberta, MacKay (1930) was able to distinguish the two formations and separate the upper 393 to 825 feet of hard, olive-green, brick-red weathering, non-coal-bearing beds of the Mountain Park from the underlying softer, more drab-coloured sandstones and shales of the Luscar formation, which contain coal seams of commercial thickness. To the south of the Mountain Park-Luscar areas, the Mountain Park formation apparently loses its ridge-forming character and becomes difficult to distinguish from the underlying Luscar beds. In 1927, MacKay (1929, p. 12) mapped part of the Brule area and extended the terms Cadomin and Luscar across Athabasca River. He was unable to recognize the Mountain Park formation, and expressed the belief that it thins out between Luscar and Brule.

Although no Mountain Park beds are discernible as such in the Grande Cache and neighbouring areas, it seems probable that the equivalent of this formation is represented, as in this area 325 feet of non-marine strata, in part olive-green sandstones, overlie the highest coal seam.

The Luscar and Mountain Park formations consist chiefly of light to dark grey and green, buff weathering, fine- to medium-grained sandstones interbedded with dark grey siltstone. Minor constituents include chert conglomerate, dark grey carbonaceous shales, dark grey shale, and coal seams. A persistent bed of unconsolidated light grey clay, possibly bentonite, 1 foot to 3 feet thick, occurs at the top of the sequence.

Some of the dark grey shale beds in the upper 800 feet of the sequence emit a strong, petroliferous odour when struck or broken, and bear some similarity to the overlying marine shales of Upper Cretaceous age. No fossils were found in these beds.

Luscar and Mountain Park strata underlie the largest part of the northwestern three-quarters of the map-area, and constitute the main ridge-forming beds. A complete section is well exposed below the Grande Mountain thrust facing Smoky River on Mount Hamell and where Roddy and Malcom Creeks transgress the Ambler Mountain anticline in the west-central part of the map-area.

Graphical measurements of the stratigraphic interval between the lower contact with the Cadomin formation and the overlying 'Fort St. John' group provide an estimate of 2,200 feet for the thickness of these formations.

The following section of the upper part of the Luscar-Mountain Park assemblage was measured at Goat Cliffs overlooking Smoky River:

Overlying beds, 'Fort St. John' shale

Thickness Feet	
0-1.4	Volcanic ash, light greenish grey to white, unconsolidated
1.4-3.4	Sandstone, grey, fine- to medium-grained; limonitic stains in upper part; carbonaceous fragments scattered throughout
3.4-4.3	Shale, grey, silty
4.3-7.3	Siltstone, grey; carbonaceous fragments scattered throughout
7.3-20.9	Siltstone or very fine-grained, well-cemented, hard, grey sandstone; some ironstone concretions; some grey, silty shale partings and bands
20.9-21.9	Shale, grey to dark grey, silty; contains carbonaceous fragments
21.9-22.7	Ironstone, grey
22.7-24.2	Shale, grey; fragments of carbonaceous material
24.2-26.2	Siltstone, grey; containing a large amount of iron carbonate and carbonaceous material

26.2-28.8	Shale, grey to dark grey, thinly bedded, fissile; contains carbonaceous material
28.8-33.9	Siltstone, grey, non-calcareous; carbonaceous fragments; some irregular, fine partings of grey, silty shale
33.9-38.4	Shale, grey, fissile, slightly calcareous; some fragments of carbonaceous material
38.4-39.6	Limestone, grey, massive, impure; contains fragments of carbonaceous material; may be highly calcareous siltstone; much veining with secondary calcite
39.6-42.4	Siltstone, shaly, grey; some fragments of carbonaceous material
42.4-43.8	Impure limestone or calcareous silstone, grey; some grains of carbonaceous material; some secondary calcite veins
43.8-46.6	Siltstone, brownish grey, calcareous; containing plant fragments; bands of dark grey shale, with ironstone concretions becoming more abundant towards the base
46.6-53.5	Siltstone, calcareous, grey, with dark grey shale finely and irregularly interbedded; plant fragments throughout
53.5-55.1	Shale, light to dark grey; in part, highly carbonaceous; ironstone concretions and bands; some parts silty; plant remains scattered throughout
55.1-55.7	Impure limestone or calcareous siltstone, grey; carbonaceous material and plant fragments
55.7-56.7	Shale, grey to dark grey; in part carbonaceous
56.7-57.5	Siltstone or impure limestone, as above
57.5-59.3	Shale, light grey to dark grey; in part highly carbonaceous
59.3-62.7	Siltstone or impure limestone, grey; some fine, irregular bands of dark grey shale
62.7-64.7	Shale, grey to dark grey, non-calcareous; carbonaceous fragments and some ironstone nodules
64.7-66.5	Siltstone or impure limestone, as above
66.5-69.1	Shale, grey to dark grey; in part carbonaceous; some ironstone bands and concretions
69.1-77.5	Siltstone or very fine-grained sandstone, grey, 'salt and pepper' appearance; calcareous cement; sandstone becoming coarser grained towards base; some fragments of carbonaceous material

