GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY,
MINES AND RESOURCES

PAPER 70-31

# TRIASSIC STRATIGRAPHY OF THE SIKANNI CHIEF RIVER-PINE PASS REGION, ROCKY MOUNTAIN FOOTHILLS, NORTHEASTERN BRITISH COLUMBIA

(Report and 6 figures)

D. W. Gibson



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1971


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## ABSTRACT

This paper provides detailed information on the character, distribution, age, and stratigraphic relationships of Triassic rocks between Sikanni Chief River and Pine Pass in northeastern British Columbia.

Triassic rocks comprise a thick succession of siltstones, shales, sandstones, limestones, and dolomites. They are divided into 8 formations which, in ascending order, are: the Grayling, the Toad, the Liard, the Charlie Lake and laterally equivalent Ludington, the Baldonnel, the Pardonet, and the Bocock. South of Peace River, the Baldonnel Formation is further divided into two lithofacies, the lower of which is called the Ducette Member. All formations and distinctive facies of the Sikanni Chief River - Pine Pass area are correlated with other formations and members in the subsurface Peace River Plains, the Liard River region to the north, and the Jasper - Banff region to the south.

Sediments of the Grayling and Toad Formations were deposited during marine transgressive and minor regressive stages, in a miogeosynclinal, relatively deep water enivronment. In contrast, sediments of the overlying formations were deposited during major regressive and minor transgressive cycles, and under more restricted, mainly shallow water, conditions.

# TRIASSIC STRATIGRAPHY OF THE SIKANNI CHIEF RIVER - PINE PASS REGION, ROCKY MOUNTAIN FOOTHILLS, NORTHEASTERN BRITISH COLUMBIA

## INTRODUCTION

Triassic rocks in the Rocky Mountain Foothills and Peace River Plains of northeastern British Columbia have long been recognized and described in variable detail by McLearn (1921, 1930, 1940, 1941, 1941a, 1945, 1946, 1947, 1947a, 1960), Kindle (1944, 1946), McLearn and Kindle (1950), Hunt and Ratcliffe (1959), Clark (1961), Muller (1961), Armitage (1962), Westermann (1962), Colquhoun (1960, 1962), Pelletier (1963, 1964), Irish (1963, 1970), Hughes (1967), and by field parties of many oil companies. Barss, et al., (1964) synthesized all published Triassic stratigraphic information in Western Canada up to the end of 1962, including the region studied by this report. Triassic faunas in the area have been extensively studied and described by F.H. McLearn and E.T. Tozer in numerous publications. In recent years Tozer (1967) has revised some of McLearn's original work, and along with his own research has established a detailed faunal zonation throughout the Triassic System in Western Canada.

This preliminary report is based on field work carried out during the summers of 1968 and 1969 in the Sikanni Chief River - Pine Pass area of northeastern British Columbia (Fig. 1). It provides new information on the nomenclature, distribution, age, and stratigraphic relationships of the Triassic rocks in the area and, furthermore, indicates the stratigraphic relationship between the old and newly recognized field units, and the formations and distinctive facies of other regions in Western Canada.

Twenty-four partial and complete field sections were examined and sampled in detail, the most important of which are included in the Appendix. All field samples were re-examined in the laboratory with a binocular microscope, and were rechecked for the presence of calcite and dolomite, using a 10 per cent hydrochloric acid solution. The samples were reclassified according to their natural colour (fresh dry surface), using a "Rock-Colour Chart" (Goddard, 1951). A qualitative and semi-quantitative, descriptive mineralogical study was made on selected thin sections cut from samples representing the different formations and facies in the region. Insoluble residue and X-ray diffraction analyses were run on selected samples of the Grayling, Toad, Liard, and Pardonet Formations. The petrological results of the investigation will be reported at a later date, pending completion of the study.

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Author's address: Institute of Sedimentary and Petroleum Geology
Geological Survey of Canada
Calgary, Alberta

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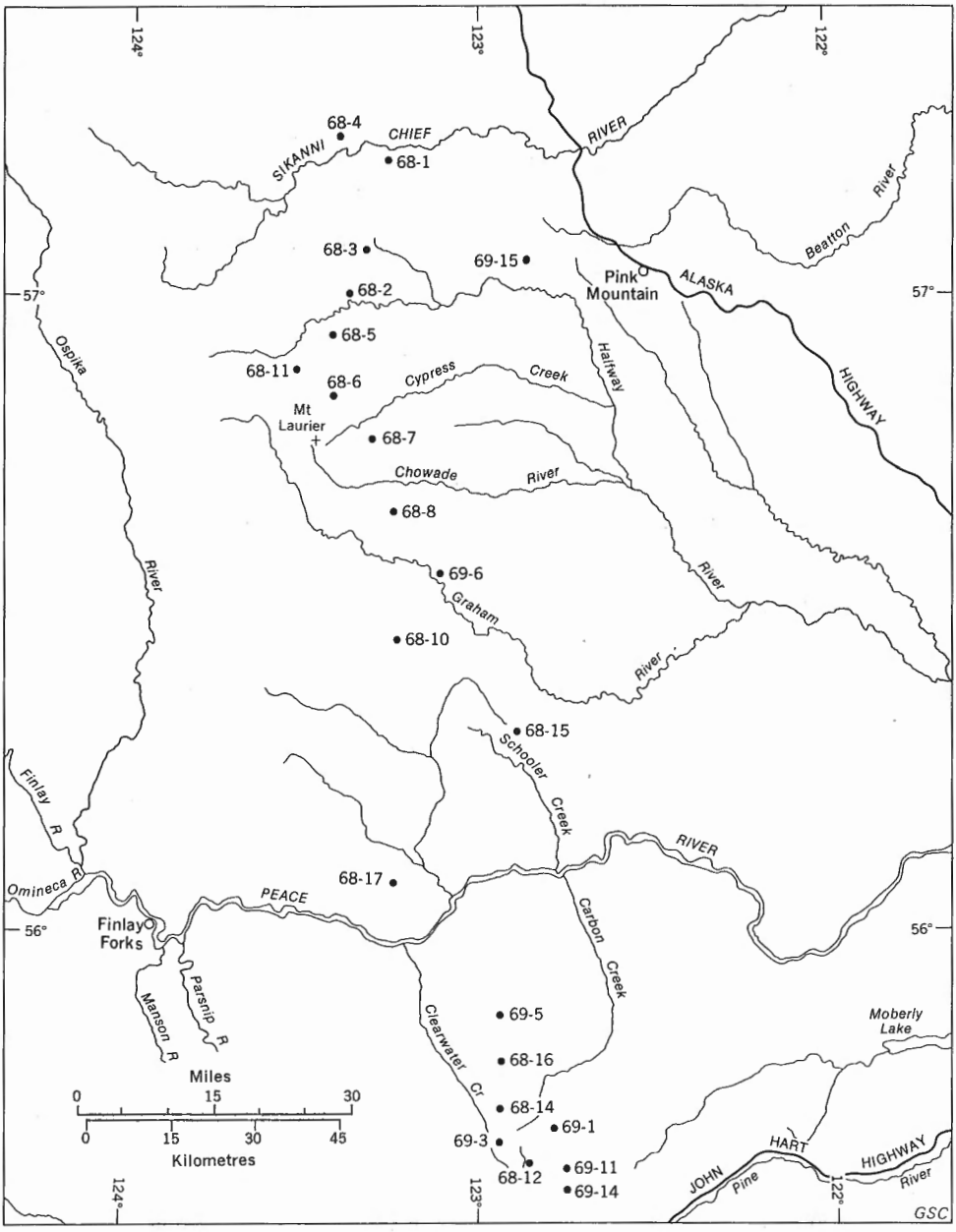


Figure 1. Index map showing location of measured sections

ACKNOWLEDGEMENTS

Field and logistical support was provided by Operation Smoky, a regional geological mapping and stratigraphic investigation, co-ordinated by G. C. Taylor of the Geological Survey of Canada. Beneficial discussions with D. F. Stott, G. C. Taylor, and E. T. Tozer have greatly assisted the writer in preparing this report. Able assistance was rendered in the field during 1968 by D. Dutton, J. Irish, R. Patterson, and E. Thorsteinsson; and in 1969 by G. Belik, J. Craig, J. Irish, and P. Lord.

All fossils collected in the field were identified, dated, and placed into appropriate zones by E. T. Tozer of the Geological Survey of Canada.

## STRATIGRAPHY

### NOMENCLATURE

A prerequisite for most field stratigraphic investigations is the careful design of a stratigraphic subdivision and nomenclature system that can be readily applied by other investigators working in the same or immediately adjacent areas. If possible, such a system should be amenable to subsurface investigations and readily correlatable to other established subdivisions and nomenclature systems in regions which form part of the same sedimentary province.

The following subdivisions proposed for the Rocky Mountain Foothills between Sikanni Chief River and Pine Pass have been designed to fulfil these requirements, and where practical are adaptable to structural mapping on a regional scale. All effort has been made to use or modify established nomenclature from previous surface studies, and wherever possible to extend long established subsurface names to similar surface lithofacies. In most studies of this magnitude and detail, the recognition of new map units and the introduction of new stratigraphic nomenclature is unavoidable.

Triassic rocks in the Sikanni Chief River - Pine Pass region are divided into 8 formations which, in ascending order, are: the Grayling, the Toad, the Liard, the Charlie Lake and laterally equivalent Ludington, the Baldonnel, the Pardonet, and the Bocock. South of Peace River, the Baldonnel Formation is further divided into two lithofacies, the lower of which is called the Ducette Member (Fig. 2).

