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SOME LOWER CRETACEOUS SECTIONS
ON PEACE RIVER BELOW THE MOUTH OF
SMOKY RIVER, ALBERTA

(Report, Plate, and Figure)

By

R. T. D. Wickenden



OTTAWA

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CONTENTS

	Page
Introduction	1
Acknowledgments	1
Previous work	1
General stratigraphy	2
Loon River formation	2
Peace River formation	4
Shaftesbury formation	7
Detailed stratigraphy	9
Section No. 1	9
Section No. 2	11
Section No. 3	14
Section No. 4	16
Section No. 5	19
Section No. 6	22
Section No. 7A	25
Section No. 7B	28
Section No. 8	28
Interpretation of stratigraphic record, and conclusions	31
Foraminifera	32
General statement	32
Description of species	34
Loon River formation and Basal member of Peace River formation	34
Middle Shale member of Peace River formation	43
Cadotte member of Peace River formation	45
References	47

Illustrations

Plates IA, IB. Illustrations of fossil foraminifera - In envelope	
Figure 1. A. Sketch map of area along Peace River,	
showing location of sections examined ..	" "
B. Graphic illustration of sections along	
Peace River	" "
C. Chart, showing distribution of	
foraminifera in Section No. 8,	
Peace River	" "

SOME LOWER CRETACEOUS SECTIONS ON PEACE RIVER
BELOW THE MOUTH OF SMOKY RIVER, ALBERTA

INTRODUCTION

During part of the field season of 1949, sections of Lower Cretaceous formations exposed along Peace River from below its junction with Smoky River to the great bend in tp. 93, rge. 20, W. 5th mer., were examined, and samples collected for microfossils. The formations include the lower part of the Shaftesbury formation, the Peace River formation, and the top of the Loon River formation. This report is intended to give details of some of the sections studied and correlation indicated by a preliminary study of the foraminifera collected.

Acknowledgments

Nick A. H. Semeluk, student assistant, gave valuable help in the field, and Frank Beauchamp rendered good service as guide and boatman. The writer also wishes to acknowledge the help and hospitality received from many of the residents of this part of Peace River Valley.

Previous Work

Reports published on previous work are based on exploratory or reconnaissance type of field work. In 1888, R. G. McConnell (1893)¹ conducted

¹ Dates in parentheses are those of references listed at end of report.

geological explorations on Peace and Athabasca Rivers. In his report, he named the Peace River sandstone and the Loon River formation, and briefly described some sections. In 1917, F. H. McLearn (1918) examined the geology along the Peace from the canyon to Fort Vermilion, a distance of about 650 miles, and in his report briefly described the Peace River and Loon River formations.

In 1931, L. S. Russell mapped the Sexsmith-Bison Lake area, and a preliminary map was published in 1943. Russell collected samples for microfossils from nearly all the Shaftesbury shale, and the results of the study of some of these samples are included in the present report.

GENERAL STRATIGRAPHY

The sections studied in 1949 include beds from the lower part of the Shaftesbury, all of the Peace River, and the upper part of the Loon River formations. With such a comparatively limited stratigraphic range, it seems best to give a résumé of the three formations and present the details in the sections studied between the town of Peace River and the great bend in tp. 93, rge. 20, W. 5th mer.

Loon River Formation

The Loon River formation is rather unsatisfactory to deal with because its limits have not been well defined. It is also possible that the formation is essentially the same as the Clearwater on Athabasca River. Apparently, McConnell applied the name to the beds he found exposed on the lower part of what he thought was Loon River, but which is actually the Wabiscaw of all recent maps. He also applied the name to beds below the "Peace River sandstone" and above the Devonian strata exposed on Peace River. The position of the base of the formation varies. The erosion surface on the Devonian formations appears to slope to the south, and although only 400 feet (McLearn, 1918, p. 15) or less of beds occur between the top of the Loon River formation and the Devonian near Fort Vermilion, wells drilled in the valley in tp. 85, rge. 20, W. 5th mer., passed through about 1,100 feet of beds above the erosion surface on the formations of Palaeozoic age (McLearn, 1918, pp. 15, 20). It seems obvious that the base of the formation in the south includes older beds than in the north, and until more detailed studies are made the lower contact of the Loon River should be considered undetermined in most of the region.

According to McConnell, the upper contact of the Loon River is transitional. He states (1893, p. 47) that this contact is exposed in the great bend about 15 miles upstream from the mouth of Battle River and disappears beneath the valley about 5 miles farther up the river. The top beds of the Loon River formation, according to him, are those that carry limestone concretions and occur below a sandy member. Section No. 8 in this report was studied about 3 miles above the great bend, and the principal beds carrying calcareous concretions are beneath a bluish grey sandy bed $2\frac{1}{2}$ to 3 feet thick. The writer has adopted the base of this bed as the contact between the Loon River and Peace River formations. Scattered concretions occur in higher beds, but they are not particularly significant. On

the whole the basal beds of the Peace River in the vicinity of Section No. 8 appear to represent a continuation of the sedimentation in Loon River time, and probably this part of the Peace River formation is more closely related to the underlying Loon River formation than to the overlying members of the Peace River. At localities farther south the lower part of the Peace River is more sandy and the relationship to the Loon River is not so obvious.

The exposed Loon River formation consists of dark grey clay or silty shales, with minor sandy zones. Although McConnell considered that the upper beds, as exposed in the great bend, did not reach the surface in outcrops much farther upstream, correlations of the sections studied during 1949 indicate that the zone accepted as representing the upper contact of the Loon River is exposed at localities along the valley as far upstream as sec. 25 or 36, tp. 85, rge. 21, W. 5th mer. (See Section No. 3, pp. 14-16, and Figure 1B).

Sand and silt beds replace some of the more clayey beds in exposures upstream from the great bend, but enough beds were traced from outcrop to outcrop to verify the correlations. The distribution of microfossils and macrofossils in the sections also bears out this conclusion.

Some thinning, from north to south, of the various strata that compose the upper part of the Loon River formation is probably due to a change of environment from marine to near shore or coastal plain.

McLearn (1918, p. 21) estimated that there might be 400 feet of Loon River lying on the Devonian in the northern part of the area. In the writer's opinion this might be as little as 250 to 300 feet. In any case, the shaly part at the top of the formation is probably no thicker than this. Such a thickness is comparable to that of the Clearwater formation, which is of much the same age, and occupies a similar stratigraphic position among the formations in Athabasca Valley. When more drilling is done and it is possible to trace beds from one region to the other by the correlation of wells, what now appears to be two formations may prove to be one.

As yet, the significance of the fossils found in the Loon River shales in the area is only partly understood. The fauna indicates the general position of the formation in the Cretaceous System and its correlation with the Clearwater formation. The following fossils were collected from the Loon River in 1949, and identified by F. H. McLearn:

Yoldia kissoumi McLearn

Nucula sp.

Pecten sp.

Nemodon mcconnelli ? McLearn

Lemuroceras ? sp.

Beudanticeras affine Whiteaves

Beudanticeras cf. glabrum Whiteaves

The range of these fossils cannot be determined with certainty from the small collections made, but it is interesting to note that Beudanticeras affine was not collected from beds above the Loon River whereas Beudanticeras cf. glabrum Whiteaves occurs in higher beds at some localities.

Foraminifera collected from various sections indicate that the range of some species is limited to beds below the top of the Loon River, but others extend into some of the clay and silt beds of the Basal member of the overlying Peace River formation.

The extension of part of the microfauna from the Loon River into the Peace River formation indicates the close age relationship of these contiguous beds, and suggests that possibly the Basal member of the Peace River formation should be grouped with the Loon River formation. The distribution of the foraminifera in these formations is shown in Figure 1C, and the species are briefly described later in the report.

Peace River Formation

The Peace River formation, as described by McConnell, included all the beds from the top of the Loon River to the base of the Shaftesbury (Fort St. John) formation. Study of exposed sections, during the 1949 field season, shows that it is composed of four members, which vary in thickness and composition as illustrated in the stratigraphic sections of Figure 1B. Except for the Cadotte member, the names used for these members in this report are descriptive rather than geographical. This was done in the hope that, when more extensive studies of the formations are made, suitable geographic names may be applied that will be useful over a wide area.

The oldest member of the Peace River formation comprises a variable succession of silt, shale, and sand overlain by 5 to 50 feet of massive

sandstone and sand. This part is referred to as the Basal member, and is mostly equivalent to McLearn's (1944a) Lower Sand. A black to dark grey marine shale 20 to 33 feet thick overlies the Basal member and is called the Middle Shale member in this report.

All sediments of the Peace River formation above the Middle Shale member were included in the Cadotte member by McLearn (1944a). The 1949 field work revealed that these beds comprised two members, the lower one of marine origin and the upper one of continental origin. As the marine member is the only one of these two exposed near the mouth of Cadotte River the name Cadotte will be restricted to this member in this report. In the northern part of the area examined, the Cadotte member consists of a sequence of shale and a little sandstone, but south of the mouth of the Cadotte these grade into massive sandstone and sand. The thickness of the member in the entire area investigated varies from 60 to 70 feet.

In the southern part of the area, from a short distance above Whitemud River to the town of Peace River, the Cadotte member is overlain by beds of continental origin consisting of sand, with silt and minor carbonaceous shales and coal in some localities. The continental beds thin out in the area between Whitemud River and Thirty Mile Island, and seem to attain a maximum thickness of nearly 80 feet in sec. 25 or 36, tp. 85, rge. 21, W. 5th mer., near where Section No. 3, Figure 1B, was measured. These beds are referred to as the Continental member of the Peace River formation in this report.

The continental beds form a wedge that may represent a disconformity at the contact of the Peace River and overlying Shaftesbury formations. Near the town of Peace River, the Shaftesbury beds at the contact are, in the writer's opinion, the equivalent of the basal beds of the Pelican formation in the Athabasca section. About 30 miles downstream, foraminifera found in the Shaftesbury at the contact are interpreted as representing a zone equivalent to the middle of the Joli Fou formation of the Athabasca section. In the sections near the mouth of the Cadotte and farther downstream, the base of the Shaftesbury formation appears to be the equivalent of beds near the base of the Joli Fou along Athabasca River just above the Haplophragmoides gigas zone. Thus, the contact of the Peace River formation and the Shaftesbury is disconformable. The areal extent of the disconformity is not known, but it may

represent a local condition only. Another disconformity may occur at the contact of the Cadotte and Continental members in the upper part of the Peace River formation. The difference in, and extent of, these two groups of beds point to a time break, but the conditions under which the upper beds were deposited have resulted in a blending of the sediments for a few feet so that the disconformity is not obvious.

Fossils and samples for microfossils were collected from the members of the Peace River formation at several localities. The shaly, silty-sandy zone of the Basal member of the Peace River formation includes beds that show crushed specimens of ammonites and pelecypods, but it is almost impossible to obtain identifiable specimens except in a few concretions. Fossils are scarce in the overlying sandstone, and very few recognizable species were collected.

The following fossils were identified by F. H. McLearn from the Basal member, from the 1949 collections:

Oxytoma canselli McLearn

Tancredia ? sp.

Pecten sp.

Yoldia sp.