77.5-79.5	Shale, grey to dark grey; contains fragments of carbonaceous material
79.5-81.5	Sandstone, grey, in part shaly; very fine- to fine-grained; containing considerable iron carbonate
81.5-83.9	Shale, dark grey; uppermost 6 inches highly carbonaceous; some ironstone bands and concretions
83.9-85.5	Siltstone or impure limestone, grey; small fragments of carbonaceous material
85.5-86.9	Shale, grey to dark grey; in part highly carbonaceous; contains ironstone bands and nodules
86.9-88.8	Siltstone or impure limestone, brownish grey; fine, irregular partings of dark grey silty shale
88.8-90.3	Shale, dark grey; in part, carbonaceous
90.3-91.9	Siltstone, grey, non-calcereous; containing fragments of carbonaceous material
91.9-93.7	Shale and siltstone, interbedded; shale, grey to dark grey; siltstone, light grey to grey
93.7-98.2	Shale, dark grey, highly carbonaceous; some bands of grey to dark grey calcareous silt containing plant fragments; shale is, in part, coaly
98.2-103.9	Outcrop obscured by slumping and talus
103.9-110.4	Shale and siltstone; shale is grey to dark grey, fissile, and contains carbonaceous fragments; siltstone is grey
110.4-117.9	Sandstone, very fine-grained, grey, 'salt and pepper'; contains carbonaceous fragments
117.9-121.9	Sandstone, grey to buff, fine- to medium-grained, 'salt and pepper'; carbonaceous fragments; some grey, silty bands; limonite stain; some white material that may be kaolinite
121.9-135.3	Shale, silty; carbonaceous fragments scattered throughout; grey to dark grey; ironstone bands and concretions
135.3-139.8	Sandstone, grey, fine-grained, 'salt and pepper'; calcareous cement; some limonitic spots; weathers buff to grey
139.8-147.5	Shale, grey to dark grey; in part, silty; containing fragments of plant remains, and ironstone bands and nodules
147.5-151.8	Sandstone, grey to buff; in part, shaly; 'salt and pepper', non-calcareous cement, platy; some banded, grey siltstone

151.8-152.8 Shale, grey to dark grey; finely interbedded with siltstone; nodules of ironstone

152.8-162.9 Sandstone, grey, fine-grained, 'salt and pepper'; carbonaceous fragments scattered throughout; a little of calcareous cement; some interbeds of grey shale and siltstone

162.9-189.6 Shale, grey to dark grey; carbonaceous fragments scattered throughout; bands of grey siltstone; ironstone bands and concretions

189.6-279.6 Sandstone, grey, 'salt and pepper', fine-grained; calcareous cement; becoming coarser grained towards the base; some thin bands of grey shale

279.6-281.6 Conglomerate, grey; pebbles of black chert and quartz up to ½ inch in diameter; matrix of medium- to coarse-grained sandstone containing much black chert

281.6-301.8 Sandstone, grey, 'salt and pepper'; with calcareous cement; some bands non-calcereous; veins of calcite; band of conglomerate at base 1.5 feet thick; pebbles of chert up to ¼ inch in diameter

301.8-305.4 Shale, light grey to dark grey, non-calcareous; carbonaceous fragments scattered throughout; in part silty

305.4-322.0 Shale, same as above except for ironstone concretions

322.0-322.7 Siltstone, grey, non-calcareous; carbonaceous grains scattered throughout

322.7-324.5 Coal, lignitic, with one band of grey, fissile, carbonaceous, non-calcareous shale 4 inches thick

324.5-327.0 Shale, silty, grey to dark grey

327.0-327.7 Siltstone, grey to dark grey; numerous ironstone nodules; limonitic stains

327.7-337.1 Shale and siltstone, interbedded; shale, grey and fissile; siltstone, dark grey; some limonitic stains in the siltstone

337.1-338.6 Sandstone, light grey to grey, fine- to medium-grained,'salt and pepper'; becoming silty in part; quartz grains subangular to subrounded; sandstone grades to siltstone at base

338.6-345.9 Shale, grey to dark grey, fissile; some ironstone concretions; some carbonaceous material; shale, silty; band of concretionary ironstone 1 inch thick at base

345.9-352.3 Sandstone, grey, medium-grained, hard, well cemented, 'salt and pepper'; traces of a green mineral; some limonitic stains between grains; grains subangular to subrounded; weathers buff to green; in part well banded; one band of dark grey shale

352.3-362.3 Shale, light grey to grey, fissile; some carbonaceous material scattered throughout

362.3-363.3 Sandstone, grey, fine-grained, 'salt and pepper'; in part silty, with partings of grey shale; grains subrounded; weathers buff to brown

363.3-380.3 Shale, grey, fissile; some carbonaceous fragments; in part silty; occasional ironstone band; some interbeds of grey siltstone at base

380.3-383.3 Sandstone, grey to light grey, fine-grained, 'salt and pepper'; trace of green mineral; limonitic stains between grains; non-calcareous cement; platy, weathers buff to brown; shaly partings near base

383.3-386.9 Shale and siltstone, interbedded; shale, light grey to grey, fissile, non-calcareous; some carbonaceous fragments scattered throughout; siltstone, grey; a few shaly partings; weathers green and buff; carbonaceous particles in siltstone; siltstone, in part, grades into fine-grained sandstone; nodules and bands of ironstone scattered throughout

386.9-388.4 Sandstone, light grey, 'salt and pepper', medium- to coarse-grained; quartz is subrounded; a few small grains of carbonaceous material; traces of pyrite; finely bedded, calcereous cement

388.4-389.9 Sandstone, grey to buff, 'salt and pepper', medium- to coarse-grained; limonitic stains; quartz grains subrounded; many grains of carbonaceous material; outcrop shows good joint system, with many joints filled with secondary calcite

389.9-391.6 Sandstone, grey,'salt and pepper; medium-grained; quartz grains subangular, with some frosting; limonite stains; calcareous, platy cement

391.6-392.8 Sandstone grey, medium-grained, 'salt and pepper'; calcereous cement; platy; some greenish grey shale interbeds

392.8-401.5 Shale, light to dark grey, finely bedded; interbedded with silt, carbonaceous fragments scattered throughout; some bands of grey siltstone; bands of coaly shale; numerous ironstone bands and concretions