The names Grayling and Toad are extensions of the terms first proposed by Kindle (1944) for Early and Middle Triassic strata in the region of Liard River. The name Liard Formation, also proposed by Kindle (1946), was used by Pelletier (1963) during his stratigraphic studies in the Peace River district. This name is now proposed for a mappable lithofacies in the Sikanni Chief River - Pine Pass region, which has a close physical resemblance to the type lithology in the Liard River region. The Charlie Lake Formation has been recognized for some years as a sequence of evaporitic rocks in the subsurface of the Peace River Plains. This name is now extended to surface exposures of similar, but not identical strata, instead of proposing a new name applicable only to field exposures. The name Ludington Formation, formerly used to refer to a facies of McLearn and Kindle's (1950) "Grey Beds", is proposed for a distinctive lithologic sequence in the western Foothills. The formation can be correlated with the Charlie Lake Formation, and possibly with the upper part of the Liard Formation south

| Formation and Member | Thickness in feet | LITHOLOGY |
|---|---|---|
| BOCOCK FORMATION | 0 to 208 | Cliff-forming, light grey- to buff-weathering, medium- to thick-bedded limestones |
| PARDONET FORMATION | 26 to 450 | Dark grey-to brownish grey-weathering, carbonaceous-argillaceous limestones, silty limestones, calcareous and dolomitic siltstones, and minor shale |
| BALDONNEL FORMATION | 270 to 480 | Light grey- to brownish grey-weathering, cliff-forming, carbonaceous-argillaceous, slightly silty limestones, dolomites, minor siltstones and very fine-grained sandstones |
| Ducette Member | 0 to 390 | Dark grey-brown, carbonaceous-argillaceous siltstones, very fine-grained sandstones, limestones, and minor dolomites |
| LUDINGTON AND CHARLIE LAKE FORMATIONS | 1,640 to 1,720+ | Ludington Formation: Medium to light grey-weathering, dolomitic to calcareous siltstones, sandstones; silty to sandy to bioclastic limestones |
| | 600 to 1,330 | Charlie Lake Formation: Buff to yellow, light grey- to orange-brown-weathering, dolomitic to calcareous sandstones, siltstones, sandy limestones and dolomites; minor intraformational and solution breccias |
| LIARD FORMATION | 92 to 1,370 | Cliff-forming, very dolomitic to calcareous, fine- to coarse-grained sandstones, calcareous and dolomitic siltstones; minor silty to sandy dolomites, and limestones |
| TOAD FORMATION | 520 to 2,700+ | Dark grey, shaly- to flaggy-weathering, carbonaceous-argillaceous, very calcareous siltstones, silty limestones and silty shales; minor silty dolomites, and calcareous sandstones |
| GRAYLING FORMATION | 118 to 335 | Recessive, shaly- to flaggy-weathering, dolomitic quartz siltstones and silty shales; minor calcareous siltstones, silty limestones, dolomites, and very fine-grained sandstones GSC |

Figure 2. Table of Formations

of Peace River. The name Baldonnel Formation is also an extension of a name originally defined for subsurface strata; however, the lower contact of these strata at the surface may not be the same as that in the subsurface. South of Peace River the Baldonnel Formation is divided into two units, the lower of which is herein named the Ducette Member. The upper unit consists of strata typical of the formation in other areas, and therefore retains the same name. The Pardonet Formation, a surface unit recognized and formally named by McLearn (1960), is recognized throughout the study area, and generally forms the highest formation of the Triassic succession. South of Peace River toward Pine Pass, a new formation has been recognized above the Pardonet Formation, and has been named the Bocock Formation.

Figure 2 illustrates the field facies recognized, and the nomenclature used in the Sikanni Chief River - Pine Pass area of northeastern British Columbia. All field formations and members were designated on the basis of lithology, exclusive of fossil content. Most formations are diachronous.

## Grayling Formation

The type section of the Grayling Formation on Grayling River consists of a "series of soft, laminated, friable, grey shales with at places beds of hard, ripple-marked sandstone" (Kindle, 1944 p. 6). Throughout much of the Sikanni Chief River - Pine Pass area, strata similar to those at the type locality have been recognized by Pelletier (1963, 1964), Irish (1970), and Colquhoun (1960, 1962). During the current study, the Grayling Formation was recognized only in the extreme western Foothills; however, because of the limited exposure and lack of sections in much of the eastern area, the presence or absence of the Grayling Formation is uncertain. Pelletier (1963, p. 5) stated that the Grayling Formation, according to his definition, did not extend south of Peace River nor likely far east of Needham Creek and Graham River. Hunt and Ratcliffe (1959), however, noted the occurrence of strata similar to the Grayling Formation in the subsurface. They combined these strata with the overlying Toad Formation and called the new subsurface unit the Toad-Grayling Formations (Fig. 4). At all field sections with an exposed Permian-Triassic contact, the lowermost Triassic strata were similar to the lithology of the type Grayling Formation.

In the Sikanni Chief River - Pine Pass region, the Grayling Formation consists of recessive, shaly- to flaggy-weathering, dolomitic quartz siltstones, silty shales and lesser calcareous siltstones, silty limestones, dolomites, and very fine-grained sandstones. The succession is dark to brownish grey, commonly very carbonaceous-argillaceous[1], slightly pyritiferous, and thin- to medium-bedded. Because of the recessive character of the formation, many sections contained large covered intervals. The formation has a maximum measured thickness of 335 feet near Clearwater Lake (Section 69-11), and a minimum thickness of 118 feet near Calnan Creek (Section 68-11). The gradational contact with the Toad Formation makes accurate formation measurements difficult to obtain. Most values represent minimum thicknesses only of the Grayling Formation.

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[1] Because of the colour-masking effect, and intimate association of the organic carbonaceous matter with the clay minerals, it was not possible to distinguish the organic and argillaceous constituents using a binocular or petrographic microscope. One or both constituents may be present in a given sample.

The mineral composition of the Grayling Formation consists mainly of angular quartz and feldspar, dolomite, calcite, minor pyrite, illite, phosphate, and trace amounts of common heavy minerals. Dark grey to black, siliceous phosphate nodules and lenticles are found in some places near the Toad Formation contact. The finely crystalline, recrystallized calcite and dolomite occur mainly as cement and matrix, and display a progressive increase in concentration from the base to the top of the formation. In addition to this change in concentration, there is an accompanying change in carbonate composition. The siltstones become progressively more calcareous toward the top, such that strata near the Toad Formation contact may be classed in part as silty limestones. This feature makes placement of the contact between the two formations arbitrary.

The Grayling Formation unconformably overlies dark grey chert and siliceous mudstone of the Permian Fantasque Formation. The contact is generally sharp and easy to place; however, at some western sections i.e. Calnan Creek, the actual contact must be placed within a 5- to 10-foot zone because of the close similarity between the dark-weathering character and the composition of the two formations. The upper contact with the overlying Toad Formation is gradational, and sometimes problematical. It is designated mainly on the basis of a change in carbonate composition, where the cement and matrix of the siltstones and shales changes upward from a predominance of dolomite to calcite. This compositional change ranges over a thick sequence of strata at some sections.

The recessive character and consequent covered intervals make fossil collections difficult to obtain. At some localities the Grayling strata contain large, silty limestone concretions up to 1 foot in diameter, some of which contain well preserved ammonites and pelecypods. Fossils identified by Tozer include Prionolobus cf. P. lilangense (Krafft) (GSC loc. 82615), Anakashmirites sp., Prosphingites sp., Arctoceras sp., and Posidonia mimer Oeberg (GSC locs. 84197 and 82624). On the basis of collected fossils, an Early Triassic Dienerian to Smithian age is suggested for the formation. At the type locality on Liard River the Grayling Formation is as old as Late Griesbachian.

## Toad Formation

The Toad Formation, with type section near the junction of the Liard and Toad Rivers in northeastern British Columbia, was first described in the Sikanni Chief River - Pine Pass area by McLearn (1946). Since then other workers have studied and applied the same name to this stratigraphic succession. In the present investigation, the Toad Formation is redefined and mapped to include younger strata. McLearn and Kindle (1950) considered these younger strata to be separate lithofacies, informally named them the "Flagstones" and "Dark Siltstones", and considered them possible correlatives of the Liard Formation. During the field investigation both units were generally recognizable and sometimes mappable depending on scale; however, their lithologic character and physical appearance is more closely akin to strata typical of the Toad Formation than to strata of the Liard Formation. Furthermore, three distinct flaggy-weathering siltstone units have been recognized by the writer (Fig. 6) and, without proper index fossil control, considerable difficulty arises in separating each of the units into their appropriate stratigraphic positions. Where the "Flagstones" are absent, as in most western localities of the Foothills, the overlying "Dark Siltstones" are not recognizable as a separate unit, and therefore would be mapped as strata typical of the Toad Formation.