Nucula athabaskensis McLearn

Beudanticeras cf. glabrum Whiteaves

Microfossils were also obtained from this part of the section, and their distribution is illustrated with the description of these fossils later in this report.

The macrofossils and microfossils of the Basal member are more closely related to those of the underlying Loon River formation than to the overlying shale and sandstone members of the Peace River. The fossils are more common in the northern part of the area examined, and it is possible that conditions were less favourable for marine life in the south.

No macrofossils were collected from the Middle Shale member of the Peace River formation. Foraminifera were found in samples, and these include a fairly distinctive species of Haplophragmoides and a Gaudryina that appears to have developed from the Verneuilina that is fairly common in beds of the Loon River formation.

The shaly facies of the Cadotte member carries the Gastrolites fauna,

and the following fossils were identified by F. H. McLearn:

Comptonia ? sp.

Trigonia albertensis McLearn

Trigonia sp.

Dicranodonta dowlingi ? McLearn

Gastrolites sp.

These fossils are all typical of the Gastrolites zone as discussed by McLearn (1944a, p. 10). Although this fauna was found only in the more shaly facies of the Cadotte member, in the vicinity of Cadotte River and other localities downstream, it is probable that it may eventually be found in the sand facies farther upstream. One fragment of rock containing fossils that resembled the Gastrolites fauna was observed among the boulders on the bank about a mile above Whitemud River.

The microfossils are nearly all foraminifera. These were obtained from samples collected from the localities near and below Cadotte River. The sandstone of the outcrops above Whitemud River is well cemented and too hard to yield specimens of microfossils. The microfauna consist mostly of Haplophragmoides and Ammobaculites, and are described later in this report.

Fragments of plant fossils occur at several localities, especially in the Continental member of the upper part of the Peace River formation, but no identifiable specimens were found.

Shaftesbury Formation

Only a few feet of the Shaftesbury formation was found in place immediately above the Peace River formation at the localities collected. The shale of this part of the formation has a tendency to slump, so that measurements of it are unreliable. In 1932, L. S. Russell collected samples for microfossils, and these have been used in some measure to help determine the correlation of this part of the section.

At most localities the lower part of the Shaftesbury is a dark grey to black, friable or platy weathering shale, with some thin sandy beds and occasional pebble zones. Some concretions usually occur near the base.

Study of the microfossils indicates a general correlation of the lower part of the Shaftesbury with part of the Joli Fou, Pelican, and overlying

'Colorado' shale of Athabasca River. The beds at the contact vary somewhat in age; those that overlie the Peace River formation appear to be older at the northern localities than farther south.

At a locality on Peace River almost opposite the mouth of Smoky River, a few microfossils were obtained from the Shaftesbury just above its contact with the Continental member of the Peace River formation. One specimen resembles Ammobaculites sp. A found in the beds immediately below the Pelican formation on Athabasca River (Wickenden, 1949, pp. 19, 21). Samples collected by Russell from beds about 60 feet above the contact near this locality contained a small microfauna that included the same species as those in a fauna occurring just above the Pelican formation on Athabasca River. The fauna on Peace River occurs through about 100 feet of beds, whereas on the Athabasca it was found in only about 20 feet of beds. If this correlation is correct, the beds at the base of the Shaftesbury in this locality are the equivalent of the Pelican or the top of the Joli Fou. About 30 miles below the town of Peace River, foraminifera in samples from the base of the Shaftesbury resemble some in the middle part of the Joli Fou, and still farther downstream, in sec. 13, tp. 91, rge. 21, W. 5th mer., the foraminifera from the basal Shaftesbury belong to species found near the base of the Joli Fou on Athabasca River. The Haplophragmoides gigas fauna was not found in any of the samples collected.

These suggested correlations indicate a revision of the relationship of some members of Cretaceous formations on northeast Athabasca River and on Peace River from those shown by McLearn's study of Lower Cretaceous formations (1944a, Figure 2). The revised correlations would place the beds on Athabasca River, from the base of the Joli Fou to somewhere in the non-calcareous shales 150 feet or so above the Pelican, as the equivalent of the Shaftesbury. According to Russell (personal communication), the samples collected by him from opposite the mouth of Smoky River come from beds more than 150 feet below the Dunvegan formation. It is evident, therefore, that the Pelican occupies a position well below the Dunvegan. No new evidence was found to indicate whether the Shaftesbury is of Upper or Lower Cretaceous age; this problem must still be considered unsettled, as indicated by McLearn (1944a, Figure 2).

DETAILED STRATIGRAPHY

The stratigraphic sections that follow are arranged in order from south to north. As it is not always possible to foretell what may be of importance for correlation, the descriptions are given in considerable detail with the hope that significant features will all be included. Some of the components of each section, and the relationship of each section to the one that follows, are discussed at the end of each measured section. The general comparison of, and the relative distance between, the sections are illustrated in Figure 1B.

Section No. 1

The following section was measured on the west bank of Peace River, about $2\frac{1}{2}$ miles upstream from the town of Peace River, just north of the mouth of a creek in SW. $\frac{1}{2}$ sec. 19, tp. 83, rge. 21, W. 5th mer.

Description	Thickness in feet
<u>Shaftesbury Formation</u>	
River alluvium and slumped shale	2-3
Shale, dark grey to black, clayey; some ochreous encrustation; few fish scales, small yellowish weathered layer, possibly bentonite, near top; few foraminifera, not specifically identified	3.5
Bentonite, light cream, buff weathering	0.13
Shale, dark grey to black, clayey; some thin streaky beds of light grey silt; some yellow, ochreous encrustation; a few fish scales	7.0
Bentonite, weathered yellow to buff	0.1-0.2
Shale, dark grey, clayey; a few light grey streaks; some yellowish, ochreous encrustation	0.5
Bentonite, weathered yellowish	0.25
Shale, dark grey, clayey; silt at base; some lenses of rusty concretions about 4 inches thick in lower part of beds	1.66
Cone-in-cone concretion, brown	0.3-0.5
Shale, clayey, and silt, weathered brown, very rusty; some hard concretionary layers near top	1.1
Shale, dark grey; some light grey silty streaks	0.5
Sandstone and silty shale, grey, weathers rusty; with much selenite; some zones with a few small chert pebbles; a few fish scales ...	0.75
Shale, dark grey, blocky when wet; base silty, with a few sand grains and top 2 feet includes streaks of light grey sand and silt; some foraminifera	4.25

Description	Thickness in feet
<u>Peace River Formation</u>	
Continental Member	
Sandstone, light grey, medium grain, crossbedded	11.66
Sand, medium to light grey; with some thin, carbonaceous lenses or beds	3.75
Silt, dark grey, carbonaceous; with some light grey streaks; lies like an unconformable bed on top of lower cross- bedded sand; grades into overlying sand	2.75
Sand, light grey, medium- and coarse-grained; some beds of carbonaceous sand 1 inch to 8 inches thick; all crossbedded, with crossbeds extending across whole member at angles as high as 20 degrees	14.5

The base of the section was at water level during fairly high water; its elevation is assumed as approximately 1,025 feet. This places the contact of the Peace River and Shaftesbury at about 1,057 feet above sea-level.

The foraminifera are not numerous enough to warrant positive correlations. The species of Ammobaculites found in the base of the Shaftesbury resembles the species mentioned as Ammobaculites sp. A from the top of the Joli Fou formation on Athabasca River (Wickenden, 1949, pp. 19, 21). This species seemed to be confined to this zone on the Athabasca, and its occurrence at this locality on Peace River suggests that the contact of the Peace River and Shaftesbury formations occurs at an horizon equivalent to the top of the Joli Fou.

The foraminifera found near the top of Section No. 1 included a species of Haplophragmoides that is fairly small, white, partly evolute, with fine-grained walls and 9 chambers in the last-formed whorl; an Ammobaculites that is small, round in cross-section, with 4 to 5 chambers in the coiled part and in the rectilinear part; and a very small species of Verneuilina, all specimens of which were crushed nearly flat. These species resemble some found in some of the beds above the Pelican formation on Athabasca River.

A short distance from Section No. 1, L. S. Russell collected samples from exposures occurring upstream on the nearby creek. The sections measured by him are probably not more than 20 feet stratigraphically above Section No. 1, and the foraminifera in them represent the same species as those found in the

beds overlying the Pelican on Athabasca River.

It is probable that most of the Joli Fou equivalent is missing at this locality, and that the Pelican is represented by stringers of sand and sandy shale, unless some of the section that is covered includes sandy beds. It should be remembered that this suggested correlation is considered to apply only to the vicinity of Section No. 1, and that the contact between the Shaftesbury and Peace River at other localities brings other beds in contact.

The part of the Peace River formation exposed in Section No. 1 includes only some of the beds belonging to the uppermost, Continental member, and no indications of the underlying massive marine sandstones of the Cadotte member. The fairly steep, crossbedded section indicates rapid deposition in a stream, or fore-set beds of a delta.

Although some of the finer grained sediments contain carbon, no identifiable plant fossils were found.

2.0

Section No. 2

On the west side of Peace River, about 100 yards south of a small creek about 10 miles below the town of Peace River, in NE. $\frac{1}{4}$ sec. 4, tp. 84, rge. 21, W. 5th mer., the following section was measured:

Description	Thickness in feet
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Shaftesbury Formation

Shale, dark grey, slumped; lower few inches may be in place ..	0-5
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Peace River Formation

Continental Member

Sandstone, buff-grey mottled with yellow, fairly massive, weathers with many irregular hollows, medium grain	14.5-15.5
Sandstone, light grey to white, with some small carbonaceous streaks; varies from fine- to very coarse-grained, poorly sorted; some crossbedding	11.5-12.5
Coal, lignitic, fairly pure; some yellowish streaks of melanterite and some selenite in weathered zones	1.5
Silt and sand, black to dark grey, carbonaceous; some thin beds of light grey sand; some yellow staining in weathered zones	0.8

Sand, brown, with some black streaks and some yellow-stained zones along joints; some vertical streaks or zones of carbon resembling fossil roots	3.5
Sand, black and white; black beds carbonaceous, including some that are almost all coal	2.2
Sandstone, black and brown, with some yellow weathering, hard; ferruginous cement	0.1
Sand, grey to black, with some brown streaks; partly carbonaceous	2.0
Sandstone, light grey to white, with a few streaks of carbon; poorly sorted, fine to coarse grains; some small pebbles; much crossbedding	15.5
Sand, silty, carbonaceous in part, varying from brown to black; some streaks or thin lenses of shale	0.66
Sand, light grey to buff; coarse grains; a few carbonaceous stringers	0.6
Sand, light grey, fine-grained	2.6
Sand and silt, carbonaceous, dark grey; with some stringers or streaks of white, non-carbonaceous sand; some thin partings of black shale	0.25
Sand, light grey, fine-grained.....	0.5
Sand, silty, black, carbonaceous	0.2
Sand, light grey, fine-grained	0.66
Sand, dark grey, carbonaceous	0.25
Sandstone, light to medium to dark, massive, mostly well cemented; lenses of brown weathering concretions resembling sandstone 3 to 6 feet thick and up to 10 or more feet long; some glauconite, especially in cemented zones	47.0
Total measured thickness of Peace River formation	105.12

The base of Section No. 2 is about 75 feet above river level, the beds in this interval being covered with talus, mostly composed of blocks of massive sandstone of the Cadotte member. The lowest beds exposed here are believed to be not more than 25 feet above the base of the Cadotte, and it is probable that erosion of the underlying shale and soft unconsolidated sand has undermined the massive sandstone beds and caused the talus to form.