401.5-404.6	Coal
404.6-409.6	Shale, dark grey, in part brownish, carbonaceous
409.6-413.2	Coal, black, bituminous; interbedded with some highly carbonaceous shale
413.2-415.9	Shale, dark grey, fissile; carbonaceous fragments scattered throughout
415.9-417.6	Coal
417.6-419.2	Siltstone, brownish grey, calcareous; carbonaceous fragments scattered throughout
419.2-421.6	Shale, grey to dark grey; in part silty; with carbonaceous specks
421.6-423.2	Siltstone, grey, non-calcareous; carbonaceous bands
423.2-426.2	Coal and interbedded carbonaceous shale
426.2-430.0	Siltstone, grey, calcareous; a little carbonaceous material interbedded with some dark grey shale
430.0-432.6	Carbonaceous shale and coal; shale, grey to dark grey
432.6-441.6	Shale, dark grey, carbonaceous
441.6-451.6	Siltstone, grey, calcareous; interbedded with some grey shale and grey carbonaceous shale; some carbonaceous fragments scattered throughout; ironstone concretions
451.6-454.6	Shale, grey, silty in part; ironstone bands and nodules; carbonaceous material scattered throughout
454.6-456.2	Coal
456.2-457.2	Carbonaceous shale and siltstone; shale, dark grey; siltstone, grey, hard; contains considerable carbonaceous material
457.2-461.2	Coal
461.2-462.7	Shale and sandstone; shale, grey to dark grey, fissile; sandstone, buff, fine-grained, well-cemented; both contain carbonaceous material
462.7-463.5	Coal
463.5-468.5	Shale, grey to dark grey, fissile; in part silty; thin ironstone bands and nodules; some fine interbeds of silt
468.5-469.3	Coal

469.3-474.1	Shale, grey to dark grey, fissile; considerable carbonaceous material; some thin bands of siltstone; some ironstone bands and nodules
474.1-480.1	Sandstone, light grey, 'salt and pepper'; calcareous cement; fine- to medium-grained; considerable carbonaceous material; parts of outcrop slumped
480.1-482.1	Siltstone and shale, interbedded; shale, grey to dark grey, with carbonaceous material; siltstone, grey; some ironstone concretions
482.1-484.8	Sandstone, grey, 'salt and pepper'; carbonaceous flakes scattered throughout; some calcareous cement
484.8-486.6	Shale, grey to dark grey, fissile, greenish
486.6-487.9	Sandstone, buff, 'salt and pepper', fine- to medium grained, thinly bedded; carbonaceous fragments scattered throughout; calcareous cement; ironstone concretions
487.9-489.2	Siltstone and shale, interbedded, grey to dark grey; carbonaceous particles scattered throughout; ironstone concretions
489.2-490.2	Sandstone, buff, fine-grained, 'salt and pepper'; carbonaceous material; calcareous cement
490.2-502.7	Shale, siltstone, and sandstone, interbedded; shale, grey to dark grey; contains carbonaceous fragments and ironstone concretions; siltstone, grey and contains carbonaceous fragments; sandstone grey to buff, very fine-grained, 'salt and pepper', well-cemented
502.7-504.7	Siltstone, grey, calcareous; carbonaceous flakes scattered throughout; some plant fragments; some calcite veins
504.7-512.7	Sandstone and shale irregularly and finely interbedded; sandstone, buff, 'salt and pepper'; calcareous cement; shale, grey to dark grey; some calcite veins
512.7-515.6	Siltstone and shale, interbedded; siltstone, grey, somewhat shaly, with fine flakes of carbonaceous materials; shale, grey to dark grey, fissile
515.6-526.3	Shale, grey to dark grey, very fissile; some bands of grey siltstone or very fine-grained sandstone; some ironstone bands and concretions
526.3-530.9	Sandstone, buff, very fine-grained; shaly partings; calcareous cement; interbedded with grey to dark grey shale; ironstone bands and concretions

530.9-536.8 Shale and siltstone, finely interbedded; shale, dark grey; siltstone, calcareous, grey; some grey shale; ironstone bands scattered throughout

536.8-544.6 Coal

544.6-545.5 Shale, dark grey, highly carbonaceous

545.5-546.5 Coal

546.5-552.5 Shale, grey and dark grey; numerous ironstone bands; dark grey shale, in part, highly carbonaceous

552.5-560.6 Coal

560.6-563.2 Shale, grey, fissile, in part dark grey; ironstone bands scattered throughout

563.2-570.6 Shale, grey to dark grey; finely interbedded grey to buff-grey sandstone; sandstone, very fine-grained; shale, silty; both contain carbonaceous fragments and plant remains; ironstone bands and concretions

570.6-571.6 Sandstone, grey, very fine- to fine-grained, 'salt and pepper'; many specks of carbonaceous material; calcareous cement

571.6-573.5 Shale, silty, grey; finely interbedded with the shale; carbonaceous fragments scattered throughout; a few beds of grey, fine-grained, 'salt and pepper' sandstone, with calcareous cement; ironstone bands and concretions

573.5-574.4 Sandstone, ash grey, quartzitic, fine-grained; quartz appears subangular; many flakes and grains of carbonaceous material; sandstone somewhat shaly

574.4-575.4 Sandstone, buff, fine-grained, 'salt and pepper'; much limonite staining between grains; some calcareous cement; calcite veins

575.4-580.3 Shale, grey to dark grey; in part silty; carbonaceous fragments scattered throughout

580.3-582.1 Siltstone, grey; carbonaceous fragments scattered throughout; ironstone concretions

582.1-583.1 Sandstone, grey, very fine-grained; calcareous cement; carbonaceous fragments; some ironstone concretions

583.1-584.9 Shale, grey to dark grey; interbedded with grey, shaly siltstone; cement contains considerable iron carbonate

584.9-587.8 Shale, grey to dark grey; interbedded with siltstone; siltstone, grey and shaly; shale, very fissile; contains fragments of carbonaceous material

587.8-590.8 Siltstone, grey, highly calcareous; fragments of carbonaceous material; contains iron carbonate; possibly an impure limestone

590.8-593.5 Shale, grey to dark grey; contains siltstone or limestone as above; carbonaceous material

593.5-594.9 Sandstone, fine-grained, 'salt and pepper'; contains carbonaceous material; calcareous cement

594.9-596.9 Shale, grey to dark grey; carbonaceous fragments; ironstone bands and concretions

596.9-601.3 Coal

601.3-605.3 Shale, grey; contains carbonaceous fragments; ironstone bands; more carbonaceous towards base