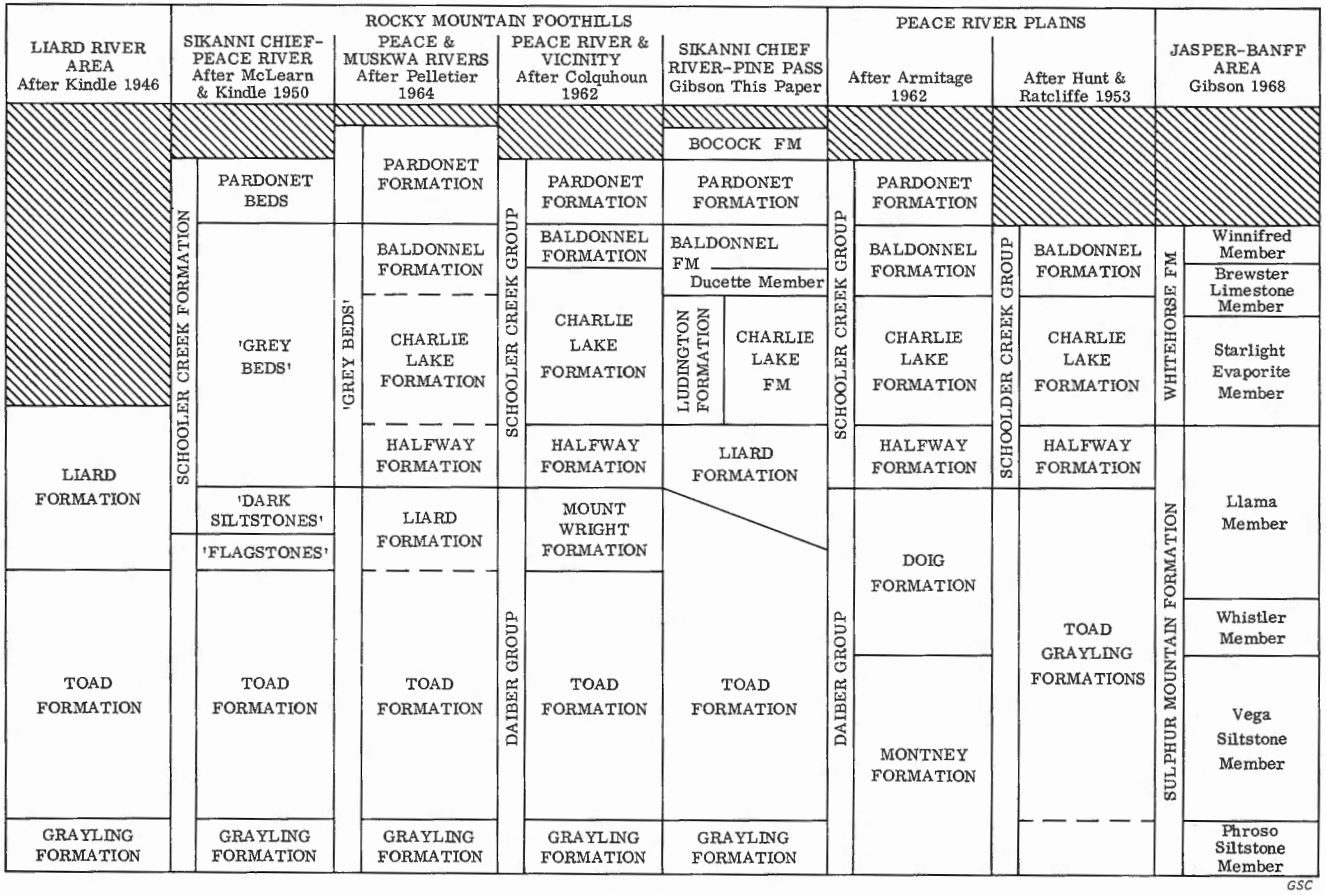


Figure 4. Nomenclature chart illustrating Triassic formations in the Sikanni Chief River - Pine Pass area, and their suggested equivalence to formations of the subsurface Peace River Plains, the Liard River region, and the Jasper-Banff region

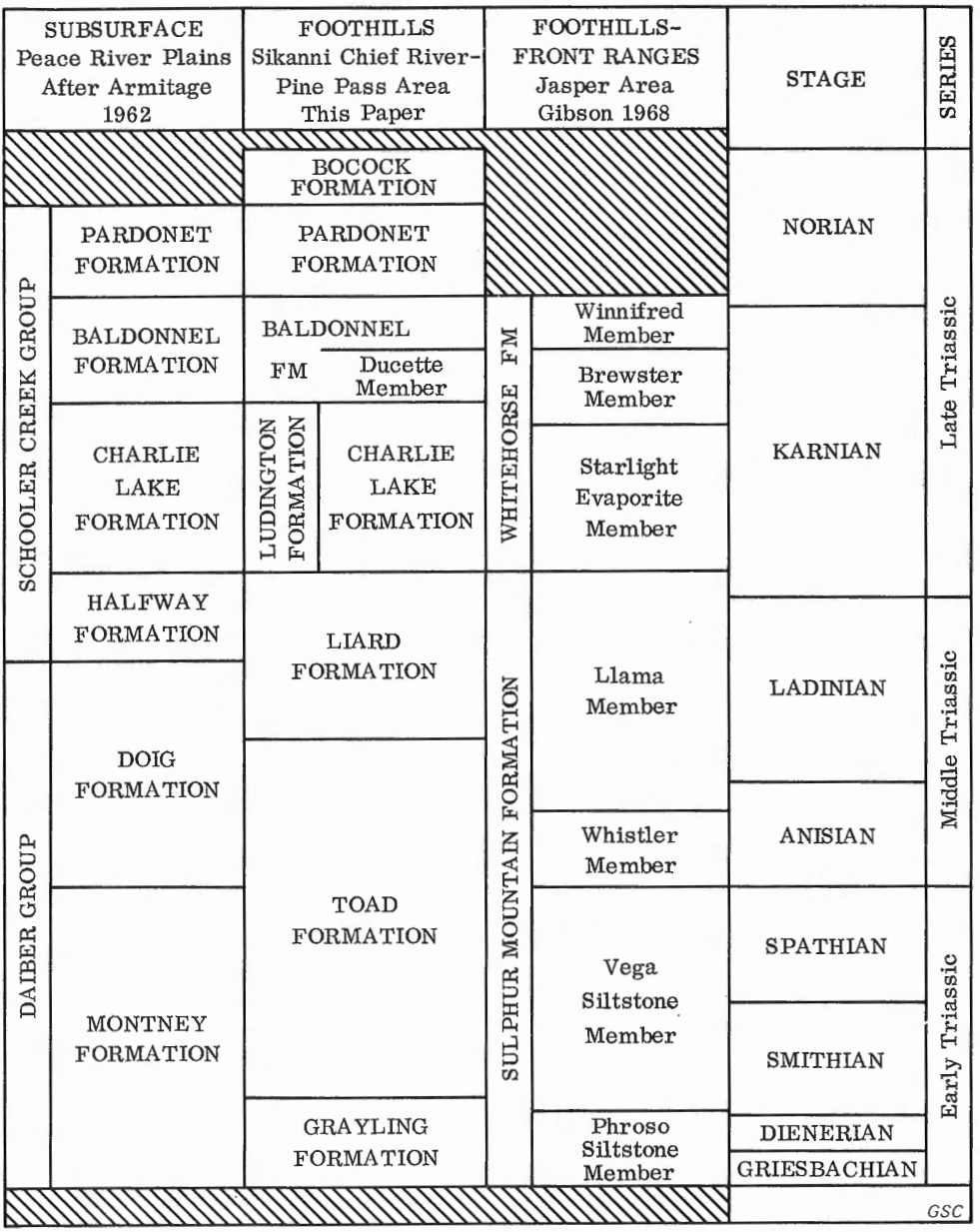


Figure 5. Correlation chart illustrating Triassic formations and members in the Sikanni Chief River-Pine Pass area, and their suggested correlation with formations and members in the subsurface Peace River Plains, and the Jasper area of Alberta.

The Toad Formation comprises a thick sequence of dark grey, shaly- to flaggy-weathering, carbonaceous-argillaceous, very calcareous siltstones, silty limestones, silty shales, and a lesser amount of silty dolomites and calcareous sandstones. At many localities the formation displays distinctive and characteristic alternation of resistant and recessive bedding, which is related to the carbonate and carbonaceous-argillaceous concentration of the strata. The thickness of the Toad Formation in the Sikanni Chief River - Pine Pass region ranges from 520 feet at Mount Greene (Section 68-17) to over 2,700 feet at South Halfway (Section 68-5). Recorded thicknesses south of Peace River are variable, possibly due to an uneven basement upon which the sediments were deposited, or to gradational contact between the underlying Grayling and overlying Liard Formations.

The most distinctive lithofacies in the Toad Formation is the "Flagstones", first observed by McLearn and Kindle (1950) near Mount Wooliever on Sikanni Chief River. The "Flagstones" consist of a dense, thin- to thick-bedded sequence of flaggy-weathering, calcareous siltstones, with thin carbonaceous-argillaceous silty shale partings. The strata are commonly laminated, and contain flute casts, groove casts, micro-cross laminations and oscillation ripple-marks, which indicate deposition by current action. The distinctive flaggy-weathering character of the facies was responsible for the name suggested by McLearn and Kindle (1950). The "Flagstones" at Mount Wolliever (Section 68-1) are overlain by recessive siltstones, limestones, and minor sandstones and shales ("Dark Siltstones"?) which contain Late Ladinian fossils of the Meginoceras meginae fossil zone (Tozer, pers. com.). South of Mount Wooliever, near the headwaters of Headstone Creek (Section 68-3), the same fossil zone was found below a typical "Flagstone" facies, thus suggesting the existence of two "Flagstone" facies in the area. At South Halfway (Section 68-5), two "Flagstone" facies were recognized, separated by a dark grey, recessive sequence of siltstones, limestones, and shales ("Dark Siltstones") containing Late Ladinian fossils of the Paratrachyceras sutherlandi zone. This zone occurs above the Meginoceras meginae zone, and therefore suggests the occurrence of a third "Flagstone" facies. Figure 6 illustrates the interfingering nature of the "Flagstones", and their lateral gradation westward into lithology typical of the Toad Formation. Another unusual lithofacies in the Toad Formation was observed at Mount Wright (Mount Stearns, Section 68-2) and South Halfway (Section 68-5). This facies, composed of fine- to medium-grained, very calcareous sandstone containing a large concentration of shell fragments is interpreted as representing a tongue or wedge of the Liard Formation (Fig. 6). It was not observed at Fiddes Creek (Section 68-6) to the west. The "Dark Siltstones" facies noted by McLearn and Kindle (1950) consists of an interbedded succession of dark grey-weathering, very calcareous, carbonaceous-argillaceous siltstones, sandstones, and silty and bioclastic limestones. At Mount Wright (Section 68-2), this lithofacies contains the Paratrachyceras sutherlandi fossil zone. Like the "Flagstone" facies, and the sandstone facies, the "Dark Siltstones" grade laterally westward into typical dark grey siltstones of the Toad Formation. In the region between Peace River and Pine Pass, the "Flagstone" and "Dark Siltstones" lithofacies were not observed.