Samples were taken of some of the shaly beds in the upper, Continental member of the Peace River formation in this section, but no microfossils were found.

The overlying Shaftesbury shale is exposed about 500 feet north of the

Peace River section on the side of Peace River Valley across the valley of a small tributary creek. There, the following series of beds was measured, and is represented in Section No. 2 of Figure 1B.

Description	Thickness in feet
<u>Shaftesbury Formation</u>	
Shale, slumped	10+
Shale, dark grey to black	5.9
Bentonite, light cream to grey	0.2
Concretion, brown, badly weathered, may be cone-in-cone	0.25
Shale, dark grey to black	0.66
Concretion band, cone-in-cone, badly weathered	0.3
Shale, dark grey to black; some fragments of fish fossils	2.6
Sand, medium to light grey, coarse; with chert and quartz pebbles up to $\frac{3}{8}$ inch	0.25
Shale, dark grey to black; blocky fragments; some fish bones and scales	0.25

Peace River Formation

Sandstones, light grey to white, similar to upper parts of previous section	25 +
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Samples for microfossils were collected, but only a few badly crushed specimens of Miliammina and Haplophragmoides were found. No detailed correlation could be established with the Shaftesbury in Section No. 1.

About $\frac{1}{2}$ mile west, on the north side of the valley of the small creek that joins Peace River at this locality, about 125 feet of the Shaftesbury formation are exposed. The base of this section occurs at an elevation 70 feet higher than the top of the Shaftesbury in Section No. 2. No attempt was made to make detailed correlations, although the exposure contains several bentonite and concretionary bands, some of which might aid correlation with other sections. The foraminifera that occur here are of the same species as those mentioned as occurring in samples collected by L. S. Russell from a locality near Section No. 1. It is probable, therefore, that the horizon of the Shaftesbury in contact with the Peace River formation near Section No. 2 is much the same as that at Section No. 1.

Between Section No. 2 and Section No. 3 the sides of the valley show

numerous exposures of the massive marine sandstone of the Cadotte member of the Peace River formation, but other parts of the formation are poorly exposed.

Section No. 3

Section No. 3 is exposed on the north side of a small tributary valley about 150 yards from the water's edge on the west side of Peace River in NE. $\frac{1}{4}$ sec. 25 or SE. $\frac{1}{4}$ sec. 26, tp. 85, rge. 21, W, 5th mer.

Description	Thickness in feet
Grass-covered soil, probably slumped glacial drift, and Shaftesbury shale	25+
<u>Peace River Formation</u>	
Continental Member	
Sandstone, light grey to white, silty, partly consolidated	5 +
Grass-covered slope	20-25
Sandstone, light grey, medium to fine grain	1.0+
Shale, dark grey, somewhat carbonaceous	2.5
Sand and sandstone, light grey to white	1.0
Grass-covered slope, with traces of sand or soft sandstone; a short distance west some alternating sand and carbonaceous shale occurs immediately above the massive sandstone	49.0
Cadotte Member	
Sandstone, light grey, massive, cliff-forming; top 10 to 15 feet fine-grained; little indication of bedding; few thin, crossbedded zones; some parts weather in rounded hollows; below this irregular zone much of the rock is stained rusty brown, and there are elongated concretionary zones of sandstone several feet thick in places; a piece of sandstone in talus showed pyrite nodules, and this may in part account for rusty staining; some rounded, tube- like weathered zones, possibly fossil roots	56.00
Sandstone, greenish grey, fairly massive but softer than above; with many beds of almost continuous concretions, ironstone in part, and mostly 4 to 8 inches thick; a few beds of dark grey shale up to 1 inch thick; much glauconite in some beds; a few coarsely arenaceous specimens of foraminifera	10.00
Sand and shale, greenish grey and dark grey in alternating thin beds; more shaly at base	1.5
Shale, dark, a few greenish stringers of sand	1.0
Middle Shale Member	
Concretion, very dense, hard, ironstone, elongate, almost continuous	0.3+
Shale, dark grey to black; some yellow ochreous deposits in weathered joints	1.00

Bentonite, light grey, somewhat yellow to greenish yellow	0.2
Shale, dark grey to black; few fine lenses of greenish sand; some yellowish ochre deposits in joints; some selenite; some foraminifera	16.00
Bentonite, yellowish grey	0.1
Shale, medium to dark grey, with a few partings and thin lenses of light grey silt; some foraminifera	14.00
Shale and sand grading into silt at base, dark grey and yellow to brown in alternating beds 2 to 4 inches thick	1.00
Basal Member	
Silt and sand, medium to light grey, weathered yellow to brown; silt in top 2½ feet in places; in others mostly sand; this layer is more than 5 feet thick in other parts of the exposure; some fragments of carbon from plant fossils	4.5
Silt, sand, and shale, greenish grey and dark grey, in alternating beds up to 4 inches thick	3.6
Sand, brownish grey, fine-grained, fairly massive; a little cement; some thin shale beds or lenses; a few concretions. This may be the equivalent of the main sandstone bed in the lower part of the Peace River formation at localities downstream	4.00
Silt and shale, medium and dark grey, in thin alternating beds up to 4 inches thick; beds near base a little sandy	3.25
Concretion, siltstone, medium grey, very hard	0.3-0.5
Sand, silt, and shale in alternating beds; sand and silt, medium to light grey, weathers yellowish; shale, medium to dark grey; sand and silt beds up to 4 or 5 inches thick; shale mostly thinner; a few fragments of carbon from fossil plants, and some fragments of fossil shells; a few foraminifera	17.75
Shale, dark grey; with a few thin beds of grey silt; some fragments of pelecypod shells; a few foraminifera	3.5
Sand, medium to light grey, weathers yellowish; with some thin beds of dark grey shale; sand is fine grained	1.25

Loon River Formation ?

Sand and sandstone, medium grey, weathers brownish yellow, fine- grained; some zones with very hard cement; a few fragments of carbonized plant fossils	2.75
Sand; with many lenses and thin beds of shale and silt; sand and silt medium grey; shale medium to dark grey; contact with above zone irregular, may vary a foot or more	4.00

Total thickness of section from top exposure of	227.7
Peace River formation.	

Section No. 3 exposes beds from all parts of the Peace River formation. The uppermost beds are believed to be within a few feet of the contact with the Shaftesbury, and the base of the section includes beds at the top of the Loon River formation. A short distance downstream, along the bank of Peace River,

large concretions are exposed, which resemble those noted elsewhere as occurring in the upper part of the Loon River formation.

The continental deposits overlying the Cadotte sand appear to be thicker here than at any other locality studied, whereas the sand and the associated shales and silts of the Basal member of the Peace River formation are thinner here than in any of the exposures farther downstream along Peace River Valley.

The sediments that comprise the Basal member of the Peace River formation in Section No. 3 contain more fragments of fossil plant carbon and fewer foraminifera and shells of pelecypods than equivalent beds do in other sections studied. These conditions may indicate a location near shore at the time of deposition.

Previous workers had not identified the Loon River formation at this locality. However, the writer has studied this formation in detail, and feels certain that several of its beds can be traced through. This conclusion is important in interpreting the geological results of drilling that was done near here between 1916 and 1924.

The Middle Shale member of the Peace River seems to be thicker here than at other localities where a complete section could be observed, though there is no indication of any change in the type of sediments. The thickness of the massive Cadotte sand is much the same as in other exposed sections. Between Sections No. 3 and No. 4 a few small exposures occur along the water's edge and on the sides of the valley, where cliffs formed of the marine sandstone in the Cadotte member of the Peace River formation occur at irregular intervals.

25. Section No. 4

The Basal member of the Peace River formation and part of the Loon River formation were studied in detail in Section No. 4. There the massive marine sandstone of the Cadotte member forms cliffs, with talus completely covering the bench formed by the lower part of this member and the underlying Middle Shale member. The section was measured beginning at contact of the Middle Shale and Basal members of the Peace River formation. The cliffs are topped with gravels of Pleistocene or post-Pleistocene age, and no indications of the upper Continental member or of the overlying Shaftesbury formation could be seen.

Section No. 4 is on the east side of Peace River near the north end of sec. 21, tp. 86, rge. 20, W. 5th mer.

Description	Thickness in feet
<u>Peace River Formation</u>	
Basal Member	
Silt, light grey, weathers greenish yellow, somewhat mottled	1.0
Sand, light grey, weathers yellowish, fine-grained, thin-bedded; a little crossbedding; partly cemented	20.0
Silt, shaly, medium grey; with some light grey lenses and very thin beds	0.6
Sand, medium grey, bluish, weathering yellowish brown, fine- to very fine-grained, angular to subrounded; a little glauconite.	4.0
Silt, shaly, medium grey, and sand, medium to light grey, fine-grained in alternating beds varying from 3 to 9 inches; a 2-inch siltstone concretion near base	3.25
Sand, medium to light grey, somewhat bluish, very fine-grained, silty in parts	2.66
Silt, shaly, medium grey to light grey; some lenticular grey ironstone concretions	0.5
Sand, medium grey; with many (about 40 per cent) thin beds of medium to dark grey, silty shale beds becoming more shaly in lowest 6 feet; some sand beds contain fragments of carbonized plants; some zones show much pyrite	21.5
Shale, clayey, dark grey, somewhat greenish; some iron-stain and ochreous deposits in joint fractures; a few ironstone concretions; a fairly large specimen of <u>Beudanticeras</u> sp., collected at this level as well as fragments of other ammonites and pelecypods	6.66
Sand, medium grey, somewhat greenish, fine-grained; many fossils at base, mostly indeterminate pelecypods and fragments of ammonites; some parts of sand well cemented into sandstone	1.66
<u>Loon River Formation</u>	
Silt, shaly; with some sand beds, mostly near the top and bottom; becomes more shaly and includes a very clayey bed at base; colour medium grey, streaked with light grey in sandy zones; many pelecypods, including <u>Yoldia</u> sp., in some beds; some sandy beds show carbonaceous partings; some sand beds near base are about 5 inches thick	16.66
Ironstone concretion, medium grey, weathers brown; no fossils noted ..	1.1
Sand, light to medium grey; with some irregular beds of dark to medium grey silt or shale 1 inch to 2 inches thick; some coaly streaks and some zones of well-cemented sand; some parts contain clay balls and ironstone balls resembling pebbles; some pelecypods and ammonites, including <u>Beudanticeras</u> sp.	4.2
Sand and silt, light greenish grey and medium grey, in alternating beds; top bed, silt, 10 inches thick; next bed, sand, 9 inches; remainder of beds mostly 4 to 6 inches or less thick; sand shows some carbonaceous partings	8.66

Sand, medium to light grey, somewhat greenish, fine-grained, thin-bedded; some beds well cemented; some carbonaceous partings; a few thin beds of medium grey silt or silty shale.	5.25
Concretion, sandy, ironstone, grey	1.2
Sand and silt in thin alternating beds, medium and dark grey; becomes shaly at base	5.0
Sandy silt or silty sand, greenish grey to yellowish; poorly bedded blocky fracture; some scattered carbon fragments ...	5.0
	<hr/>
Total thickness of measured section	98.9

The base of the section was at water level or a foot or so below when this level was several feet above low water for the summer. Apparently, the dip of the formations between Sections No. 3 and No. 4 amounts to about 8 feet per mile, or a total of 40 feet, using the base of the Middle Shale member as datum.