605.3-607.2 Coal

607.2-608.0 Siltstone, grey; interbedded with grey shale; carbonaceous fragments scattered throughout

608.0-608.8 Shale, dark grey to black, highly carbonaceous

608.8-609.6 Shale, grey, fissile; carbonaceous fragments; ironstone concretions

609.6-620.6 Coal

620.6-622.5 Siltstone, grey, shaly, sandy, soft

622.5-624.5 Sandstone, light grey, 'salt and pepper', fine-grained; in part, shaly; some interbeds of grey siltstone

624.5-672.1 Shale, grey to dark grey; fragments of carbonaceous material; some bands of grey siltstone containing carbonaceous material; some bands of fine-grained 'salt and pepper' sandstone; ironstone bands and concretions

672.1-676.2 Sandstone, light grey, 'salt and pepper', fine-grained; calcareous cement; some calcite veins

676.2-677.8 Sandstone, very shaly; interbedded with dark grey shale; poorly cemented

677.8-681.5 Sandstone, buff to grey, fine-grained, 'salt and pepper'; calcareous cemenh; some bands of grey siltstone

681.5-682.5 Shale, dark grey, fissile, carbonaceous

682.5-694.8 Shale, grey to dark grey; interbedded with grey siltstone; carbonaceous fragments scattered throughout; ironstone bands and concretions

694.8-702.0 Shale and siltstone, interbedded; siltstone, grey, somewhat sandy, calcareous; containing fragments of carbonaceous material; shale, grey, silty; containing carbonaceous fragments; becoming less silty towards base

702.0-711.5	Sandstone, grey, medium-grained, 'salt and pepper'; quartz grains subangular to subrounded; some stains between grains; calcareous cement; some limonitic thin beds of dark grey shale and grey siltstone; some calcite veins
711.5-721.4	Shale and siltstone, interbedded; shale, grey, fissile, and silty; in part sandy and containing carbonaceous fragments; siltstone, grey; some shaly partings and carbonaceous fragments; some bands of ironstone concretions
721.4-724.5	Coal
724.5-726.3	Shale, grey, in part brownish, carbonaceous
726.3-728.8	Coal
728.8-730.7	Shale, brownish grey; in part carbonaceous
730.7-732.5	Coal
732.5-734.2	Shale, brownish grey, carbonaceous
734.2-738.0	Coal
738.0-743.9	Shale, grey, silty; carbonaceous fragments; some bands of grey siltstone
743.9-745.9	Siltstone, grey, highly calcareous, possibly an impure limestone; carbonaceous fragments scattered throughout
745.9-821.9	Sandstone, grey, buff weathering, fine- to very fine-grained; some fine irregular partings of grey shale; calcareous cement; platy in part; becoming medium grained towards base
821.9-817.9	Shale, grey; some interbedded grey siltstone; both calcareous and containing carbonaceous material
817.9-846.6	Coal
846.6-849.6	Shale, grey; interbedded, grey siltstone; both calcareous; some carbonaceous fragments; calcite veins
849.6-855.1	Sandstone, brownish grey, very fine-grained; calcareous cement; carbonaceous fragments; shaly partings, becoming more silty and shaly at base; upper surface of sandstone covered with asymmetrical ripple-marks
855.1-857.7	Shale and siltstone, interbedded; shale, grey, somewhat calcareous; siltstone, brownish grey, calcareous; both contain carbonaceous fragments

857.7-862.0 Shale, grey, fissile; carbonaceous fragments; becoming more carbonaceous at base; some thin beds of brownish grey shale

862.0-862.6 Siltstone, grey to brownish grey, shaly, calcereous; carbonaceous fragments

862.6-864.2 Shale, grey to dark grey; band of lignitic coal 4 inches thick at base

864.2-866.6 Shale, silty, calcareous, grey; carbonaceous fragments

866.6-873.6 Sandstone, brownish grey, medium- to coarse-grained, 'salt and pepper'; quartz grains subangular to subrounded; calcareous cement; becoming more silty towards base; calcite veins

873.6-894.4 Shale and siltstone, interbedded; shale, grey to dark grey, calcareous; siltstone, grey, calcareous

894.4-908.2 Shale, grey to dark grey, slightly calcareous, carbonaceous; some ironstone concretions

908.2-910.2 Sandstone, grey to brownish grey, very fine-grained, shaly; ironstone concretions; some poorly preserved fossil fragments, including pelecypods

910.2-918.6 Shale, dark grey, fissile; in part carbonaceous and coaly

918.6-919.6 Sandstone, grey, 'salt and pepper', fine-grained, in part shaly; non-calcareous cement; carbonaceous fragments

919.6-958.8 Sandstone, brownish grey, fine-grained, 'salt and pepper'; a few irregular partings of grey shale; calcareous cement; some calcite veins

Numerous collections of fossil plants were obtained from the Luscar and Mountain Park formations, including the following:

Cladophlebis virginiensis forma acuta (Fontaine)

Coniopteris brevifolia (Fontaine)

Elatides dichsoniana Heer

Ptilophyllum speciosum (Heer)

Athrotaxites ungeri (Halle)

A non-marine or brackish water invertebrate fauna, collected 850 feet above the base of the Luscar formation on Franks Creek included the following forms:

Unio (Elliptio) ex. aff. blairmorensis Russell

(cf. also Unio (Elliptio) hamili McLearn, and

Unio (Elliptio) douglassi (Stanton)

cf. Goniobasis ? multicarinata Russell

? Viviparus sp. indet. (cf. Viviparus murraiensis

Russell)

? Unio ex gr. lacombi McLearn (cf. also Unio (Pleurobema)

dowlingi McLearn)

Lower Cretaceous (?)

'Fort St. John' Group

The 'Fort St. John' group of mainly dark grey shale and argillaceous shale, with a few interbeds of ironstone concretions, possesses a negative topographic expression. Many of the smaller streams follow its structure.