The dark-weathering siltstones and interbedded sandstones of the formation are composed of angular grains of quartz, some feldspar, micro-aggregates and crystals of pyrite, and black to dark brown opaque carbonaceous-argillaceous matter, all cemented with recrystallized calcite and minor dolomite. Rutile, zircon, tourmaline, mica, and collophane occur as traces. The opaque carbonaceous-argillaceous matter is distributed throughout the strata, coating grains and permeating and staining the calcite cement and matrix. The opaque material, in conjunction with minor pyrite, is

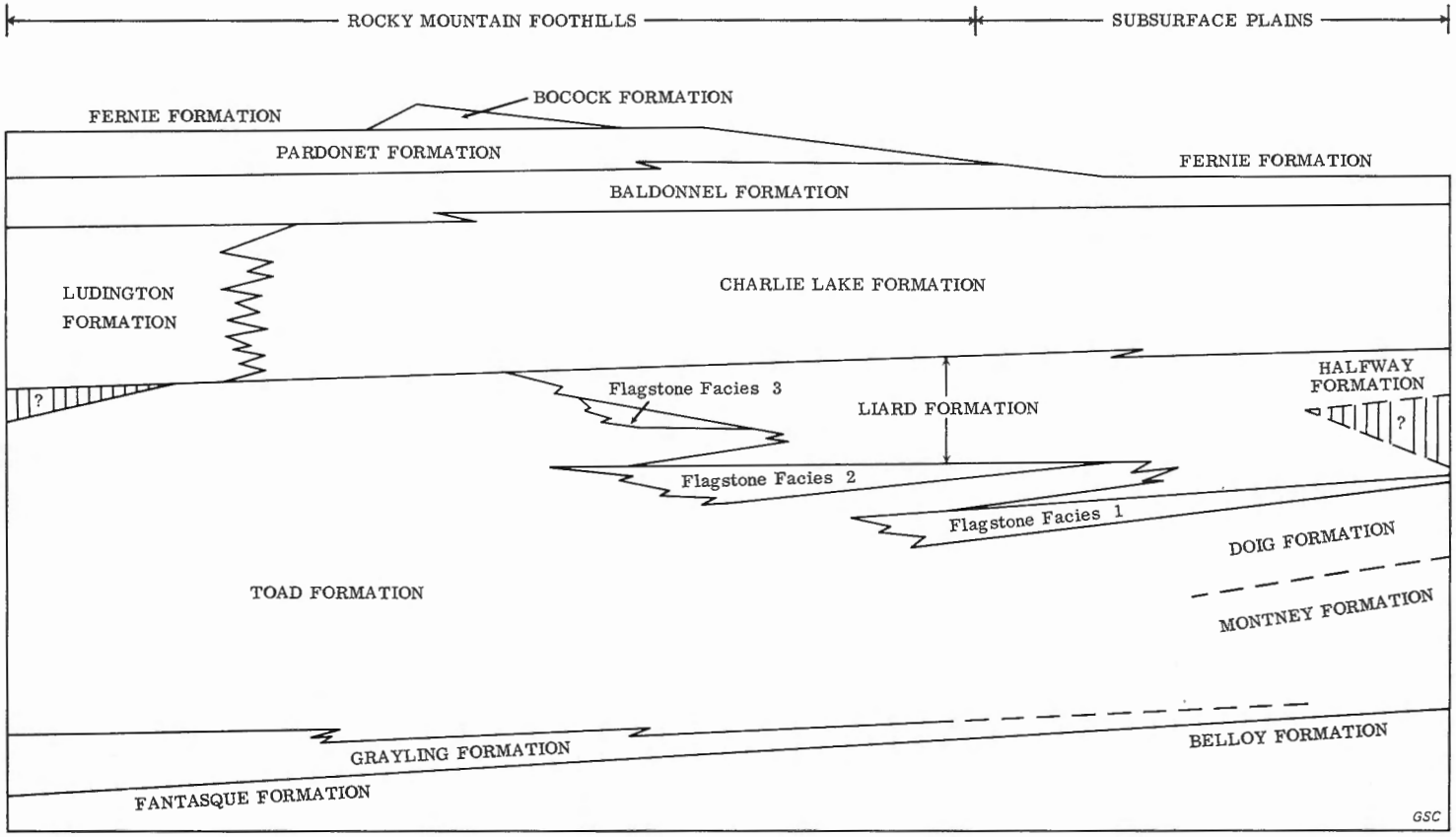


FIGURE 6. Schematic diagram showing probable relationships between Triassic formations between Rocky Mountain Foothills and subsurface Plains, Sikanni Chief River–Pine Pass area, northeastern British Columbia

partly responsible for the generally recessive, shaly-weathering character and the dark colouration of much of the strata in the formation. The carbonate minerals consist of calcite, lesser amounts of dolomite, and trace amounts of siderite. Calcite is mainly sparitic (Folk, 1959) and has been recrystallized, obliterating most primary textures and structures. Much of the detrital quartz and feldspar in the limestone occurs as isolated individual grains, and appears to "float" in the carbonate. This feature, along with ghost outlines of a few well rounded calcite grains, suggests that some or most of the carbonate may be of detrital origin. Dolomite commonly occurs as zoned euhedral rhombs. The large carbonate concentration of many of the siltstones creates difficulties in classifying field samples, because the distinction between silty, quartzose limestone or calcareous, quartzose siltstone is commonly dependent on laboratory analysis. Marine phosphate occurs sparingly throughout the formation. However, near the Toad-Grayling Formation contact at many western sections, black nodules, coarse grains, and lenticles are found over a stratigraphic interval of 100 to 350 feet. These nodular phosphates are well illustrated at Mount Ludington (Section 68-10), and at Peck Creek (Section 68-14).

The contact of the Toad Formation with the overlying Liard and Ludington Formations ranges from gradational, to sharp and conformable, to probably unconformable, depending on location in the Sikanni Chief River - Pine Pass area. South of Peace River, the contact is gradational. It is placed within a stratigraphic interval where the dark grey siltstones, silty limestones, and silty shales grade vertically into a sequence of predominantly lighter weathering, coarser grained siltstones, very fine-grained sandstones, and subconchoidally fracturing limestones. This contact with the Liard Formation, depending on type and degree of exposure , can usually be placed within a small stratigraphic interval, as illustrated at Clearwater Lake (Section 68-12). However, if the contact interval is partly covered or recessive, i.e. along mountain ridges, it is very difficult to place and must be allocated within a broad stratigraphic interval. The sharp, conformable type of contact is well illustrated at South Halfway (Section 68-5) and Mount Withrow (Section 68-4), around Halfway and Sikanni Chief Rivers, and in the immediate area north of Peace River. There, the dark grey, generally recessive siltstones, sandstones, limestones, and shales of the "Flagstone" and "Dark Siltstone" facies of the Toad Formation change abruptly into the light weathering, more resistant, crossbedded, very fine- to fine-grained sandstones of the Liard Formation. In the subsurface of the eastern Peace River Plains, an unconformity has been postulated at the base of the Halfway Formation by Hunt and Ratcliffe (1959) and by Armitage (1962). However, this unconformity is not apparent and is probably not present in the above region of the eastern Foothills. In the extreme western Foothills north of Peace River, the Toad Formation is probably overlain unconformably by medium grey-weathering, very fine-grained sandstones, siltstones, and silty to sandy to bioclastic limestones of the Ludington Formation. At most localities this contact is sharp and readily placed; however, at Fiddes Creek (Section 68-6) the contact may be conformable and gradational. Near Calnan Creek (Section 68-11), the base of the Ludington Formation is characterized by a 5-foot thick zone of conglomerate containing subangular and well rounded pebbles and cobbles of siltstone up to 1 foot in diameter. At Mount Ludington (Section 68-10), a similar notable lithologic break occurs between the Toad and Ludington Formations, but no conglomerate was observed. The magnitude of the unconformity is unknown because of the lack of fossils in the lower strata of the Ludington Formation. The contact of the Toad Formation with the underlying Grayling Formation is gradational as previously discussed.

The Toad Formation, as recognized by the writer in the Sikanni Chief River - Pine Pass area, encompasses a fauna ranging in age from Early Smithian to Late Ladinian. The best preserved and most useful faunas were collected from the siltstones and limestones overlying Flagstone facies 2 (Fig. 6). The following collections were identified by E. T. Tozer. The oldest fossils collected, representing the Smithian Stage, were Euflemingites cirratus (White), Wasatchites sp., and Posidonia mimer Oeberg (GSC locs. 82608, 82609). From the Early Ladinian Stage Daonella cf. D. degeeri Boehm, Daonella cf. D. longobardica Kittl, Daonella cf. D. subarctica Popov, Daonella cf. D. moussoni Merian, Nathorstites sp. and Protrachyceras sp. (GSC locs. 82638, 82676, 82656, 82668, 82657, 82658) were collected. Paratrachyceras sutherlandi McLearn, Asklepioceras laurenci McLearn, Nathorstites mcconnelli (Whiteaves), Megaphylites sp., Lobites ellipticus (Haver), Daxatina sp., Protrachyceras sp., "Prenkites" n. sp., Daonella cf. D. elegans McLearn and Daonella cf. D. nitanae McLearn (GSC locs. 82664, 82665, 82612, 82683, 82651, 83645, 82676, 82666) were collected and represent the Late Ladinian Stage. Brachiopods represented by "Terebratula" liardensis Whiteaves, Spiriferina abichi Oppel, and Rhynchonellids (GSC locs. 82685, 84213), and the ammonites Mclearnoceras? ?sp. and Protrachyceras sp., (GSC locs. 84215, 84257) were collected from strata of undifferentiated Ladinian age.