Section No. 4 is very similar to Section No. 3 except that the sand at the top of No. 4 is considerably thicker than in the other section, and fossil ammonites are more common in Section No. 4, at the site of which, apparently, conditions were more favourable for marine life.

The contact of the Loon River and Peace River formations is placed at the base of a thin sand bed that appears to correlate with the sand found above the Loon River at exposures downstream where McConnell designated the top of the formation. In Section No. 4, however, the beds assigned to the Loon River are much sandier than those described by McConnell.

Downstream from Section No. 4 are several exposures, which do not include enough beds to warrant detailed study but indicate the continuity of the Loon River and Peace River formations. One point of interest in this part of the valley is Tar Island, where a seepage of tar-like oil and some gas occurs in the river gravels. The correlations demonstrated by the present study indicate that the beds at river level at Tar Island would lie a short distance below the top of the Loon River, and that, if the river has not gouged a deep channel in the bedrock, the source of the gas and tar might be a sand bed in the Loon River formation. The dip being downstream, such a bed would be covered everywhere down dip except possibly at the localities examined farthest down the valley, where, however, the sands are replaced by shale. Other explanations for the occurrence of gas and tar might involve faulting, although no indication of faults

was observed in the exposures, or the erosion of the channel into bedrock to such a depth as to tap some of the sands below the Loon River. Such erosion of the valley would have to be to a depth of about 200 feet, and would result in a canyon-like development of the valley in bedrock. Under the circumstances the writer favours the first explanation for the occurrence of the gas and tar.

Section No. 5

Section No. 5 includes beds from the base of the Shaftesbury to the upper part of the Loon River formation. Although this can be considered as one section, the upper part of the Peace River formation was studied at a locality about $\frac{1}{2}$ mile north of where its middle and lower members and the top of the Loon River were measured; on this account the diagram (Figure 1B) indicates two adjacent sections.

The outcrops on which Section No. 5 is based are exposed in a bend of Peace River on the northeast side of the valley in NW. $\frac{1}{4}$ sec. 26 and NE. $\frac{1}{4}$ sec. 27, tp. 87, rge. 20, W. 5th mer. The upper part of the Peace River and the lower beds of the Shaftesbury formation were measured in section 27, and the lower part of the section was studied in section 26.

Section No. 5A

(Upper part of Section No. 5)

Description	Thickness in feet
<u>Shaftesbury Formation</u>	
Shale, dark grey; some hard bands; a few foraminifera	2-5
<u>Peace River Formation</u>	
Continental Member	
Sandstone, light grey, hard, massive	12-15
Sandstone, medium to light grey, brown, weathering soft; some thin beds of dark grey shale	5
Sandstone, light grey, soft, crumbly; with some thin beds of dark grey, carbonaceous shale or coal	22-25
Cadotte Member	
Sandstone, light grey to medium grey; lower part weathers rusty, with some irregular hollows; no indication of long elliptical	

concretionary zones in this part of No. 5A 67

Total thickness 113

The beds below this point are covered to the top of the Basal member.

Although traces of the Shaftesbury occur along the top of the cliff, this formation is mostly slumped for some distance back from the river. However, a fair section is exposed some distance back from the cliffs showing beds about 50 feet above the contact with the Peace River formation. This section was not measured.

The lowest part of the Cadotte member of the Peace River formation, as seen in Section 5A, is 10 feet or less above the contact with the Middle Shale member. Underlying beds to and including the upper part of the Loon River were measured as Section No. 5B.

Stratigraphic Section 5B

(Lower part of Section No. 5)

Description	Thickness in feet
Gravel, pre-Glacial or younger	20-30
<u>Peace River Formation</u>	
Cadotte Member	
Sandstone, light grey, massive, with occasional elongate sandstone concretions, fairly hard, fine-grained	10.00
Sand, medium grey, fairly soft; with some hard bands and some ironstone; many thin carbonaceous partings; thin-bedded; a few shaly beds; some glauconite in hard bands	1.00
Sandstone concretion, medium grey, very dense; glauconite	0.8
Sand, medium grey to light grey, somewhat greenish, very fine-grained; some glauconite; lower 6 inches somewhat shaly	2.2
Silty sand, medium grey, somewhat shaly; some lenses of coarser sand; becomes nearly all shale at base	1.25
Middle Shale Member	
Ironstone concretion, medium grey, very dense, amorphous	0.66
Shale, dark grey, blocky when fresh, weathers to thin chips; a few light grey streaks and some indication of thin beds; melanterite or ochreous deposits and selenite in joints; a few fish scales and bones	23.00
Shale, silt, and sand irregularly interbedded; shale, dark grey; sand, greenish grey; and silt, medium to light grey; top 6 inches partly cemented; lower foot contains much pyrite	3.66

Basal Member

Sand, light grey, weathers bright greenish yellow, somewhat mottled; fine grains, somewhat silty and clayey	5.00
Sand, light grey, weathers yellowish; some irregularly cemented zones; a few shells, a little glauconite in mostly fine grains ($\frac{1}{2}$ mile north this sand is 48 feet thick)	39.00
Sand, medium to light grey; with some beds of dark grey shale; shale beds vary from 2 to 5 inches in thickness, sand beds 1 inch to 2 inches thick; sand is fine grained, weathers brownish; shale somewhat silty; some ochreous material in fractures	4.5
Shale and silt, medium to dark grey; with some alternating thin sand beds; most beds 2 to 3 inches thick; some very sandy beds at 13, 15, and 23 feet in section; some flat ironstone concretions near top and at 6 feet down; a few carbonaceous partings; fragments of ammonites and pelecypods; rock has a tendency to splintery fractures, which affect most fossils; <u>Nucula athabaskensis</u> McLearn and <u>Yoldia</u> sp. collected near base of this member	33.25
Shale, clayey, dark to medium grey, somewhat mottled, splintery; some thin sandy lenses	4.33
Sand, medium to light grey, bluish, very fine grains; a little glauconite	3.00

Loon River Formation

Silt, shaly, medium grey, with a few light grey streaks, thin-bedded; a few thin beds of very fine-grained sand, becoming more numerous towards the base; some fragments of fossil shells	20.00
Sand, medium to light grey, somewhat bluish, weathers yellowish brown to brown, fine grain, subangular to rounded; a few shaly streaks; some thin partings, with carbon from plant fossils; some zones cemented into rounded masses resembling concretions and several feet across; some fossils, including ammonites and pelecypods ...	8.25
Concretion, ironstone, grading into cone-in-cone in places; fossils, including <u>Yoldia kissoumi</u> McLearn, <u>Nucula</u> sp., <u>Lemuroceras</u> ? sp., <u>Beudanticeras affine</u> Whiteaves, and <u>Beudanticeras</u> cf. <u>glabrum</u> Whiteaves.	1-2.5
Silt and shale, light grey and medium grey; some thin sand beds, light bluish grey	4.5
Silt, medium grey and light grey; a few pelecypods and many fragments of carbonized plants	3.5
Total bedrock thickness	175.00

There is only a slight but indeterminate overlap in Sections No. 5A and No. 5B. The base of the section is a few feet, possibly 20 feet, higher in the Loon River formation than the bottom of Section No. 4, indicating a slight dip in the formation towards Section No. 5.

The beds at the base of Section No. 5 are only about 30 feet lower in the section than the beds exposed in Section No. 3, and the total thickness of the Peace River formation at Section No. 5 is about 275 feet as compared with 220 feet in Section No. 3; the thickening of the formation occurs in the lower member. The Continental member, at the top of the Peace River, and the Middle Shale member are both thinner in Section No. 5 than in Section No. 3. The thickness of the sand at the top of the Basal member in an exposure about 3 miles northeast of, and downstream from, Section No. 5 was measured as 47 feet, the greatest thickness observed for this sand.

Samples from the lower part of the section were collected from the exposures 3 miles downstream, and the foraminifera were studied. These fossils show a similar faunal succession to those found at localities where McConnell (See Section No. 8) observed the Loon River formation, and verify the lithologic correlations indicated on Figure 1B for the various sections.

Between Thirty Mile Island and Cadotte River, where the next detailed section was made, marked changes take place in the composition of the Cadotte member of the Peace River formation. The overlying beds of the Continental member disappear, and the massive marine sandstones below grade into sands and shales. The upper beds pinch out somewhere above the mouth of Whitemud River, and in this vicinity the shale beds appear in the marine sandstone. Exposures are very poor for a mile or two above the Whitemud, and the transition was not observed. In the valley of the Whitemud, a short distance back from Peace River, cut banks expose all of the upper part of the Peace River formation and much of the lower part down to the upper part of the Loon River formation. There, the Cadotte member contains only 10 to 15 per cent shale beds and some sandstone and ironstone concretions. About 2 miles downstream, on the east side of the valley, the Cadotte consists of about 20 per cent shale and silt interlayered with beds of sand. No fossils were observed at these localities, although a short distance above the Whitemud a piece of float was found, which contained casts of pelecypods similar to those associated with Gastroplites at Section No. 6.

Section No. 6

The following section is exposed in NE. $\frac{1}{4}$ sec. 13, tp. 30, rge. 21, W. 5th mer., on the left bank of Peace River about $\frac{1}{4}$ mile upstream, and on the opposite side, from the mouth of Cadotte River.