The aggregate thickness of these shaly strata appears to vary considerably, probably owing to the incompetent character of the beds and, in consequence, the faulting and folding to which they have been subjected. However, the overlying Dunvegan formation undergoes radical changes in thickness laterally, which may well contribute to the variability in thickness of the underlying shales in this area.

Several complete sections of the 'Fort St. John' are exposed in the Grande Cache area. On the Muskeg and in the canyon of Sulphur River, especially good exposures may be found. Between the right-angle bend in Sulphur River near the Indian village and its junction with Smoky River, five complete sections are exposed. Some of these are difficult to examine. The second section upstream from

the confluence of these rivers was measured and its thickness found to be 376 feet. This is believed to be a minimum, as graphic measurements elsewhere indicate an average of 450 to 500 feet for the area.

In general, the 'Fort St. John' group may be divided into four lithological units. These are manifest in the measured section on Sulphur River, the details of which are as follows.

Overlying beds - Dunvegan formation

Thickness Feet	
0-36	Shale, argillaceous shale, buff to grey weathering, dark grey, fissile, grading imperceptibly upward into siltstone
36-136	Shale, yellow-stained, dark grey, friable
136-379.5	Shale, argillaceous, rusty weathering, dark grey, hard, fissile; twelve ironstone concretionary bands or ellipsoidal layers occur between 260 and 379.5 feet
379.5-381	Conglomerate and shale; dark grey weathering; chert and quartzite pebbles in a fine-grained quartzitic groundmass, 1 foot thick, overlying a bed of dark grey fissile shale 0.5 foot thick

Base of 'Fort St. John' group

The lower contact with the Luscar and Mountain Park formations is abrupt, and is invariably marked by a thin bed of shale overlain by a bed of chert conglomerate 1 foot to 3 feet thick, the upper surface of which is marked by symmetrical ripple-marks averaging 2 feet from crest to crest and 0.7 foot in height from crest to trough. The upper contact with the Dunvegan is generally gradational, and where this is the case the contact is drawn at the first persistent sandstone bed.

In many places, the shales, and particularly the ironstone concretionary bands, emit a strong petroliferous odour when struck or broken.

Five-foot samples were taken from the measured section. These were washed and examined for microfossils. None was found. Fish scales are common in the formation at certain horizons. Fossils collected on Pearl Creek, a tributary of Sulphur River, 217 feet above the lower contact of the formation, include the following:

Neogastroplites ex gr. cornutus (Whiteaves)

Neogastroplites ex aff. cornutus (Whiteaves)

Neogastroplites sp. indet.

? Engenoceras (s. lato) sp. indet.

cf. Inoceramus sp. indet.

Gastropod, genus and species indeterminate

Barnacles (cf. Balanus sp. indet.)

Fish scales (in masses)

Fossil wood (in masses)

Concerning the age significance of this fauna, Jeletzky has made the following statement:

" . . . all the Neogastroplites forms of the Pearl Creek collection are morphologically distinct from any Neogastroplites species hitherto described. Nor are there any forms exactly like them in the Geological Survey fossil collections. They are also associated with certain ammonoid forms not known to occur together with the Neogastroplites species of the typical localities of this fauna in northeastern British Columbia, nor were any index species, such as Posidonomya nahwisi, of the Neogastroplites fauna, recognized in the Pearl Creek collections.

"The above circumstances make it impossible to assert a strict contemporaneity of the Pearl Creek Neogastroplites fauna

with the typical Neogastroplites fauna of northeastern British Columbia . . . The Pearl Creek fauna might indeed represent a new faunal sub-zone, or even a new zone, somewhat older or somewhat younger than the typical Neogastroplites fauna. Or it might be nothing else than a local, contemporary, faunal facies of the latter.

Dr. Jeletzky feels, however, "that the affinities of both faunas is sufficiently strong to make a material difference in age quite unlikely, which justifies the general correlation of the two, above-mentioned faunas.

Although a correlation between the 'Fort St. John' group in the Grande Cache and adjacent regions and the Fort St. John group of northeastern British Columbia is suggested by the discovery of the Pearl Creek fauna, it should be emphasized that the two groups are only partly correlative. These shales in the Grande Cache area can, at best, be only correlated with the upper strata of the Fort St. John group of British Columbia. More detailed stratigraphic mapping and fossil collecting will be necessary between this region and northeastern British Columbia before a more exact correlation can be established or a new formational name ascribed to these beds. Until then it is considered best to refer to these beds provisionally as the 'Fort St. John' group.

Upper Cretaceous

Dunvegan Formation

The Dunvegan formation in Grande Cache map-area lies conformably, and in most places gradationally, above the 'Fort St. John' shales. It consists of light grey to buff weathering, fine- to medium-grained, calcareous sandstones and quartzitic sandstones interbedded with dark grey siltstone and shales. Locally it carries coal seams less than 2 inches in thickness.

Lithologically, the Dunvegan beds greatly resemble strata in the Luscar and Mountain Park formations.

Because of the comparatively small thickness of the Dunvegan formation and its positive topographic expression, complete sections a re exposed in many places, particularly on the lower reaches of Sulphur River. Outcrops are widely distributed, occurring in characteristic narrow bands, whose distribution approximates closely that of the underlying 'Fort St. John' group.

Two complete sections of the Dunvegan formation, one where the 'Fort St. John' group was measured and another in the Syncline Hills, were 279 and 281 feet thick respectively. These are believed to represent a coincidence of minimum thicknesses as graphic measurements indicate an average thickness of 325 feet, and thicknesses up to 400 feet are not uncommon.

The following section of the Dunvegan formation on the north-facing escarpment of the Syncline Hills, which lie about a mile north of Grande Mountain, is roughly characteristic of the lithology of the formation throughout the map-area.