## Liard Formation

The Liard Formation, with type section at Hell Gate on Liard River, was named by Kindle (1946) for a massive-bedded sequence of "grey limestone and sandstone" resting conformably on the Toad Formation. McLearn and Kindle (1950) did not extend the name Liard south into the Peace River region of British Columbia; however, they included the equivalent lithofacies in the "Grey Beds". The name was first used in the area of study by Irish (1963, 1970). In the same area Pelletier (1964) recognized a Liard Formation overlain by the Halfway Formation, with both units containing fossils of the Nathorstites faunal zone. In the present investigation only the upper formation is included in the Liard. Beds assigned to the Liard Formation by Pelletier (1964) are included in the Toad Formation for reasons previously discussed. The Liard Formation, as defined by the writer in the Sikanni Chief River - Pine Pass area, includes strata considered equivalent to the subsurface Halfway Formation, and possibly part of the subsurface Charlie Lake Formation.

The Liard Formation consists of resistant, cliff-forming, very dolomitic to calcareous, fine- to coarse-grained sandstones, calcareous and dolomitic siltstones, and minor amounts of silty to sandy dolomites. Sandy to silty to bioclastic, buff-weathering limestones are intercalated in the succession at many localities. South of Peace River, these limestones are dark grey-weathering, very finely crystalline, and display a subconchoidal fracture. The formation is thin- to thick-bedded, and is generally light to medium grey to yellowish grey, except for strata south of Peace River. There, the formation is darker grey and weathers dark yellow-grey to brownish grey, reflecting a larger carbonaceous-argillaceous concentration. Regular to lenticular laminations and colour banding occur throughout most of the sandstones and siltstones. Crossbedding, micro cross-laminations, and oscillation ripple-marks are common in the sandstones and siltstones north of Peace River. Azimuth values recorded from crossbeds in some coarse-grained sandstones suggest a direction of current transport from the northwest. The Liard Formation north of Peace River has a variable thickness, which may be due in part to the difficulty in placing the contact with the overlying Charlie Lake Formation. The formation thins to the south,with a corresponding

increase in thickness west, of the Charlie Lake and Ludington Formations. At Headstone Creek (Section 68-3) the formation is 540 feet thick, whereas southwest at South Halfway (Section 68-5) it is 92 feet thick. In contrast, the Liard Formation thickens rapidly south of Peace River, again at the probable expense of the Charlie Lake Formation. At Clearwater Creek (Section 69-3), the formation is 1,370 feet thick. The minimum thickness recorded in the southern area is 1,160 feet at Peck Creek (Section 68-14).

Facies changes are common throughout much of the region, probably because of the shallow water depositional environment postulated for the sediments of the formation. One such change occurs between localities north and south of Peace River. In the central and eastern Foothills north of Peace River, the Liard Formation is characteristically yellow-grey to buff-weathering, and is composed mainly of sandstones and minor siltstones. In contrast, the formation south of Peace River is characterized by much darker weathering strata, with siltstones predominating over very fine-grained sandstones. Furthermore, south of Peace River the Liard Formation contains interbeds and thin intervals of dense, subconchoidally fracturing cherty limestone. North of Peace River, limestones occur throughout much of the Liard strata, but are very sandy to silty, and frequently bioclastic as noted around Schooler Creek (Section 68-15). At localities near Calnan Creek (Section 68-11), Mount Ludington (Section 68-10), and Fiddes Creek (Section 68-6), strata of the Liard Formation were not recognized. At the first two sections the Liard strata may have been truncated by erosion as is suggested by the occurrence of a conglomerate horizon at the base of the Ludington Formation near Calnan Creek. At Fiddes Creek, Liard strata may have thinned and/or changed into a facies typical of the Ludington or Toad Formations.

Mineralogically, the Liard Formation is similar to the underlying Toad Formation and some of the overlying formations. It differs, however, in texture and relative concentration of the constituent minerals. The detrital fraction consists mainly of quartz, with lesser amounts of orthoclase and plagioclase feldspar, all of which exhibit varying degrees of secondary silicification and carbonate corrosion. Accessory minerals include chert, muscovite, collophane, tourmaline, zircon, rutile, pyrite, possible clay minerals, and opaque carbonaceous matter. Dolomite, and to a lesser degree calcite, are fine to medium crystalline, and commonly occur as an intergranular cement. The dolomite, which is considered to be of secondary and of replacement origin, generally increases in concentration toward the Charlie Lake Formation contact. As in the other formations of the area all carbonate has been recrystallized, thus eliminating carbonate textures and microstructures of the original rock framework with the exception of some bioclastic limestone beds.

The contact of the Liard Formation with the overlying Charlie Lake Formation is gradational and very difficult to place at many sections. In the vicinity of Sikanni Chief and Halfway Rivers, it is defined on the basis of intercalated dolomite beds and the degree of weathering resistance. The contact is generally placed within an interval, where the sandstones and siltstones of the Liard Formation grade into or contain a large proportion of light-weathering silty to sandy dolomites. The dolomite strata are considered part of the Charlie Lake Formation. In addition to the lithologic change, the overlying Charlie Lake Formation is more recessive, and is characterized in part by numerous and sometimes large covered intervals. These contact characteristics are well displayed at Mount Withrow, Headstone Creek, and Mount Wright (Sections 68-4, 68-3, and 68-2). Between Halfway and Peace Rivers, the Liard-Charlie Lake Formation contact is again gradational and difficult to place. In this region the Charlie Lake

Formation is resistant, and contains very few intercalated dolomite beds in the basal part of the formation. The contact must, therefore, be drawn where the carbonate cement changes from mainly calcite to predominantly dolomite, and where the darker weathering strata of the Liard Formation change to buff- and yellow-weathering sandstones characteristic of the lower Charlie Lake Formation. South of Peace River, the contact with the Charlie Lake Formation is still gradational, but at most localities is readily apparent. In this southern region, the contact is drawn where dark grey-brown-weathering sandstones and siltstones of the Liard Formation change to light grey- to buff-weathering dolomites and dolomitic sandstones of the Charlie Lake Formation. Only at Clearwater Creek (Section 69-3) was the contact difficult to place because of interfingering facies between the two formations. Because of the gradational and variable nature of the Liard-Charlie Lake Formation contact, it might be suggested that a combination of the two formations as a single map unit would be more appropriate in mapping and studying the Triassic System in the region; however, the definitive stratigraphic characteristics between the two formations are apparent enough in most cases to warrant division into separate units, even though the contact between the two formations may in some localities be completely gradational, and may have to be placed within a gradational interval ranging over several hundred feet.

The Liard Formation, as now defined in the Sikanni Chief River - Pine Pass area, contains few fossils compared with the underlying Toad Formation. North of Peace River indeterminate bivalves and lingulid brachiopods were collected. In the region south of Peace River good index fossils of Late Ladinian and Early Karnian age were collected at Callazon Gap (Section 69-14). Tozer suggests that the fauna consisting of Daxatina cf. canadensis Whiteaves, Clionitites cf. wheeleri (Johnston), Clionitites cf. reesidei (Johnston), and Protrachyceras sp. (GSC locs. 84271, 84268) may represent a new subzone above the Early Ladinian Paratrachyceras sutherlandi zone. Also collected at the same locality were Trachyceras obesum Tozer, Halobia sp., and Badiotites sp. (GSC locs. 84269, 84267). Tozer indicates an Early Karnian age, with the fauna specifically assigned to the Trachyceras obesum zone (Tozer, 1967, p. 12).

## Charlie Lake Formation

The name Charlie Lake, proposed by L. M. Clark (1957) for upper Triassic subsurface evaporitic strata in northeastern British Columbia, was formally adopted by Hunt and Ratcliffe (1959) for a sequence of "massive anhydrites, red dolomitic siltstones, microcrystalline to cryptocrystalline, buff to grey dolomites, interbedded anhydrites and minor amounts of salt", with the type section located in Pacific Fort St. John Well No. 16. In the Foothills region, strata equivalent to this distinctive subsurface formation were recognized by McLearn and Kindle (1950) and included in their "Grey Bed" facies. The name Charlie Lake was first extended into the surface of the Foothills area by Colquhoun (1960, 1962), followed later by Pelletier in 1964. In the present investigation, the name is extended and used for all strata equivalent to, and of similar facies to the subsurface formation, even though the formational contacts between the surface and subsurface units may not coincide exactly. The general lithology and mineralogical concentration is similar between the surface and subsurface facies. Surface reference sections illustrating the lithology and facies variations in the Charlie Lake Formation are found at Schooler Creek (Section 68-15) north of Peace River, and Clearwater Lake and Callazon Gap (Sections 68-12, and 69-14) south of Peace River.

In the Foothills of the Sikanni Chief River - Pine Pass area, the Charlie Lake Formation comprises a buff to yellow, light grey to orange-brown weathering assemblage of dolomitic to calcareous sandstones, siltstones, sandy limestones and dolomites, and minor intraformational and solution breccias. The sandstones and siltstones, which predominate at most localities, are very quartzose, and are cemented by very fine to medium crystalline dolomite and lesser amounts of calcite. The sandstones are fine- to medium-grained, thin- to thick-bedded, partly laminated and crossbedded, and north of Peace River are usually friable and sometimes porous. The carbonates are often sandy to silty, and are composed of recrystallized, very fine to medium crystalline mosaics of calcite and dolomite. The dolomites are thin- to medium-bedded, and normally occur in the lower half of the formation; however, north of Peace River dolomite forms a dominant lithologic type in places in the upper third of the formation. Limestones are similar in character to the dolomites, but generally do not form as high a concentration. The collapse or solution breccias are composed of yellow to buff, angular clasts of silty to sandy dolomite and chalky limestone, up to 1 1/2 inches in diameter, cemented with sandy to silty, medium to coarsely crystalline limestone and dolomite. The general lithology and weathering character of the Charlie Lake Formation closely resembles, and is probably equivalent to, the Starlight Evaporite Member of the Whitehorse Formation in the Smoky-Athabasca River region of Alberta (Gibson, 1968). Because of the gradational and interfingering nature of the Charlie Lake - Liard Formation contact, formation thicknesses in some regions are quite variable. The formation ranges in thickness from a maximum of 1,330 feet at the headwaters of Schooler Creek (Section 68-15) to a minimum value of 600 feet measured at Mount Withrow on Sikanni Chief River (Section 68-4).