Description	Thickness in feet
Glacial drift and slumped shale	10
<u>Shaftesbury Formation</u>	
Shale, dark grey to black; with melanterite and ochreous deposits in joint fractures	1.00
Bentonite, cream-coloured	0.1
Shale, dark grey to black; with melanterite and ochreous deposits in joint fractures	4.7
Silt, sand, and shale; brown weathering, partly cemented or concretionary bed containing many fragments of fossil fish ...	0.5
Shale, dark grey to black; some silt and sand lenses; fossiliferous revision of the lower part of the Peace River	3.00
<u>Peace River Formation</u>	
Cadotte Member	
Sand, medium to light grey, somewhat silty, fine-grained, cross- bedded; thickness somewhat variable	1.00+
Silt, sandy, medium grey, somewhat mottled light grey	2.50
Silt, sandy, medium grey; with some beds of medium to light grey sand or sandstone and dark grey shale; some concretions at irregular intervals	11.00
Concretion, sandy	1.00
Silt, medium grey; with some thin beds of sand and shale	8.00
Concretion, sandstone at top grading into ironstone at base; fossils collected here include <u>Pecten</u> cf. <u>alcesianus</u> McLearn, <u>Trigonia albertensis</u> McLearn, smooth pelecypods, <u>Gastrolites</u> sp., and <u>Comptonia?</u> sp.	2.00
Silt, sandy, medium grey; with some thin sand beds and a few clayey beds	3.00
Sandstone, concretion, medium to light grey, weathers yellowish brown	2.00
Silt, sandy, medium grey; with some thin beds of sand and a few shaly beds	15.00
Concretion, sandstone, medium to light grey; weathers yellowish brown	1.5
Sand and silt, with a little clay shale; sand, medium to light grey; silt, medium grey; and clay shale, dark grey; few sand beds near top 3 or 4 inches thick; most of rest of unit is irregularly bedded or in lenses; general appearance is medium grey; sand all fine grained	8.5
Sand, medium to light grey, weathers yellowish, thin-bedded; with some carbonaceous partings; very fine grained	2.00

Silt, dark grey to medium grey; with some lighter grey, sand beds up to 4 or 5 inches thick; several thin beds of dark grey clay shale containing melanterite or ochreous deposits 7.6

Middle Shale Member

Concretion, ironstone, medium grey, weathers reddish brown, very dense and hard 0.5

Shale, dark grey to black; a few thin light grey silt beds; some melanterite or ochreous deposits in joint fractures 19.25

Sand and shale, medium grey, partly cemented; some coal near the top; many fragments of fossil fish 0.5

Sand, silty, medium grey; much yellow melanterite or ochreous material in joints 1.3

Shale, silty, medium grey, with some light grey silt streaks; some zones with much yellow melanterite or ochre; many sandy beds in lower foot; somewhat splintery fracture 5.7

Basal Member

Sand, silty, mottled yellowish and grey; some shaly beds 7.5

Concretion bed, ironstone 0.3

Sand, medium to light grey, weathers brownish yellow; mostly massive, with a few thin-bedded zones; some large, rounded, cemented masses resembling concretions 21.00

Sand and shale, medium and dark grey, in thin alternating beds ... 0.5

Sand, medium to light grey, weathers yellowish and brown, in some places thin-bedded; some carbonaceous partings. 6.00

Silt, clay shale, and sand beds; silt and clay shale, medium to dark grey; sand, light grey; sand beds, 6 or 7 inches thick, especially in lower part of section 7.00

Sand, medium grey, fine-grained; some silt and shale beds near top and bottom; remainder mostly massive; occasional large ironstone concretions 10.5

Silt, shaly, and sand in alternating thin beds; silt, dark grey; sand, medium grey, very fine grains; some scattered ironstone concretions near middle of section 37.00

Covered to river level 13.00

Total thickness of exposed bedrock section 191.5

The base of this section is a short distance above the top of the Loon River formation. Some of the large concretions, such as those that occur in the sandy zones near the top of the Loon River at Section No. 5, were observed along the river bank a short distance downstream. It is apparent that the dip of the formations is nearly the same as the gradient of the river.

The thinning of the sands in the lower part of the Peace River formation is noticeable here as compared with the previous section. This

condition and the fact that glauconite and marine fossils are more common than in the sections to the south may indicate that the site of Section 6 was farther from shore and the influence of fresh water.

The occurrence in the Shaftesbury of a thin sandy bed containing numerous fragments of fossil fish was first noted here, and seems to be characteristic of these beds just above the Peace River contact at other exposures examined farther downstream. This may indicate that the contact is more nearly conformable in this part of the area.

Foraminifera were collected from the Cadotte member and the Middle Shale member at this locality. These indicate correlation with the same members elsewhere along the river, but no evidence was found for correlation with the beds on Athabasca River.

Below Cadotte River, the exposures are discontinuous and incomplete for about 15 miles. The dip exceeds the gradient of the river, so that the Loon River is below river level. The low point in the elevation of the beds seems to be about 10 to 12 miles downstream near sec. 27, tp. 90, rge. 27, W. 5th mer. The beds rise to the north again somewhere below this point to reach a high point in about SW. $\frac{1}{4}$ sec. 13, tp. 91, rge. 21, W. 5th mer. A short distance farther downstream the beds dip north again. The formations are well exposed on the east side of the river in the high part of the structure, and Sections No. 7A and No. 7B give the details of the beds at this locality.

Section No. 7A

On the east side of Peace River, in NW. $\frac{1}{4}$ sec. 13, tp. 91, rge. 21, W. 5th mer., the following section was measured:

Description	Thickness in feet
Silts and sand, Glacial or post-Glacial	6+

Shaftesbury Formation

Shale, dark grey to black, with much melanterite or ochreous deposit in joint fractures; very flaky on weathered surfaces ...	4.00
Silt, sand, and fragments of fossil fish, brown	1.2
Shale, dark grey to black, weathers flaky; some melanterite or ochreous deposits; some thin sand beds	0.1

Shale, dark grey to black; with some sand beds, light grey, 1 inch to 2 inches	2.00
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Peace River Formation

Cadotte Member

Sand, light grey, very fine grain, crossbedded; some lenses of black shale; 2½-inch ironstone concretion at base, and some irregular occurrences of ironstone higher in this unit	2.9
Shale, silty, medium to dark grey; with some beds and lenses of light grey sand.	7.7
Sand, medium to light grey, fine-grained	2.2
Shale, silty, medium grey	1.00
Sand, medium to light grey, fine-grained	2.3
Silt, shaly, medium grey; some thin sand beds and irregular lenses of ironstone concretions	6.00
Sand, medium to light grey, fine grain, partly cemented; some thin ironstone concretions, mostly at base; fossils occur in ironstone including <u>Trigonia</u> sp., <u>Dicranodonta dowlingi</u> ? McLearn, smooth pelecypods, and gastropods	5.00
Silt, medium grey; with many medium to light grey sand beds	5.00
Silt, shaly, medium to dark grey; with irregular beds of sand and some ironstone; some sand beds thicken from a few inches to 4 or 5 feet in less than 30 feet laterally; a fairly prominent ironstone bed about 3 inch s thick about 3 feet above base of this unit.	32.00
Silt, medium to dark grey; with some thin beds of dark grey to black shale and some light grey sand beds; some crushed fossils, including a thin-shelled <u>Inoceramus</u> type	10.00

Middle Shale Member

Concretion, ironstone, very dense, hard, amorphous	0.5
Shale, dark grey to black	2.0
Bentonite, cream to grey	0.4
Shale, dark grey to black	3.00

(The last 5 feet of section are from a soil augur-hole)

Covered (part of the Middle Shale member)	14.00
Shale, dark grey to black, with much melanterite or ochreous deposits in joint fractures	1.00
Clay shale, dark grey to black, and grey, brown weathering sandstone; interbedded in 1-inch to 2-inch beds; sand grain coarse to fine, angular; some glauconite	0.9

Basal Member

Sand, silty, mottled medium grey and greenish yellow, may be light grey in unweathered state; some clay; sand grains fine; some glauconite and some fragments of carbon; a few thin beds of dark grey shale near top	7.2
Sand, medium to light grey, weathers yellowish brown, medium- to fine-grained; some beds and lenses of dark grey shale	3.1
Sand, mottled grey and brownish yellow, fine-grained; some melanterite or ochreous zones; some rounded concretions; a specimen of <u>Beudanticeras</u> cf. <u>glabrum</u> Whiteaves	5.5
Sand and sandstone, medium to light grey, partly to well cemented in irregular lenses from 1 foot to 5 feet long; may be replaced to some extent laterally by sand and shale beds near base; some lenses and irregular inclusions of ironstone; some ripple-marks and crossbedding; a few irregular beds or lenses of dark grey shale; sand mostly fine grained; some zones with many fragments of fossil wood or plants; some fragments of ammonites and other shells; <u>Oxytoma camseli</u> McLearn collected here	3.9
Sand, medium to light grey, very fine-grained, thin-bedded; with some to many beds of dark grey shale; some thin ironstone concretions; contact with underlying shale and silt uneven; a few feet to one side, contact rises 2 to 3 feet.	4.5
Silt and clay shale, light and dark grey, interbedded in thin beds; 6-inch ironstone concretion band about 4 to 4½ feet down in section	6.5
Silt, shaly, medium and light grey, thin-bedded, splintery fracture, rusty coating on weathered surface; few clay shale beds; scattered lenticular ironstone concretions at about 6 feet down and near base, usually about 1 foot thick; a few fossil pelecypods below 10 feet.	15.00
Silt, shaly, medium grey; few clayey beds; some thin beds of light grey, very fine-grained sand; some lenticular concretions scattered near base	13.00
Sand, medium to light grey, in beds 5 to 10 inches thick, with some medium grey shaly silt between	3.7
Silt, shaly, medium and light grey; with some thin beds of light grey, fine-grained sand and a few beds of dark grey clay shale; some fragments of fossils	29.3

The base of the above section is 44 feet above river level. Section No. 7B was measured about ½ mile from No. 7A. The top of the exposure is partly covered, and the section commences approximately in beds equivalent to those at the base of Section No. 7A (72 feet below the 3.9-foot sandstone unit).

Section No. 7B

Description	Thickness in feet
Silt, shaly, medium and light grey, with a few sand beds up to 2 or 3 inches thick; some fragments of fossils, including pelecypods and ammonites	10.5
Clay shale, somewhat silty, dark grey, grades into overlying silt at top; many fragments of ammonites	5.00
Sand, medium to light grey, bluish, very fine-grained, silty; some ammonite fragments	3.9

Loon River Formation

Silt, shaly, medium grey, splintery fracture; some light grey sandy beds and lenses; fragments of ammonites	20.00
Slumped and covered to river level	13.00

The base of Section No. 7B is just above a concretionary sandstone bed that carries some ammonites. The lower part of the section was measured near the highest part of a small anticline. The beds are a little lower at Section No. 7A, and the northerly dip appears to continue for more than a mile downstream. The southerly dip could be observed for about a mile upstream, and probably accurate levels would have indicated an even greater extent to this structure.

The presence of ammonites in the sandstone and the greater abundance of fragments and crushed specimens of ammonites in all the Basal member of the Peace River formation indicate more extensive marine conditions in the north as compared with the more southerly described localities.

Downstream from Section No. 7 for nearly 18 miles the outcrops yield only limited exposures of the formations, and in many parts the valley sides are mantled with glacial drift or alluvium. The beds apparently dip north over much of this area, but a change in dip takes place a few miles above the great bend in tp. 93, rge. 20, W. 5th mer. There, beds rise gently again, and beds lower in the Loon River formation than any in the previous sections are exposed.

Section No. 8

At Section No. 8 the beds from the base of the Middle Shale member of the Peace River formation to about 74 feet in the Loon River are described.

The following section was measured on the southeast side of Peace River about $\frac{1}{3}$ mile below a sharp bend in SW. $\frac{1}{4}$ sec. 28, tp. 93, rge. 20, W. 5th mer.