Overlying beds, Kaskapau formation

Thickness Feet	
0-8.6	Sandstone, grey, very fine-grained, shaly, quartzitic; numerous finely disseminated carbonaceous fragments throughout; becomes more shaly and silty towards base
8.6-9.9	Shale, grey, silty; some carbonaceous fragments
9.9-10.5	Siltstone, or very fine-grained sandstone, grey, hard; some calcareous and siliceous cement; shaly partings; some calcite veins; some carbonaceous fragments
10.5-40.0	Shale and siltstone, interbedded; shale, silty, contains carbonaceous fragments; siltstone, grey to brownish grey; contains carbonaceous fragments; ironstone bands and concretions

40.0-40.9	Sandstone, grey, fine-grained, quartzitic; some black chert; carbonaceous flakes scattered throughout
40.9-47.4	Sandstone, grey to buff, medium-grained, 'salt and pepper'; quartz grains subangular to subrounded; some limonitic stains between grains; calcareous cement; becoming fine grained and less carbonaceous towards the base
47.4-48.8	Shale, grey; specks of finely disseminated carbon scattered throughout; in part interbedded with grey siltstone; some ironstone nodules
48.8-49.3	Siltstone, brown; with irregular partings of dark grey shale; siltstone and shale, calcareous
49.3-49.7	Shale, grey, silty, slightly calcareous
49.7-50.3	Siltstone, grey, well-cemented, calcareous; fine fragments of carbonaceous material
50.3-53.0	Shale, grey to dark grey, fissile, non-calcareous; carbonaceous fragments scattered throughout; some thin beds of brownish grey siltstone up to 1 inch in thickness
53.0-56.4	Siltstone, brownish grey, irregularly interbedded with grey shale; calcareous cement; some nodules of ironstone, and bands of grey to dark grey, fissile, non-calcareous shale with siltstone; siltstone becoming more shaly and non-calcareous at base
56.4-60.0	Shale, grey to dark grey, fissile; in part, with brownish tinge
60.0-62.5	Siltstone and shale, interbedded; carbonaceous fragments scattered throughout; some bands of dark grey shale; some calcite veins; siltstone, grey, slightly calcareous to non-calcareous, with some shaly partings; shale, mainly non-calcareous, but becoming more calcareous towards base
62.5-66.5	Shale, grey to dark grey; in part with brownish tinge; carbonaceous fragments scattered throughout
66.5-68.3	Siltstone, brownish grey, calcareous; containing some carbonaceous fragments; some bands of grey shale; siltstone, sandy in part; some irregular partings of grey shale; becoming more shaly toward base
68.3-72.0	Shale, grey to dark grey; in part, highly carbonaceous fragments scattered throughout
72.0-72.8	Sandstone, grey, very fine-grained, 'salt and pepper', non-calcareous, well-cemented; some calcite veins; carbonaceous fragments

72.8-77.0	Sandstone, light buff to light grey, quartzitic; carbonaceous fragments scattered throughout; calcareous cement; some calcite veins; numerous shell fragments, including pelecypods
77.0-77.9	Shale, grey to dark grey, calcareous; carbonaceous fragments; some brownish grey siltstone bands
77.9-84.2	Siltstone, brownish grey, calcareous; some irregular partings of grey silty shale; calcite veins; 30 per cent of this section is shale
84.2-88.0	Siltstone, brownish grey, calcareous; partings of grey silty shale; shale composes 20 per cent of this section
88.0-89.1	Shale, grey, non-calcareous; in part silty; carbonaceous fragments scattered throughout
89.1-90.5	Coal
90.5-92.6	Siltstone, grey, hard, massive, weathers rusty on surface, non-calcareous; contains iron carbonate
92.6-142.7	Shale, grey, somewhat fissile; carbonaceous fragments; somewhat silty in part; some bands of grey to brownish grey siltstone, and some ironstone concretions
142.7-144.7	Sandstone, grey, very fine-grained, shaly; carbonaceous fragments
144.7-147.6	Shale, silty, grey; carbonaceous fragments
147.6-150.8	Sandstone, silty, very fine-grained, brownish grey; shaly in part; shaly partings
150.8-161.8	Shale and siltstone, interbedded, grey to brownish grey; carbonaceous fragments scattered throughout
161.8-169.5	Sandstone, brownish grey, massive, medium-grained, 'salt and pepper'; carbonaceous fragments scattered throughout; calcareous cement
169.5-171.6	Shale, silty, grey, finely interbedded with lighter grey silt
171.6-205.0	Sandstone, very fine-grained to fine-grained, grey, 'salt and pepper'; some medium-grained; some calcareous cement; ironstone concretions, casts of fossils, and carbonaceous fragments; some irregular partings of dark grey shale
205.0-231.4	Shale, grey to dark grey; some bands of grey siltstone; some ironstone concretions
231.4-241.7	Siltstone, brownish grey, interbedded with grey shale; carbonaceous fragments; ironstone concretions

241.7-242.7 Sandstone, very fine-grained, brownish grey; calcareous cement; some carbonaceous flakes

242.7-247.1 Shale, grey to dark grey, silty; ironstone concretions

247.1-257.4 Sandstone, brownish grey, fine- to very fine-grained; silty in part; numerous bands of grey shale

257.4-280.0 Shale, grey to dark grey; carbonaceous fragments; bands of grey siltstone

280.0-280.4 Sandstone, grey, very fine-grained, may be siltstone; calcareous cement; carbonaceous fragments

Underlying beds 'Fort St. John' group

The following fossils were collected from the Dunvegan formation in the Grande Cache area:

Unio (Elliptio) sulfuriensis McLearn

Inoceramus aff. concentricus Parkinson

Inoceramus cf. tenuis Mantell

Ostrea soleniscus Meek

Brachyodontes multilinigera Meek

Corbula cf. nematophora Meek

Melania ? sp.

Viviparus-like gastropods

Inoceramus dunveganensis McLearn

Inoceramus rutherfordi Warren

Exogyra ex gr. laeviuscula Roemer

Corbicula cf. durkeei Meek

Kaskapau (Blackstone) Formation[1]

The Kaskapau formation overlies the Dunvegan conformably and gradationally. It comprises the youngest beds outcropping in the Grande Cache area; consequently, no complete thickness can be given, but an estimated maximum for exposed beds in this area is 1,300 feet.