Facies changes in the Charlie Lake Formation are common in northeastern British Columbia, possibly attributable to the shallow water environment postulated for the deposition of these sediments. The most notable facies change occurs between the subsurface of the Plains and the surface exposures of the western Foothills. The Charlie Lake Formation in the subsurface is characterized by a thick sequence of evaporitic strata. To the west in the eastern and central Foothills, the equivalent stratigraphic interval consists of light grey- to buff-weathering sandstones, siltstones, and dolomites. Evaporitic strata are not present. These light-weathering strata again change facies westward into a medium grey succession of siltstones, sandstones, limestones, and minor dolomites. This western facies is so distinctive that a new name, the Ludington Formation, has been proposed. An excellent example illustrating the lateral gradation of the Charlie Lake Formation into the Ludington Formation can be seen near Chowade River (Section 68-8). At this locality, facies typical of the Charlie Lake Formation interfinger with strata typical of the Ludington Formation. East of this section, 2 miles across the valley, the lithology consists entirely of the Charlie Lake Formation. South of Peace River, the Charlie Lake Formation is more dolomitic and contains more intercalated dolomite beds than in the region to the north. A prominent vertical facies variation is evident between the lower two thirds and upper one third of the formation in the area bounded by Sikanni Chief and Peace Rivers. The upper facies consists mainly of medium dark grey to light grey, silty dolomites, bioclastic limestones, and minor amounts of dolomitic siltstones, in some localities containing white quartz-chert-filled vugs. This lithology is gradational with the main sand facies of the Charlie Lake Formation, and is not mappable as a separate unit in field exposures. Facies similar to the upper unit of the Charlie Lake Formation have been observed by the writer in subsurface cores of the Baldonnel Formation taken from the Plains region to the east. This surface facies may therefore be equivalent partly to the subsurface Baldonnel Formation.

The contact of the Charlie Lake Formation with the overlying Baldonnel Formation is commonly gradational north of Peace River, and is abrupt and distinct to the south between Pine Pass and Peace River. In the Sikanni Chief - Peace River area, the contact is placed within an interval where medium grey dolomites, siltstones, and limestones of the Charlie Lake Formation grade into light-weathering, cliff-forming limestones and calcareous dolomites of the Baldonnel Formation. The interfingering nature of this contact sometimes ranges over an interval of as much as 30 feet. However, at most sections the contact can be placed within an interval of 5 feet. South of Peace River, the contact with the Baldonnel Formation is abrupt and readily apparent. Typical of this contact relationship is Section 68-12, near Clearwater Lake. The Charlie Lake Formation consists of buff- to light grey-weathering, sandy to silty dolomites, and dolomitic siltstones and sandstones, and is overlain in sharp contrast by dark greyish brown-weathering limestones and dolomitic siltstones of the Ducette Member of the Baldonnel Formation. Field evidence which might suggest the presence of a small unconformity is lacking; however, because of the sharp and distinctive nature of this contact, the possibility of a minor diastem should not be discounted. The contact with the underlying Liard Formation is gradational as previously discussed.

The Charlie Lake Formation contains few fossils, probably because of the shallow water evaporitic conditions existing during deposition of the sediments. The deeper water correlative facies to the west, the Ludington Formation, contains a fauna of probable Karnian age. The only fossils collected from the Charlie Lake Formation were Pleuromya sp. and indeterminate pectinid bivalves (GSC loc. 82675). These pelecypods were collected 100 feet below the Baldonnel contact at Headstone Creek (Section 68-3). No age was assigned to the fossils by Tozer.

## Ludington Formation

In the extreme western part of the Foothills north of Peace River, the upper Triassic rock succession consists of a distinctive lithofacies equivalent to the Charlie Lake Formation and possibly to the upper part of the Liard Formation. These rocks have been named the Ludington Formation, after excellent exposures on Mount Ludington (Section 68-10); the exposure at this locality is designated the type section and the lithology is described in Section 4 of the Appendix. Other locations illustrating the typical lithology of the formation are found at Calnan Creek (Section 68-11), Fiddes Creek (Section 68-6), and Chowade River (Section 68-8). Similar strata occupying the same stratigraphic position in the Triassic succession have been observed by the writer in the area south of Liard River, near the Alaska Highway.

The Ludington Formation consists of a thick sequence of medium- to light grey-weathering, dolomitic to calcareous siltstones, sandstones, and silty to sandy to bioclastic limestones. The predominate siltstones and very fine- to fine-grained sandstones are quartzose and generally calcareous; however, at some sections to the east these strata are characterized by a high dolomite concentration. The grain size of the terrigenous detritals is such that a thin section or sieve analysis study is necessary for accurate petrographic classification. Furthermore, the high concentration of carbonate as cement and matrix makes classification of field samples difficult. Some siltstones and sandstones may in fact be very silty to sandy quartzose limestones. The siltstones and sandstones are thin- to medium-bedded, dark to medium grey, medium grey- to brownish grey-weathering, dense, well indurated, and do not appear to have any porosity. Where the strata have a high calcite concentration, they have a characteristic

"tinny" sound under foot on felsenmeer and scree slopes. Near Calnan Creek (Section 68-11), the base of the Ludington Formation is characterized by a conglomerate interval up to 5 feet thick, consisting of well rounded siltstone-sandstone pebbles and cobbles up to 1 foot in diameter in a very calcareous, ferruginous, sandstone matrix and cement. The conglomerate interval is interpreted to indicate the presence of an unconformity. The limestones occur as thin to medium interbeds, are frequently silty to sandy, and in some sections contain black chert bands and lenses. Where the limestones are siliceous, they are very finely crystalline, dense, and exhibit a subconchoidal fracture. The bioclastic limestones, consisting of a coquina of slightly silicifed, fragmented pelecypod-brachiopod shells and crinoid columnals, occur as lenticular beds, pods, and as distinctive "shell banks". At Fiddes Creek (Section 68-6) a "shell bank" facies has a measured thickness of 14 feet, whereas westward on the north side of Laurier Pass a similar "shell bank" unit is estimated to be over 200 feet thick. The coquina limestones are light grey- to white-weathering, sometimes sandy, and appear to be very porous. Black, vitreous pyrobitumen residues were observed filling the interfragmental vugs. The thickness range of the Ludington Formation in the Sikanni Chief - Peace River region is uncertain because of the lack of complete field sections. At Mount Ludington, the type locality of the formation, 1,640 feet of strata were measured; however, a small fault was observed at the contact with the Pardonet Formation. The displacement may be minor, and the recorded thickness close to the true value. At Fiddes Creek (Section 68-6) 1,720 feet of strata were measured, although there was no top to the section. The formation appears to attain its maximum thickness around Mount Laurier, where Pelletier (1964) recorded 3,150 feet of Triassic strata above his Liard Formation. Most of these strata are considered by the writer to be equivalent to the Ludington Formation.

The mineral composition of the Ludington Formation is similar to that of the Charlie Lake Formation, differing mainly in the concentration of calcite, which is much greater in the Ludington Formation. Conversely, the dolomite concentration is much greater in the equivalent Charlie Lake Formation. The detrital quartz and feldspars are generally finer grained in the Ludington Formation, suggesting deposition in deeper water than for detrital sediments of the Charlie Lake Formation. The occurrence of dark grey, carbonaceous-ferruginous matter is responsible in part for the dark colouration of much of the strata.

Two facies variations are worthy of note in the Ludington Formation. The most obvious variation is shown by the bioclastic "shell bank" limestones. These carbonates change laterally very abruptly into medium dark grey, silty limestones and calcareous siltstones as shown near Laurier Pass. The other notable facies variation concerns the concentration of dolomite as a cementing agent. At Fiddes Creek (Section 68-6), the lower third of the Ludington Formation has more dolomite than calcite as cement and matrix. At localities west and southwest of Fiddes Creek, the lower third of the Ludington Formation noticeably contains a much larger percentage of calcite than dolomite as the cementing agent in the sandstones and siltstones.

The main lithofacies variation was previously discussed under Charlie Lake Formation. This major facies change was significant enough to warrant establishing the Ludington facies as a new formation.

The lower contact of the Ludington Formation with the Toad Formation ranges from sharp and apparently unconformable to gradational and conformable. Near Calnan Creek (Section 68-11) the base of the Ludington Formation is characterized by a 5-foot thick zone of conglomerate containing pebbles and cobbles of siltstone up to 1 foot in

diameter. At Mount Ludington (Section 68-10) a similar sharp lithologic change occurs between the Ludington and Toad Formations, but the conglomerate was not observed. At Fiddes Creek (Section 68-6) the base of the Ludington Formation comprises a sequence of dark grey-weathering siltstones to sandstones and minor limestones which rest conformably upon dark grey-weathering siltstones and silty limestones of the Toad Formation. No lithologic or faunal evidence was observed to suggest the presence of an unconformity. The Ludington Formation was not observed in contact with the Liard Formation.

The upper contact with the Baldonnel Formation, where exposed, is generally sharp and conformable. Only at Mount Laurier was the contact observed. There, it is drawn where strata typical of the Ludington Formation pass abruptly into dense, well indurated, light grey-weathering limestones containing an abundance of crinoid columnal and shell fragments typical of the Baldonnel Formation. At Mount Ludington (Section 68-10) strata characteristic of the Baldonnel Formation were not observed, and the Ludington Formation was overlain by dark grey- to brown-weathering limestones and siltstones of the Pardonet Formation. This contact appears to be faulted as previously mentioned. The magnitude of the displacement, if significant, may only be minor. The absence of the Baldonnel strata may be explained by fault truncation or by a facies change into strata typical of the Ludington Formation. Near Mount Laurier (Fig. 1) strata typical of the Baldonnel Formation were estimated to be 50 feet thick. Therefore, if the Baldonnel Formation is present at Mount Ludington, the fault may have truncated at least 50 feet of strata. The alternative explanation of a possible facies change to account for the absence of the Baldonnel Formation at Mount Ludington is uncertain, because of the lack of stratigraphic sections in that vicinity containing exposures of the Ludington, Baldonnel, and Pardonet Formations. Except at Mount Laurier and Mount Ludington, the Ludington Formation forms the highest Triassic exposures in the westernmost Foothills because of weathering and Quaternary and Holocene erosion.