Description	Thickness in feet
Glacial drift	10-15
<u>Peace River Formation</u>	
Base of Middle Shale Member	
Shale, dark grey to black; some melanterite or ochreous filling in joint fractures; top may be partly slumped	7.00
Sandstone and shale, medium grey and dark grey, in alternating beds about 1 inch thick; weathers brown	1.00
Basal Member	
Sand, mottled, yellowish and greenish grey; yellow colour partly due to melanterite or ochreous material; much clayey material...	5.00
Sandstone, weathers rusty brown, with ferruginous cement,	0.8
Sand and sandstone, medium to light grey, medium- to fine-grained, with irregularly cemented zones; a few fossils	4.00
Sand, medium grey, somewhat mottled, partly clayey; some fossils; pelecypods and ammonite fragments; one lens a coquina-like aggregate of pelecypod shells	5.25
Sandstone, medium to light grey, mostly well cemented; some fossils	3.8
Sand, mottled, yellowish and medium grey; yellow colour may be due to melanterite or ochreous material; somewhat clayey; some concretions of ironstone and sandstone 6 to 8 inches thick; pelecypods	2.25
Sand and shale in alternating beds, light and dark grey; some thin ironstone concretions	4.00
Sand and sandstone, mottled, medium greenish grey and light grey, cemented in fairly large concretionary lenses, crossbedded; some fragments of plants and shells	4.00
Ironstone concretion, botryoidal surface, fairly continuous	0.5-0.7
Sand and shale in thin alternating beds and lenses; sand, light grey, weathering brown, and shale, dark grey	3.8
Silt, shaly, dark and light grey, in thin beds; light grey beds somewhat sandy; dark beds clayey; splintery fracture nearly vertical; upper 5 feet rusty weathering, fairly sandy; less sandy below 20 feet; some discontinuous ironstone concretions at 30 and 36 feet; some plant fragments and shell fragments; foraminifera fairly common in these beds and all those below them in this part of the section	59.00
Clay shale, dark grey; with a few thin beds of silt and sand, light grey; fragments of shells, including ammonites	9.5

Sand, silty, bluish grey, few small (3 to 4 inches), rounded siltstone concretions	2.5
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Loon River Formation

Concretions, ironstone, almost a continuous band.	0-1
Silt, shaly, somewhat clayey, medium grey; with light grey lenses and thin beds somewhat sandy at top; splintery fracture; some scattered concretions about 20 feet down; fossils fairly common, mostly crushed; some fragments of plants; <u>Nemodon mcconnelli</u> ? McLearn and <u>Lemuroceras</u> ? sp., collected from this zone	30.25
Sand, very silty, medium grey, somewhat streaked and mottled with lighter greenish grey; fragments of fossils including ammonites	2.5
Silt, sandy, medium grey; fragments of fossils	3.00
Silt, shaly, medium to dark grey, somewhat clayey; becomes somewhat sandy in lower 2 feet; some rounded concretions 4 to 8 inches in diameter	6.7
Ironstone concretion, lenticular, 4 to 6 feet long, fairly continuous	2.5-0
Silt, shaly, medium grey, with some lighter streaks; splintery fracture; some fragments of ammonites and pelecypods	6.0
Silt and clay shale, light and dark grey, thin-bedded, weathers rusty; forms distinct marker in cut banks	0.8
Silt, shaly, medium bluish grey; with fine streaks of light grey ..	2.5
Ironstone concretion; septarian fractures filled with calcite; almost continuous	1-0
Silt, shaly; with much clay, medium grey to bluish; fossils fairly common, mostly crushed ammonites and pelecypods (1 foot above river level)	2.6
Silt, shaly, as above, in augur-hole	15.00
<hr/>	
Total thickness of measured section	180 ⁺

This locality is near the one where McConnell described the top of the Loon River formation. Just which concretions were referred to by McConnell as those marking the top of the Loon River is a little puzzling, as the most definite break in sedimentation that occurs above prominent beds of concretions is the sand $2\frac{1}{2}$ feet thick about 60 feet above river level; this has been chosen for the contact of the Loon River and Peace River formations.

The sequence of two prominent concretionary bands associated with sand, overlain by a series of shaly silts, in turn overlain by a bluish sand that underlies a bed of dark grey clay shale, was observed, so far as exposures permitted, at Sections Nos. 4 to 8, and is even indicated at Section No. 3. Furthermore, the

sequence of foraminifera and micro-fragments of other fossils, such as echinoderms, support the correlation in these sections, with the exception of Section No. 3, although even in this section fragments of echinoderms were observed at the same horizon. It is evident from these correlations that beds that were included in the Loon River formation by McConnell are exposed at many localities along Peace River.

INTERPRETATION OF STRATIGRAPHIC RECORD AND CONCLUSIONS

As a result of detailed study of a group of sections, such as those described above, some understanding may be gained of the environmental conditions under which the formations were deposited. Such an interpretation is important in correlations of the members and formations, and may be valuable in locating features of economic importance such as stratigraphic traps for oil and gas. The application of the conclusions and the interpretation based on the sections described in this report are considered limited to the immediate vicinity of the area studied. Similar conditions undoubtedly existed elsewhere in the region during Lower Cretaceous time, and must be considered in examining other areas.

Evidence presented by McLearn (1944 b, p.4) indicates that the seas came in from the north and that the land mass supplying most of the sediments lay to the west and southwest. A low-lying land mass probably also lay to the east within part of the present area of the Precambrian Canadian Shield. Under these conditions the advances and retreats of the sea over parts of the area might be expected to follow, roughly, south and north directions. The sections along Peace River lie approximately in the direction of movement of the seashore, and show the sequence changes in sedimentation that took place during a part of Lower Cretaceous time.

The beds of the Loon River formation and those of the lower part of the Peace River formation are closely related in mode of origin. They represent similar lithological types, and all contacts are gradational. In the northernmost, or No. 8, section the same fauna, including even the same species of some foraminifera, occur in both formations. Apparently the top of the Loon River and the Basal member of the Peace River represent a period of general off-lap, though there may be oscillations within this group of beds. The upward and northward

migration of sediments of marine origin is evidence of such off-lap. The Middle Shale member of the Peace River formation may represent the still-stand or complete off-lap period, when black muds were being deposited in lagoons or shallow-barred basins, and it may be expected to include coal or carbonaceous shales farther west and south and to pinch out to the north or seaward side. The foraminifera of this shale indicate a marine environment, but they belong to genera that can exist in brackish water. Examples of such conditions are described by Lowman (1949) in the Gulf Coast of Texas and Louisiana. The thinning of the shale is characteristic of still stand, lagunal deposits. The Cadotte member of the Peace River formation probably represents an extensive period of on-lap. The well-defined ironstone band that occurs in all the sections at the top of the Middle Shale member may have been formed during the interval between the off-lap period of the black shale and the development of the on-lap of the overlying sands.

The continental beds that have been included in the Peace River formation, because they are mostly sands, are probably unrelated to the rest of the formation and represent an extreme of off-lap. Erosion may have occurred between the period of deposition of the underlying marine beds and that of the overlying continental beds. The typical non-marine character of the latter -- extensive crossbedding and heterogeneity of sand grains -- is very different from that of the uniform, well-sorted, marine sands that underlie them. It is true that no very sharp break is noticeable, but this is to be expected, as the basal Continental beds may have been largely derived from the underlying member.

The contact between the continental beds at the top of the Peace River formation and the overlying Shaftesbury shales may also represent a period of erosion. It has already been mentioned that there is a disconformity at this horizon, and the pinching out of the continental beds may be in part due to erosion before the deposition of the Shaftesbury. This mass of continental sands, and others like it, may have been part of the source for sands that comprise the Upper Cretaceous Pelican formation farther east and south.

FORAMINIFERA

General Statement

The foraminifera dealt with in this report have been identified as to genera, and have been subdivided into species without establishing species names.

It is probable that many are new species, as has been the case with macrofossils. Furthermore, the distribution of the species may be affected to some extent by changes of environment. The time during which the Peace River and Loon River formations were deposited was one when the seas advanced and retreated, and sediments of the same age vary considerably in character from place to place. Until more detailed studies are made in other areas the distribution of the foraminifera must be considered as local. It is possible, however, that the comparison of the faunas found in the sections studied may be useful for correlation elsewhere, and that the brief descriptions of the species and their distribution may aid others and help to develop an understanding of the value of these fossils in stratigraphic studies of this region. The faunas described are from the Peace River and Loon River formations only. They are divided into three zones, the lowest one from the upper part of the Loon River and the Basal member of the Peace River formation to the base of the Middle Shale member, the middle zone from the Middle Shale member, and the upper zone from the Cadotte member.

The description and names that are applied to the foraminifera are considered to apply only to the material studied for this report. Where the generic description given in Cushman's classification (1949) applies, only the specific characteristics will be given. As no attempt is made to name the species, letters will be used to designate different species of a particular genus. The application of these letters is confined to the material used for this report, and has no reference to similar specific designation in other publications. The order of genera as given in Cushman's classification is followed in describing the faunas.

Descriptions of fossils are supplemented by outline figures shown on plates attached to the report. To facilitate comparison of the various species the magnification of the figures on the plates are 50 diameters in all but a few very small species; these small species are figured with a magnification of 100 diameters.

Description of Species

Loon River Formation and Basal Member
of Peace River Formation

Leptodermella ? sp. Plate IA, figure 1

Small, oval-shaped, arenaceous specimens found in the Loon River formation near the bottom of Section No. 8 bear some resemblance to this genus. The species is small, oval in shape, with arenaceous walls of fine material, with the aperture a rounded opening on the broad face, and with a slight lip or rim around the edge of the opening. Some specimens appear to be partly filled with silty material, which may be somewhat labyrinthic in structure. Most specimens are crushed and distorted. Diameter: 0.250 to 0.4 mm. Range: part of Loon River formation.

Ammodiocus sp. A. Plate IA, figure 2

A fairly small, white species occurs in samples from the Loon River and lower part of the Peace River formations. The walls of most specimens are collapsed. The species is a rather generalized type, and has no particular stratigraphic significance.

Haplophragmoides

Most specimens of this genus found in the samples collected are badly crushed, and many cannot be identified specifically. Three species have been separated, but it is probable that one or two others are represented.

Haplophragmoides sp.A. Plate IA, figure 3

This is a fairly large species, 0.6 to 0.8 mm., with 12 to 13 chambers in a nearly completely involute coil; the periphery is somewhat carinate, the sutures straight, and the walls are of fine sand grains, with a fair amount of cement. Diameter: 0.7 to 0.8 mm. Range: Loon River formation and lower part of Peace River formation.

Haplophragmoides sp.B. Plate IA, figure 4

This species is smaller than H. sp.A, has about 7 chambers in the last coil, and is completely involute; the walls are medium grained for the size of the specimen, and are well cemented with a white or transparent cement. The periphery

is somewhat acute, but rounded. Most specimens tend to be crushed, and the sutures are slightly curved. Diameter: 0.7 to 0.8 mm. Range: Loon River formation and lower part of Peace River formation.

Haplophragmoides sp. C.

Plate IA, figure 5

This is a smaller species than either of the others and most specimens are crushed. It is completely involute; its periphery is subrounded; there are about 8 chambers in the last coil; the sutures are slightly curved, not very distinct; walls are fairly thin, composed of fine grains, fairly smooth, with a fair amount of cement; the aperture is a low arch in the base of the last formed chamber; colour, white to cream. This species is fairly common, and is probably long ranged. It resembles the species described as H. sp.A in the Joli Fou formation on Athabasca River (Wickenden, 1949, p. 19).

Ammobaculites sp. A.

Plate IA, figure 6

This is a medium-sized species, resembling Ammobaculites humei very closely. Most specimens are poorly preserved, and specimens are few in many samples. Length, about 0.5 mm.; width, about 0.3 mm. Range: Loon River formation and most of Basal member of Peace River formation.

Ammobaculites sp.B.

Plate IA, figure 7.