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[1] In the Pierre Greys Lakes map-area, Irish (1951)

applied the name "Blackstone" to the formation referred to as "Kaskapau" in the present report. The author's preference to the usage of Kaskapau in this region is explained as follows:

(1) McLearn (1919, p. 4C) assigned the name Kaskapau to the lower shale member of the Smoky River formation, which embraced all strata between the Dunvegan formation and Wapiti group and included a middle, Badheart sandstone and an upper (unnamed) shale member. Subsequent usage has elevated Kaskapau and Badheart to formational names, and the Smoky River, shortened to Smoky, is retained as a group name.

(2) Joseph Gleddie (1949, p. 522) reports that in the plains of the Peace River area the Cardium formation (now generally referred to as the Bighorn) is traceable into the Badheart. This established the stratigraphic equivalence of the Kaskapau formation of that area with the shales occupying a similar stratigraphic position in the Grande Cache area. Although the Bighorn formation does not outcrop in the latter area its presence has been established in the adjoining Pierre Greys Lakes area.

That the shales assigned to the Kaskapau in the Grande Cache area are not the stratigraphic equivalent of the beds referred to as Blackstone farther south is substantiated by the following:

(1) Mallock (1911, pp. 49-50), when mapping in the district of Bighorn River in west-central Alberta, proposed the name Bighorn for the sandstone unit equivalent to, yet thicker than, the Cardium. He named the shales below and above the Blackstone and Wapiabi formations respectively. The Blackstone rested upon the Blairmore. In recent years these terms have come into general use throughout the Foothills wherever the threefold division is manifest, the three formations together representing the Alberta group.

(2) Lang (1947, p. 26), while mapping the Brule area, was the first to observe the southernmost extension of the Dunvegan formation. This was a 20- foot bed of sandstone 400 feet above the Blairmore group, and apparently, it lensed out, before reaching Athabasca River, into what had been earlier regarded as the Blackstone formation. Later work to the north of the Brule area substantiated the presence of the Dunvegan formation and 'Fort St. John' group, which, with the Kaskapau, constituted a threefold division and the stratigraphic equivalent of the Blackstone formation of areas south of Athabasea River.

The formation is essentially a uniform succession of thinly bedded, dark grey marine shales, with interbedded bands of ironstone concretions. The shales weather easily and, consequently, the formation is generally expressed in the topography by broad valleys with gentle, commonly grass-covered slopes above the small canyons of streams and rivers. Good exposures are almost all confined to the valley of Sulphur River.

The Kaskapau outcrops in three principal localities: where Sulphur River transgresses three separate synclinal structures, in several synclines and along fault slices between Grande and Flood Mountains, and in the northeast corner of the map-area in the valley of Muskeg River.

A well-defined and generally persistent fossil zone occurs 115 to 125 feet above the Dunvegan-Kaskapau contact and bears the following:

Dunveganoceras albertense (Warren)

Inoceramus fragilis Hall and Meek

Inoceramus corpulentus McLearn

Inoceramus fragilis cf. var. prairiensis McLearn

Another fossil, ? Watinoceras sp. indet., was found in this formation at an indeterminate horizon.

Pleistocene and Recent

Effects of glaciation are everywhere in evidence in the Grande Cache area. Valleys of the major rivers have characteristic U-shaped valleys, and the valley of Smoky River presents ideal examples of truncated spurs. Glacial scouring and rounding are in evidence on the most exposed points, and glacial debris still remains in the deeper recesses along valley slopes and floors, into which the rivers and their tributaries continue to cut.

Remnants of two well-defined terraces, and possibly others, are to be found along the banks of Smoky and Sulphur Rivers. These are mantled by coarse gravels of variable thickness.

STRUCTURAL GEOLOGY

General

All pre-Pleistocene bedrock formations in the Grande Cache area have been subjected to deformation associated with the Laramide revolution and the creation of the Rocky Mountains. This orogeny has been dated by Russell (1951) as between Paleocene and Oligocene time.

The Grande Cache area lies within the Disturbed belt of the Alberta Foothills. Complex and in general close, collinear, asymmetrical, northwesterly trending folds, cut by high-angle strike thrusts, are the dominant structural features of the area. Although deformation of the rocks of the entire map-area may be regarded as moderately intense, there is little noticeable increase southwesterly across the area, as judged from increasing asymmetry, closeness of folding, or increase in the number of faults. However, the structurally highest region of the map-area lies in the south-central part, the only part in which beds of the Fernie group are exposed.

Folds

Folds in the map-area vary from small drag-folds to large structures several miles wide. Only a few of these major folds are continuous across the area. From southwest to northeast, these are: (1) the Knife Mountain anticline; (2) the Roddy Creek syncline; (3) the Ambler Mountain anticline; (4) the Sulphur River syncline; (5) the Sterne Creek anticline; and (6) the Susa Creek anticline.

The Knife Mountain anticline is a tight, symmetrical anticline transgressing the southwest corner of the map-area, and crossing the western border at Kvass Flats. Fernie shales are exposed along the entire length of the axis.

The Stearn Mountain anticline connects Stearn Mountain and Mount Mawdsley on opposite sides of Smoky River, and disappears northwestward under the Mount Russell thrust at the foot of that mountain. Nikanassin strata are exposed along the axis of this structure.

The Roddy Creek syncline and Ambler Mountain anticline are two minor folds that take origin and association with other complexly folded and faulted structures, arranged en echelon in the vicinity of the junction of Smoky and Sulphur Rivers. Both structures plunge out to the southeast. Northwesterly they cross the north-central border of the map-area. Kaskapau shales are exposed along the axis of the Roddy Creek syncline, and the Nikanassin is the oldest formation exposed along the crest of the Ambler Mountain anticline.

The Sulphur River syncline, the broadest and most obvious structure in the region, roughly divides the map-area into two equal halves. This syncline plunges gently to the southeast. Kaskapau shales, highly contorted and broken by numerous faults, are exposed along its axis.