Fossil collections from the Ludington Formation are scarce, but the few obtained provide a lower and upper time range for the formation. At Fiddes Creek (Section 68-6) Halobia cf. H. ornatissima Smith (GSC loc. 82653) was collected 313 feet above the lower contact. Tozer suggests that the collection represents the Dilleri or Welleri Zones of Late Karnian age. At the same locality Tozer (pers. com.) collected Juvavites hyatti, a representative of the Welleri Zone. A similar age was suggested by Tozer for a collection consisting of "Anatomites" sp., and Spiriferina abichi Oppel (GSC loc. 82650) obtained from an interfingering tongue of Ludington strata south of Cypress Creek (Section 68-7). Near Calnan Creek (Section 68-11) Monotis montini McLearn (GSC loc. 82614) was collected 6 feet above the base. Tozer suggests a probable Ladinian age for the fossil. Thus, on the basis of scant fossil collections, the Ludington Formation is thought to range in age from Ladinian to Late Karnian.

## Baldonnel Formation

The Baldonnel Formation was defined by Hunt and Ratcliffe (1969) for a subsurface sequence of "buff, brown to grey, finely crystalline to microcrystalline, fossiliferous dolomite with some residual chert". The type section assigned was that occurring in the Pacific Fort St. John No. 16 Well. In the Foothills of the Sikanni Chief River - Pine Pass area, strata equivalent to the subsurface facies were originally included in the "Grey Beds" of McLearn and Kindle (1950), and were characterized by

the presence of the Lima poyana fauna. Later, Colquhoun (1960, 1962) and Pelletier (1964) extended the use of the subsurface name and applied it to surface exposures of a similar lithology and containing the Lima poyana fauna. The thickness of the Baldonnel Formation given by Pelletier (1964, p. 9) suggests that he included part of the Charlie Lake Formation as defined herein. Colquhoun (1960, 1962), on the other hand, recognized contact boundaries similar to those of the writer. The Baldonnel Formation in the Sikanni Chief River - Pine Pass region can be divided into two distinct facies. The upper main unit occurs throughout the study area; however, the lower unit, herein named the Ducette Member, is confined to the area adjacent to and south of Peace River. The lithology of the Ducette Member will be described and discussed as a separate unit following documentation of the main facies of the Baldonnel Formation.

The Baldonnel Formation comprises a light grey- to brownish grey-weathering, resistant, cliff-forming sequence of limestones, dolomites, lesser siltstones, and very fine-grained sandstones. The carbonates are slightly silty, commonly carbonaceous-argillaceous, and at most localities contain medium to dark grey chert lenses and nodules. The limestones are finely crystalline to aphanitic to bioclastic, are slightly silty, and may be very dolomitic. The bioclastic limestone consists of abraded and fragmented crinoid columnals and pelecypod - brachiopod shells. The dolomite is very calcareous, slightly silty, and displays similar textural parameters to the limestone. At Pink Mountain (Section 69-15), the dolomite and limestone beds emit a strong fetid petroliferous odour upon fracture, and some of the bioclastic interbeds contain micro-vugs lined and filled with calcite, white quartz, and black vitreous pyrobitumen residues. The very fine- to fine-grained sandstones and siltstones were observed only in the eastern Foothills as intercalated thin to medium beds. They are quartzose, very calcareous, commonly laminated, and locally contain crossbedding. Calcite and dolomite form the dominant mineral assemblage in the formation, occurring as distinct lithofacies, as cement, as detrital grains, and as bioclastic fragments. The carbonate minerals have been recrystallized, thus masking and obliterating much of the original framework and texture of the strata. Other minerals present but in smaller concentrations are quartz, feldspar, and traces of collophane, pyrite, carbonaceous matter of variable concentration, rutile, zircon, tourmaline and apatite. The Baldonnel Formation ranges in thickness from a minimum of 270 feet at South Halfway (Section 68-5) to a maximum of 480 feet at the headwaters of Eleven Mile Creek (Section 68-16) south of Peace River. The thickness range of the main and typical facies of the formation, excluding the Ducette Member, is from a minimum of 150 feet at Carbon Creek (Section 69-1) to a maximum of 340 feet at Mount Wooliever (Section 68-1) on Sikanni Chief River.

Facies variations in the Baldonnel Formation are minor in comparison to those in the underlying formations. The most prominent lateral change is shown by the calcite to dolomite mineral proportions from the western Foothills to the subsurface Plains in the east. At Mount Laurier, the most western exposure of the Baldonnel Formation, the strata consist entirely of limestone. Northeast, across the topographic strike of the area near Mount Wooliever and Mount Withrow (Sections 68-1, 68-4), the calcite and limestone concentration decreases with a proportionate increase in dolomite. In the subsurface the Baldonnel Formation consists mainly of dolomite with very little to no limestone. Furthermore, the mineral change is accompanied by a prominent porosity and permeability change eastward, thus making the Baldonnel Formation in the subsurface a productive gas reservoir. Another conspicuous facies change concerns the carbonaceous-argillaceous concentration of the strata. The concentration increases from north to south, such that strata south of Peace River are generally much darker and more recessive than equivalent strata north of Peace River.

The contact of the Baldonnel with the overlying Pardonet Formation is generally sharp and distinct; however, at some localities the contact is gradational and must be placed within a stratigraphic interval of 10 feet. It is placed at the top of resistant, cliff-forming, light to medium grey-weathering carbonates, underlying finely laminated, thin-bedded, carbonaceous-argillaceous limestones of the Pardonet Formation. The lower contact with the Charlie Lake and Ludington Formations ranges from gradational to sharp and distinct, depending on locality.

Fossils obtained from the Baldonnel Formation in the Sikanni Chief River - Pine Pass area include Terebratula julica Bittner, Spiriferina abichi Oppel, and Lima sp., (GSC locs. 82688, 82671, 82669). Tozer considers the collection to be part of the Mysidioptera poyana zone, and of Karnian age.

Ducette Member

South of Peace River, the lower part of the Baldonnel Formation consists of a distinctive dark grey-brown-weathering sequence of strata, herein named the Ducette Member. The type section of this member is that occurring near the headwaters of Eleven Mile Creek (Section 68-16; see Section 7 of Appendix for description). This distinctive unit was formerly mapped as the Pardonet Formation by Muller (1961).

The Ducette Member consists of dark grey-brown, carbonaceous-argillaceous siltstones, very fine-grained sandstones, limestones, and minor dolomites. The siltstones and sandstones are quartzose, very dolomitic to calcareous, dark grey to greyish brown, thin- to thick-bedded, and commonly display fine regular to wavy laminations and colour banding. The limestones and minor dolomites, usually restricted to the lower half of the member, are dark grey, slightly quartzose, and finely crystalline to bioclastic. The bioclastic strata are similar to those in the main facies of the Baldonnel Formation. All strata of the Ducette Member are dense, well indurated, and emit a slight petroliferous odour upon fracture. The member varies in thickness from a minimum of 145 feet near the headwaters of Carbon Creek (Section 69-1) to a maximum of 390 feet near Clearwater Lake (Section 68-12), indicating a thickening trend toward the west.

The Ducette Member is restricted mainly to the area between Peace River and Pine Pass. At Schooler Creek (Section 68-15), a thin unit of dark grey-brown-weathering siltstone, outcropping in a partly covered interval below the main Baldonnel contact, suggests that the member is present in this area. The most eastern surface exposure of the member was observed near the headwaters of Carbon Creek (Section 69-1). On the basis of this exposure of 145 feet, the Ducette facies is thought to extend eastward into the subsurface.

The upper contact between the Ducette Member and the typical Baldonnel facies is gradational. It is placed within a small interval where the dark grey-brown-weathering siltstones and silty limestones grade into more resistant and lighter-weathering limestones and dolomites of the typical facies of the Baldonnel Formation. The lower contact with the Charlie Lake Formation is sharp and readily apparent, and may represent a diastem. The contact is placed at a point where the light grey- to buff-weathering dolomites and dolomitic sandstones of the Charlie Lake Formation change abruptly into the dark weathering limestones and siltstones of the Ducette Member.

The Ducette Member is mainly unfossiliferous except for the bioclastic limestone interbeds found near the lower contact. At Clearwater Lake and Clearwater Creek (Sections 68-12, 69-3), undetermined rhynchonellid brachiopods were collected. No age was suggested by Tozer.

## Pardonet Formation

In his early Triassic investigations in northeastern British Columbia, McLearn (1940) recognized a distinctive sequence of dark siltstones at the top of the Schooler Creek Formation to which he gave the name Pardonet Beds. McLearn (1960) later elevated the unit to formational status because of its wide geographical extent and excellent mappable boundaries. A type section containing over 2,000 feet of strata was designated at Pardonet Hill on the south side of Peace River. Tozer (1967, p. 57) re-examined the type section of the Pardonet Formation, and discovered fossil zone and stratigraphic repetition resulting from small scale thrust faulting. The Pardonet Formation as defined in the present study has lithologic boundaries similar to those recognized by McLearn (1960), Colquhoun (1960, 1962), Pelletier (1963, 1964), Tozer (1967), and Irish (1963, 1970). However, in the region south of Peace River Pelletier (1964) included strata of the overlying Bocock Formation in the Pardonet Formation. Because of faulting and generally poor exposure at the type section, a supplemental reference section is proposed near the headwaters of Eleven Mile Creek (Section 68-16). This section, one of the thickest and most completely exposed in the area of study, is 19 miles south of Pardonet Hill.