This is a long, narrow species, consisting of 4 or 5 chambers in the coiled part and a series of up to 9 or more somewhat globular chambers in a uniserial series, increasing slightly in width in the uncoiled part; sutures are distinctly depressed; walls of fine quartz or chert grains, with a fair amount of cement. This species is not common, and occurs only in some of the Loon River samples. Length, 1.0 to 1.5 mm.; width, about 0.2 mm. Range: upper part of Loon River formation.

Verneuilina sp.A.

Plate IA, figure 8

A fairly small species, with a definite triangular cross-section in the initial third or half of the test, the latter part becoming more twisted; chambers somewhat flattened in initial part, becoming partly rounded in adult part; sutures nearly flush in early part, somewhat depressed in twisted part; walls fairly thin, fine grained, of white quartz, the outside partly coated with a very thin layer

of black carbon; aperture, a low arch at the base of the last formed chamber. The length ranges from about 0.5 to 0.6 mm.; width, about 0.2 mm. Range: upper part of Loon River formation.

This species shows a tendency to become biserial, and may be the ancestral form for the Gaudryina found in the Middle Shale member of the Peace River formation. No specimens from the Loon River formation were observed to develop the biserial stage. It is a species that may be closely related to a peculiar facies, and probably will be found elsewhere.

Gaudryina A. Plate IA, figure 9

This is a fairly long, narrow species, with a short, somewhat triangular triserial part, and a fairly long biserial part, which shows a rounded cross-section; the chambers in the triserial part are fairly small and indistinct; in the biserial part, they are somewhat flattened; the sutures are indistinct in the triserial part and slightly depressed in the biserial part; walls are of fine-grained quartz; rough, with a moderate amount of cement. The aperture is a low narrow arch in a slight re-entrant at the base of the last formed chamber. Length, about 0.8 to 0.9 mm.; width, about 0.23 mm.

Most specimens of this species are very much distorted or crushed, and identification is uncertain where good specimens are lacking. The range seems to be confined to the Loon River formation.

Quinqueloculina sp. Plate IA, figure 10

This is a small species, with thin elongated chambers. The aperture is a simple opening at the end of a slight neck-like extension of the last formed chamber. Length, about 0.4 mm.; width, about 0.18 mm. The species was fairly common in a few samples of the Loon River in Sections No. 7 and No. 8.

Robulus sp. Plate IA, figure 11

This is an involute species, having a fairly well-developed umbo, with somewhat rounded periphery; the chambers tend to be nearly as wide as long, and number about 8 in the last formed coil. The sutures are slightly raised in the older part of the coil, and slightly depressed between the last 2 chambers. Diameter: 0.6 to 0.7 mm. This species is most common in the Loon River formation, but a few specimens were observed in the lower part of the Peace River.

Lenticulina sp. . . . Plate II, figures 12, 13

This is a fairly large, close-coiled, involute species, with a well-developed umbo, which shows a tendency to uncoil, although in some specimens the last formed chamber overlaps the inner end of the previous chamber; the sutures are slightly raised except for those between the last two chambers, which are slightly depressed; aperture, at the periphery, radiate. Length, about 0.7 to 1 mm.; width, 0.5 to 0.6 mm.

The species shows considerable variation, some variants tending to remain more involute than others, but as intermediate stages occur in the extreme developments they probably all belong to the same species. Specimens were found in the Loon River formation and in the lower part of the Peace River formation at several localities.

Marginulina sp. A. . . . Plate II, figures 14-16

This is a medium-sized species, with longitudinal costae; it has a rounded cross-section, and the chambers are about as long as broad; sutures are slightly curved and depressed. The walls carry 6 to 8 costae on each side, which run from the initial end to well upon the apertural face; the aperture is rounded almost at the periphery on the last formed chamber. The species varies from a rather stout form, whose width is about $2\frac{1}{2}$ times as long as wide, to thinner ones whose length is nearly 4 times the width. Length, about 0.5 to 0.8 mm.; width, about 0.1 to 0.35 mm.

The species occurs in the Loon River formation in the northern part of the area; some specimens were collected from the lower part of the Peace River formation.

Marginulina sp. B. . . . Plate II, figures 17, 18

This is a small, somewhat variable species, with a fairly elongate and compressed test and rounded periphery; ventral margin, slightly concave; dorsal margin, convex; chambers, few early ones coiled in the microspheric form; others in a curved series, about 5 or 6 in most specimens; sutures, slightly depressed, curved, becoming nearly straight between last formed chambers; walls, thin, smooth, finely punctate; aperture near the periphery, somewhat radiate. Length, 0.4 to 0.6 mm.; width 0.14 to 0.2 mm.

This species is not very common, and seems to occur in various beds both in the Loon River formation and lower part of the Peace River formation.

Marginulina sp. C.

Plate IA, figure 20

This is a small species, somewhat elongate, with an oval to nearly circular cross-section; ventral side concave; dorsal side convex; chambers distinctly arranged, about 6 in a coiled part and 3 or 4 in a curved part; becoming larger and even somewhat inflated in mature part of test; sutures depressed, slightly curved; walls thin, with a few discontinuous costae on curved part of test, mostly on ventral side; aperture rounded or only partly radiate, terminal, near periphery on the last-formed chamber. Length, about 0.6 mm.; width, about 0.2 mm.; thickness, about 0.15 mm. Range: upper beds of Loon River formation and lower part of Peace River formation; the species is not very common.

Marginulina sp.D.

Plate IA, figure 19

This is a medium to small species, which is nearly straight on ventral side and only slightly curved on dorsal side; chambers distinct, somewhat inflated in a curved or slightly coiled arrangement at the initial end and in a nearly rectilinear series in remainder of test; sutures distinct, curved, depressed; walls smooth, finely punctate; aperture terminal near the periphery, radiate. Length, 0.5 to 0.6 mm.; width, about 0.2 mm.; thickness, about 0.17 mm.

This species was found only in the lower part of the Peace River formation.

Saracenaria sp.A.

Plate IA, figure 21

Test concave on ventral side and convex on dorsal side; chambers distinct, becoming inflated in adult stages, triangular, with rounded corners in cross-section, 5 or 6 in coiled part and 3 to 4 in uncoiled part; sutures slightly depressed, distinct, curved in early stages and nearly straight between chambers of uncoiled part; walls smooth, finely perforated; aperture terminal at the periphery, radiate. Length, about 0.5 mm.; width and thickness of mature specimens about 0.3 mm. Range: Loon River formation; not found in higher beds.

becoming less curved in uncoiled part;

Saracenaria sp.B.

Plate IA, figure 22

Test slightly curved on ventral side and much curved on dorsal side, becoming less curved in uncoiled part; chambers distinct, somewhat inflated, somewhat pyramidal, with rounded edges in mature stage, 3 or 4 in coiled part and 4 or 5 in uncoiled part; sutures distinct, curved, depressed; walls smooth, finely punctate; aperture terminal near the periphery, radiate. Length, about 0.5 to 0.6 mm.; width and thickness, about 0.2 mm. Range: lower part of Peace River formation.

Nodosaria

Several species seem to be represented by one or two specimens or broken specimens in various parts of the section. The scarcity of specimens does not indicate that any of these are of stratigraphic significance.

Nodosaria sp.

Plate IA, figures 23, 24

This is a medium to small species, pointed at both ends, the sides at the initial end taper, but become nearly parallel in the mature part of the test; chambers distinct, tending to become globular in the mature part; sutures depressed, straight; walls finely perforate, with 4 to 6 longitudinal costae extending the length of the test; aperture rounded, opening at the end of a neck formed by the junction of the costae. Length, 0.7 to 0.9 mm.; width, about 0.2 mm.

Specimens assigned to this species show considerable variation. Some tend to be more elongate, with the adult chambers becoming more separated. The costae also vary in numbers. It seems probable that these are all variations of the same species, as specimens show gradational varieties in samples from nearly all the horizons where the species occurs. Range: Loon River formation.

Pseudoglandulina sp.

Plate IA, figure 25

Small species with a few overlapping chambers seem to belong to the genus. The one illustrated was the only one that was represented by several specimens and that occurred in more than one sample. Two or three other species were represented by single specimens from the same zone near the base of the Loon River beds; collected at the location of Section No. 8.

Lingulina sp.

Plate IA, figure 26

Test elongate, oval cross-section; chambers rounded at initial end and becoming more elongate in adult stage, arranged in a rectilinear series, although arrangement of early ones may be slightly curved; sutures depressed, straight in adult, slightly curved between first two or three chambers; walls smooth, finely perforate; aperture, ~~terminal~~ — a short oval slit, with thin, slightly projecting lips or hoods on each side. Length, about 0.6 mm.; maximum width, about 0.14 mm. Range: lower part of Peace River formation.

This is a fairly rare species, but a few specimens were found in samples from the lower part of the Peace River formation at three localities, and it seems to be confined to this horizon.

Globulina sp.

Plate IA, figure 27

Test sub-globular, nearly twice as long as broad, base rounded; chambers few, overlapping so that they nearly reach the base; walls smooth; sutures distinct, curved, nearly flush; aperture, radiate, terminal. Length, about 0.25 to 0.45 mm.; greatest width, about 0.16 to 0.27 mm. Range: lower part of Peace River formation, and possibly the upper beds of the Loon River formation. This species occurs at several localities in beds several feet above the contact of the Loon River formation, and locally seems to be a good guide fossil.

Bulimina sp.A.

Plate IA, figure 29

Test very small, rotund; maximum width nearly as great as length, tapering to a somewhat rounded initial end; chambers triserial throughout, early ones very small and obscure, adult ones very much larger and distinct; sutures very slightly depressed, curved; walls thin, smooth, and finely punctate; aperture, small rounded opening at the centre of the base of the last formed chamber. Length, about 0.13 to 0.15 mm.; maximum width, about 0.12 mm. Range: upper part of Loon River formation at location of Section No. 7. This species resembles B. reussi Morrow in many features, but is smaller, more rotund, and the aperture does not show the tendency to be comma-shaped.

Bulmina sp.B. Plate IA, figure 28

Test very small, about twice as long as broad, tapering throughout length, round in cross-section; chambers distinct, gradually increasing in size toward adult end; sutures slightly depressed, curved; walls smooth, thin, perforate; aperture, small, comma-shaped opening at centre of base of apertural face of last formed chamber. Length, about 0.14 mm.; greatest width, 0.07 mm. Range: upper part of Loon River formation.

Conorbina sp. Plate IA, figure 33

Test small, dorsal side convex and ventral somewhat concave; periphery subangular to somewhat rounded; chambers distinct, all visible on dorsal side, only last whorl visible on ventral side, 4 to 5 to a whorl in early stages but only $3\frac{1}{2}$ in last whorl; sutures slightly depressed, curved, show slight re-entrant on ventral side in some specimens; walls smooth, finely perforate; aperture, a low opening at the base of the apertural face on the ventral side between the periphery and the umbilicus. Diameter, about 0.2 to 0.25 mm.; thickness, about 0.17 to 0.2 mm. Range: Loon River formation and possibly in the lower part of the Peace River formation.