The Sterne Creek anticline parallels and shares the northeastern, folded and faulted limb of the Sulphur River syncline. It is a continuation of the anticline of the same name that transgresses the adjoining Pierre Greys Lakes map-area on the east (Irish, 1951). Nikanassin strata are the oldest beds exposed along the crest of this structure. It plunges gently southeasterly.

The Susa Creek anticline is also a continuation of a structure named in, and crossing, the adjoining Pierre Greys Lakes area. The main axis plunges out in the northwest corner of the Grande Cache area, but the structure is continued by a re-entrant

anticline. Nikanassin strata are the oldest beds exposed along this structure. The Sterne and Susa Creek anticlines are separated by a zone of complex imbricate faults and minor folds, repeating, chiefly, 'Fort St. John', Dunvegan, and Kaskapau beds.

Faults

The major faults in the Grande Cache area are southwesterly dipping, northwesterly trending thrust or reverse faults. There is evidence that one of the fault planes has been folded, and all but two of the thrusts dip at angles considerably greater than 45 degrees. Release from horizontal stresses has also found manifestation in numerous, high-angle, northeasterly dipping, northwesterly trending thrust faults of generally less stratigraphic displacement than those that dip southwest. In general, the former have disrupted the southwest limbs of anticlines, whereas the latter displace the northeast limbs.

Three of the major thrusts outcrop continuously across the Grande Cache map-area. From southwest to northeast these are the Mount Russell, Grande Mountain, and Mason thrusts.

The Mount Russell thrust parallels the northwestern limb of the Knife Mountain anticline in the southwest corner of the map-area. The fault dips about 43 degrees southwest and thrusts Nikanassin and Fernie beds over Nikanassin and Blairmore strata. The stratigraphic displacement along this fault is about 7,000 feet, and represents a maximum for faults in the Grande Cache area.

The Grande Mountain thrust begins just beyond the east-central border of the map-area and parallels the southwestern flank of the Sterne Creek anticline, causing a repetition of all the strata exposed along that structure. The dip of this fault,

which is well exposed along the flank of Mount Hamell facing Smoky River, is approximately 56 degrees southwest. Stratigraphic displacement along it increases rapidly. to a maximun of 6,500 feet at Mount Hamell, where Nikanassin beds are thrust over the shales of the 'Fort St. John' group.

The Mason fault crosses the northeast corner of the map-area, paralleling the northeastern limb of the Susa Creek anticline. It is a northwesterly continuation of a fault by that name in the adjoining Pierre Greys Lakes map-area to the east. The folded nature of this fault is well exemplified to the north of Goat Cliffs, where fold axes may be traced continuously across Luscar and Mountain Park beds, which have been thrust over Upper Cretaceous strata.

ECONOMIC GEOLOGY

Coal

The Smoky River region has long been known to contain high-grade bituminous coal seams (McEvoy, 1925). Several workable coal seams occur in the Luscar formation in the Grande Cache area, but no seams more than 2 inches thick were seen in any of the other exposed rocks. There are five principal localities in which workable seams outcrop:

(1) Along the face of Goat Cliffs overlooking Smoky River in the north-central part of the map-area, the upper 908 feet of the Luscar and Mountain Park formations is exposed (See stratigraphic section, pp. 18-24). Within this section, between 327 and 846 feet below the upper contact, are eighteen seams of coal more than 1 foot thick; the two thickest seams measure 28.7 and 11 feet respectively.

(2) A 5-foot seam of coal is exposed in the valley of the Smoky along Hells Creek, which drains the southeastern slopes of Mount Hamell. This seam occurs about 50 feet above the conglomerate.

(3) Across the Smoky from Hells Creek and exposed in a creek joining Smoky River opposite Gustavs Flats, an 8-foot seam of coal is well exposed at an indeterminate horizon in the formation.

(4) Near the junction of Sulphur and Smoky Rivers, where the Sulphur meets the Cadomin formation to flow down the upper contact of this conglomerate to the Smoky, a 17-foot seam of coal is partly exposed, probably within 400 feet of the base of the Luscar formation.

(5) A 5½-foot seam of coal outcrops on the upper reaches of Sulphur River in the northeast corner of the map-area.

It is of interest to note that no coal seams more than 1 foot thick were seen in the Luscar and Mountain Park formations where Stearn and Roddy Creeks transgress the Ambler Mountain anticline, although there are four completely exposed sections of these formations. Nor has the coal seam that occurs 50 feet above the basal contact of the Luscar on Hells Creek been observed at any other locality in the area, in spite of good exposures at this horizon.

Oil and Gas

No wells have been drilled for oil and gas in the Grande Cache area. The failure of the Muskeg No. 1 well, which was drilled about 10 miles east of the area on a favourable surface structure at the eastern border of the Foothills, to reach production has tended to discourage, temporarily at least, further exploratory effort in this general region. The close folding and thrust faulting

that characterize the surface rocks of the Grande Cache area are generally considered unfavourable for drilling programs.

The Palaeozoic formations, considered the best source and reservoir rocks in Alberta, do not outcrop in this area and, consequently, could not be studied for their porosity or other features conducive to oil and gas accumulations.

None of the anticlinal structures in the map-area is free of the possibility of being underlain at depth by thrust faults. Consequently, surface mapping alone may not correctly delineate subsurface structures. Furthermore, complete data on closure of structures are lacking in most cases because many of these structures extend beyond the borders of the area mapped.

The "carbon-ratio" theory (Lahee, 1934), which assumes that the percentage of fixed carbon (in regions having undergone diastrophism) provides a qualitative index of the possibilities for the occurrence of oil and gas, lends little encouragement to exploration for petroleum in the Grande Cache area. This "theory" purports that regions yielding carbon ratios above 60 are unfavourable for petroleum exploration, and that, above 70, the possibilities are practically nil. Analyses of coal from Smoky, Muskeg, and Sheep Rivers (MacVicar, 1923, p. 50B) yield carbon ratios between 53.7 and 82.5, and average 72 for the entire area.

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