Gyroidina sp.A. Plate IA, figure 30

Test small, dorsal side slightly convex, ventral side strongly convex; chambers distinct, somewhat inflated in adult stage, 5 in the last whorl, completely involute on ventral side, with a small umbilical depression opening towards apertural face of last formed chamber; sutures slightly depressed in last few chambers, especially on ventral side; earlier sutures on dorsal side flush or covered, slightly curved; walls fairly smooth; aperture, small low arch at base of face of last formed chamber between periphery and umbilical area. Diameter, about 0.25 to 0.3 mm.; thickness, 0.15 to 0.2 mm. Range: Loon River formation and lower part of Peace River formation.

This species resembles G. nitida (Reuss) and G. berssili White in general appearance.

Gyroidina ? sp.B. Plate IA, figure 31

Test strongly convex on dorsal side, with broad depressed umbilical area on ventral side; periphery broad, rounded; chambers distinct, becoming

somewhat inflated in adult stage, 6 in last whorl; sutures distinct, slightly depressed; walls thin, smooth, finely perforate; aperture, a low arch at the base of a slight extension of the face of the last formed chamber between the periphery and the umbilical area. Diameter, about 0.4 mm.; thickness, about 0.25 mm. Range: Loon River formation, and possibly in the lower part of the Peace River formation. The species seems to be confined to a few scattered beds, and it is probable that it existed in a certain environment only.

Allomorphina sp.

Plate IA, figure 32

Test very small, roughly three sides with broad rounded corners, dorsal and ventral sides nearly equally convex; chambers indistinct in early parts, become inflated and distinct in last whorl, trochoid, about 3 in last whorl; sutures distinct in last whorl, nearly flush, curved; walls smooth, finely perforate; aperture, a very low arch on ventral side. Diameter, 0.1 to 0.13 mm.; thickness, about 0.07 mm. Range: Loon River formation and lower part of Peace River formation. This species is fairly common in the lowest beds at the locality of Section No. 8, and a few specimens were found in several samples from higher beds in the Loon River formation and in the lower part of the Peace River formation.

Quadrिमorphina sp.

Plate IA, figure 36

Test small, biconvex, trochoid; chambers all visible from dorsal side, only those of last whorl visible on ventral side, 4 chambers in last formed whorl; sutures slightly curved, flush in young stages on dorsal side, those of last whorl partly depressed; walls smooth, finely punctate; aperture, an arch opening near the inner part of the face of the last formed chamber on the ventral side, with an overhanging lip. Diameter, about 0.3 to 0.37 mm.; thickness, 0.2 to 0.25 mm.

Placing this species in the genus Quadrिमorphina extends the range of this genus into older beds than previous records show. The generic identification compares favourably with the characteristics given by Finely in his original description of the genus.

Anomalina sp.

Plate IA, figures 34, 35

Test somewhat trochoid, tending to become planispiral in adult form, dorsal side somewhat more convex than ventral side; chambers all visible from dorsal side, part of most chambers visible on ventral side, 7 to 8 in adult whorl;

central part of some specimens covered with a boss of clear calcareous material on ventral side; sutures curved, slightly depressed in adult and raised in early stages; walls fairly smooth with fine pores; aperture, a low arch at the base of the face of the last formed chamber on the ventral side, with some specimens showing small secondary openings into umbilical area. Diameter, 0.25 to 0.35 mm.; thickness, about 0.1 mm., Range: Loon River formation and possible rare specimens in lower part of Peace River formation.

Middle Shale Member of Peace River Formation

The foraminifera of the Middle Shale member of the Peace River formation, although fairly numerous in some zones, belong to few species, five of which are common at the localities collected. All are arenaceous species. The specimens are thin walled, with very fine sand or silt grains, and nearly all are somewhat crushed or distorted. The species are fairly distinctive, and should be easily recognized. It is possible that this faunule represents sedimentary facies that may be limited in extent.

Ammodiocus sp.B. Plate IB, figure 5

This is a fairly small, white species, which tends to crush easily. Its range is uncertain, because similar species have been observed at other horizons in various localities in the west. The diameter is about 0.4 mm.

Haplophragmoides sp.D. Plate IB, figure 1

This is a fairly large species with weak walls, so that all specimens are crushed and distorted to some extent. It appears to be somewhat involute, with 13 or 14 chambers in the last whorl; walls apparently thin and collapsed over the chambers, composed of very fine white silt grains; sutures thick and fairly wide, forming ridges between collapsed areas of chambers, straight; maximum diameter, about 0.8 mm. Range: throughout central part of Middle Shale member of Peace River formation.

Haplophragmoides sp.E. Plate IB, figure 2

Test small, almost completely evolute, planispiral periphery, rounded, chambers somewhat rounded, becoming a little larger and slightly elongate in adult stage; sutures curved, depressed, not distinct in early stages; walls thin, with

fine grains and much cement, giving a translucent appearance especially in first two whorls; aperture, a low arch at base of face of last formed chamber. Diameter, 0.3 to 0.4 mm.; thickness, 0.07 to 0.1 mm. Range: lower part of Middle Shale member of Peace River formation.

Haplophragmoides sp.F.

Plate IB, figure 3

Test medium size, involute, planispiral in first coil, somewhat trochoid in later whorls; periphery broadly rounded; chambers, 6 to 9 in last formed coil, somewhat rounded; walls medium grain, well cemented; sutures distinct, depressed in last few chambers, somewhat obscure in earlier parts; aperture, a low slit or arch at base of the face of last formed chambers, almost on periphery. Diameter, 0.3 to 0.7 mm.; thickness, 0.15 to 0.3 mm. Range: upper half of Middle Shale member of Peace River formation.

Gaudryina sp.B.

Plate IB, figure 7

Test small, mostly triserial, with distinct triangular cross-section in early stages and a short more rounded biserial part; periphery angular in early stages, becoming rounded in triserial part; chambers somewhat flattened and angular in triserial part, becoming more rounded in biserial part, only about 4 in biserial part; sutures flush in triserial part, later curved and distinct in biserial part; walls fairly thin, very fine white grains, with a fair amount of cement; aperture, a low arch on the base of the face of the last formed chamber; colour white, with a very thin coating of black carbon over some parts, especially near the sutures. Length, about 0.5 to 0.6 mm.; width, about 0.4 mm. Range: Middle Shale member of Peace River formation.

This species appears to be a development from Verneuilina sp.A., described from the Loon River formation.

Gaudryina sp.C.

Plate IB, figure 6

Test small, with a short triserial part and a long biserial part; periphery rounded, especially in biserial part; chambers rounded, about 9 in triserial part, 10 or more in biserial part; sutures depressed, curved, distinct; walls thin, fine grained, with fair amount of cement; aperture, a low arch at the base of the face of the last formed chamber; colour, white to cream. Length, about 0.4 mm. or longer; width, about 0.16 mm. Range: lower central part of Middle Shale member of Peace River formation.

Cadotte Member of Peace River Formation

The foraminifera collected from the Cadotte member in this area are all arenaceous, with fairly large coarse-grained species most numerous. It is possible that these species are related to the environment peculiar to the deposits found in this region. The material was collected from beds that contain a fair amount of shale, and probably mark a transition from shallow open water of the sand facies to the deeper or quiet water of the shale facies. Probably elsewhere, if deeper water deposits occur, the fauna may be found to contain more calcareous species.

The species described are only the most common ones. Several other species are represented by one or two specimens or by incomplete specimens, and their stratigraphic significance is uncertain.

Glomospira sp. Plate IB, figure 9

This species is very similar to G. gordialis (Parker and Jones) as described by Cushman. The specimens can easily be mistaken for Ammodiscus, as the irregular coiling is not pronounced, especially in the adult stages.

Haplophragmoides sp.G. Plate IB, figure 8

Test fairly large, almost evolute, especially in adult; chambers somewhat rounded, about 8 or 9 in last formed whorl; sutures indistinct, nearly straight, slightly depressed; walls coarse grained, mostly quartz, with a few grains of dark chert, many grains 0.1 mm. or a little larger, fair amount of white cement in parts; aperture, a low arched opening at the base of the face of the last formed chamber; colour, white. Diameter, about 1 mm.; thickness, about 0.4 mm. Range: throughout the Cadotte member.

Haplophragmoides sp.H. Plate IB, figure 12

Test rather rotund, almost completely involute; chambers in a planispiral coil, except for the last 2 or 3, which tend to form a little to one side; 6 or 7 in last formed whorl; sutures indistinct, straight, or very slightly curved, those separating last chambers may be slightly depressed; walls coarsely arenaceous, fairly smooth, with much cement separating grains of about 0.06 mm. or less; aperture, a low arch at the base of the face of the last formed chamber at the periphery. Diameter, about 0.7 mm.; thickness, about 0.35 to 0.4 mm.

Range: throughout Cadotte member.

Ammobaculites sp.C. Plate IB, figure 13

Test stout, with a round cross-section; chambers rounded, about 5 in coiled part and 4 in rectilinear part; sutures slightly depressed, not very distinct; walls coarsely arenaceous, with much white cement between grains; aperture, a terminal opening between some of the grains. Length, about 1.2 mm.; thickness, about 0.4 mm. Range: upper part of Cadotte member.

Ammobaculites sp.D. Plate IB, figure 14

Test elongate, with a round cross-section; chambers about 4 in coiled part and 5 or 6 in rectilinear part, rounded in coiled part as well as the first few of rectilinear part, last 2 or 3 becoming elongate and somewhat pear-shaped; sutures depressed but not well defined; walls coarsely arenaceous; with grains up to a little more than 0.1 mm.; with a fair amount of white cement; aperture, terminal, an irregular opening. Length, about 1 mm.; thickness, about 0.2 mm. Range: lower part of Cadotte member.

Ammobaculites sp.E. Plate IB, figure 15

Test fairly large, elongate, tapering somewhat towards initial end, somewhat compressed, with an oval cross-section; chambers, about 3 in coiled part and 6 or 7 in uncoiled part, becoming somewhat larger and drawn out in adult part; sutures indistinct, slightly depressed in rectilinear part; walls coarsely arenaceous, rough grains about 0.1 mm., mostly quartz, with a few scattered grains of dark chert; aperture, a somewhat elongate terminal opening. Length, about 1.5 to 2 mm.; greatest diameter, about 0.4 to 0.5 mm. Range: from a short distance above the base to the top of the Cadotte member.

Eggerella ? sp. Plate IB, figure 16

Test small, somewhat conical; chambers rounded, about 4 to each spiral turn in the early part, $3\frac{1}{4}$ to 3 later; sutures fairly distinct, depressed; walls fairly coarse grained for size of specimen, and a moderate amount of cement; aperture, a small arch at the base of the apertural face of the last formed chamber. Length, about 0.4 mm.; maximum width, about 0.3 mm. Range: lower part of Cadotte member.

Miliammina sp.A. Plate IB, figure 11

This is a moderately broad species that resembles M. manitobensis Wickenden. Most of the specimens are coarser grained than specimens elsewhere. Length, about 0.5 to 5.5 mm.; width, about 0.3 mm.; thickness, about 0.08 mm. Range: lower part of Cadotte member.

Miliammina sp.B. Plate IB, figure 10

This is a more slender and elongate species, with very fine-grained walls. It seems to be very close to M. sproulei Nauss. Length, about 0.4 to 0.5 mm.; width, about 0.16 mm.; thickness, about 0.1 mm. Range: throughout Cadotte member, more common in upper half.

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