The Pardonet Formation consists of dark grey to dark brownish grey-weathering, carbonaceous-argillaceous limestones, silty limestones, calcareous and dolomitic siltstones, and minor shale. The limestone is commonly quartzose and dolomitic, finely crystalline to bioclastic, and emits a fetid odour upon fracture. The bioclastic limestone consists of whole and fragmented pelecypod and brachiopod shells which generally form dense coquina interbeds. The limestone is thin- to medium-bedded, and weathers shaly to flaggy, commonly forming recessive, partly covered intervals. The dark grey siltstones are thin- to thick-bedded, quartzose, carbonaceous-argillaceous, and cemented by finely crystalline calcite and minor dolomite. The siltstones occur mainly in the upper two-thirds of the formation. Laminations form a distinctive feature of the formation and are used in part to define the lower contact. There are four main types. The most common type of lamination consists of a coquina layer of very thin-shelled, often fragmented, Halobia pelecypods. These laminations are very wavy, and have a distinctive crenulated appearance. The second type of lamination consists of a coquina of much thicker and larger intact shells of the index pelecypod Monotis subcircularis. These laminations, like the first type, also are very wavy and crenulated. Near the base of the Pardonet Formation at Pink Mountain and Carbon Creek (Sections 69-15 and 69-1), a third type consisting of very fine wavy, crenulated laminations with no obvious shell material were observed in association with well preserved ooliths and pisoliths. The laminations may be of algal origin, similar to laminated stromatolites observed today along coasts of recent carbonate sedimentation. Their genesis is difficult to determine because of the recrystallization of the carbonate minerals composing the strata. The last type of lamination was confined to the quartzose siltstone interbeds. These laminations were very light grey, containing little to no organic carbonaceous matter, and were composed mainly of quartz and medium crystalline calcite and dolomite. In contrast to the organic laminations of the limestones, the siltstone laminations are lenticular to regular, with no obvious crenulations. Some of the

laminated coquina intervals contained large and small, flattened, ovoid concretions as much as 2 feet in diameter. These concretions commonly contained well preserved ammonites and pelecypods. The formation ranges in thickness from a maximum of 450 feet near the headwaters of Eleven Mile Creek (Section 68-16) south of Peace River, to 126 feet at Pink Mountain (Section 69-15). The eastward thinning is mainly the result of pre-Fernie erosion and possibly, to a lesser degree, sedimentary convergence with the eastern edge of the depositional basin.

The Pardonet Formation north of Peace River is unconformably overlain by dark grey, recessive shales, shaly siltstones, and limestones of the Jurassic Fernie Formation. At Pine River Bridge near Pine Pass, the Pardonet Formation is overlain unconformably by the Fernie Formation. Throughout the rest of the area south of Peace River, the formation is overlain, probably disconformably, by the Bocock Formation. The contact is placed where dark grey-brown, recessive limestones and minor siltstones of the Pardonet Formation change abruptly into very light grey- to white-weathering limestones of the Bocock Formation.

The Pardonet Formation, one of the most fossiliferous units in the Triassic succession, has yielded many collections which have been studied and grouped into faunal zones by McLearn (1960) and Tozer (1967). The following collections from field Sections 68-1, 68-2, 68-4, 68-5, 68-7, 68-15, 68-16, 69-1, 69-4, 69-6, and 69-15 were identified and dated by Tozer. The Late Norian lower Rhabdoceras suessi Zone (Tozer, 1967, p. 12) was represented by Monotis subcircularis Gabb and Gryphaea sp. (GSC locs. 82689, 82682, 82659, 82633). Collected from strata representative of the Middle Norian Himavatites columbianus Zone were Monotis scutiformis pinensis Westermann, Monotis scutiformis typica Kiparisova, Halobia sp., Parajuvavites n. sp., and Alloclinoites ?? sp. (GSC locs. 82686, 82680, 82674, 82662, 82631). Drepanites sp., Juvavites magnus McLearn, and Halobia sp. (GSC locs. 82663, 82649) were collected from beds lying within the Middle Norian Drepanites ruthordfordi and Juvavites magnus Zones. Malayites dawsoni McLearn (GSC loc. 82647) from the Early Norian Malayites dawsoni Zone was collected near Cypress Creek (Section 68-7). The oldest fossils obtained from the Pardonet Formation were Guembelites cf. G. jandianus Mojsisovics, and Thisbites cf. T. dawsoni McLearn (GSC loc. 84198), which represent the Early Norian Mojsisovicsites kerri Zone. The distribution and ages of the above fossil collections indicate that the Pardonet Formation is diachronous toward the south, containing fossils older than those found toward the north. For a more complete and comprehensive discussion of fossil zones in the Pardonet Formation of the Sikanni Chief River - Pine Pass area, the reader is referred to reports by McLearn (1960) and Tozer (1967).

## Bocock Formation

Between Peace River and the John Hart Highway (Fig. 1), the Pardonet Formation is overlain by a distinctive, resistant sequence of limestones, herein named the Bocock Formation after excellent exposures in the vicinity of Bocock Peak (Section 69-5). The type section assigned to the formation is located near the headwaters of the east fork of Carbon Creek (Section 69-1), where all lithofacies typical of the formation are exposed (see Section 9 of Appendix for lithology of type section). Pelletier (1963) observed this unusual facies during his regional studies but did not name the unit, and grouped it as part of the post-Liard lithologic succession.

The Bocock Formation comprises a very resistant, light grey- to buff-weathering, medium- to thick-bedded sequence of limestone. The limestone is medium to medium light grey, aphanitic to coarsely crystalline to bioclastic, and at some localities is slightly dolomitic and sandy. The bioclastic limestone is restricted mainly to the most eastern exposures, and consists of fragmented pelecypod and brachiopod shells, and crinoid columnals forming medium to thick beds of encrinite with good intergranular porosity near Bocock Peak (Section 69-5). The bioclastic limestones are sometimes permeated by black vitreous pyrobitumen residues, and emit a strong fetid odour upon fracture. At the type section, large well-rounded mounds or "balls" were observed near the overlying Fernie Formation contact. These structures closely resemble stromatolites; however, no lamination or algal filaments have been recognized. Strata of the Bocock Formation become more dense, nonporous, and more finely crystalline from east to west, as shown by exposures at the type section near Carbon Creek and near Eleven Mile Creek (Section 68-16). Bioclastic interbeds follow the same trend, such that at most western localities bioclastic limestones are uncommon. The Bocock Formation ranges in measured thickness from a minimum of 65 feet near Bocock Peak (Section 69-5) to a maximum of 208 feet at the type section on the east fork of Carbon Creek. Thickness values indicate a thickening trend from east to west. The eastward extent of the formation is not known; however, on the basis of thickness values at some eastern sections, it is postulated as extending into the subsurface. The formation has not been observed north of Peace River nor south of the John Hart Highway. At Pine River Bridge crossing, the formation is absent and the Pardonet is overlain by the Fernie Formation.

The lower contact with the Pardonet Formation may be unconformable. Near Bocock Peak (Section 69-5), the contact has a relief of as much as 2 inches, with the lowest bed of the Bocock Formation containing phosphatic, rust-coated, angular clasts up to 1 inch in length. Near Eleven Mile Creek (Section 68-16), the contact relief and thin conglomerate horizon were not observed; however, the contact was sharp and abrupt as previously discussed. The upper contact with the Jurassic Fernie Formation is distinct and probably unconformable. It is placed where the light-weathering, cliff-forming limestones of the Bocock Formation change abruptly into dark grey to black siltstones, shales, and limestones of the Fernie Formation. Near Eleven Mile Creek this contact was observed to have an estimated relief of 25 feet with the Fernie Formation.

Because of the lack of diagnostic and identifiable fossils, the age of the Bocock Formation is unknown. However, lithologic similarity to limestones and dolomites of the Baldonnel Formation, and the contrast in lithology between the dark weathering strata of the Fernie Formation, suggest that the Bocock Formation is probably part of the Triassic rock succession, and possibly Late Norian or younger in age.

Figure 3 contains columnar sections illustrating thickness, lithology, and facies relationships of Triassic rocks between the Foothills and subsurface Plains in the northern and southern regions of the Sikanni Chief River - Pine Pass area, northeastern British Columbia.

## CORRELATION

The correlation of all formations and facies units in the Sikanni Chief River - Pine Pass region has been established and documented in the foregoing text. Suggested correlations with formations and facies in the subsurface has been mentioned briefly, and will now be discussed in more detail. The correlation of Triassic strata in various regions of Western Canada has previously been outlined and discussed by McLearn and Kindle (1950), Hunt and Ratcliffe (1959), Colquhoun (1960, 1962), Armitage (1962), and Barss et al., (1964). The writer agrees with many of the correlations made by the above writers with minor modifications, and will, therefore, concentrate on the equivalance of the new stratigraphic units recognized in the study area, and how they relate to similar units of other regions in the Western Canada sedimentary basin. Until the region between Pine Pass and Smoky River has been studied in more detail, some of the correlation must remain tentative. All correlations are based on stratigraphic position, fossil content, and lithologic similarity. Figures 4 and 5 are nomenclature and correlation charts respectively illustrating the Triassic formations in the Sikanni Chief River - Pine Pass area, and their suggested correlation with formations in the subsurface of the Peace River Plains, and the Jasper - Banff region to the south.

The Grayling Formation in the Sikanni Chief River - Pine Pass area is poorly exposed, and difficult to correlate with other areas. At all localities where the Triassic - Permian contact is exposed, a Grayling lithofacies similar to the lithology of the type section on Liard River was observed. The Grayling Formation in the study region has not as yet yielded fossils older than Dienerian age, whereas the Grayling of the type locality contains Claraia stachei of Late Griesbachian age. The Grayling Formation in the Sikanni Chief River - Pine Pass area, therefore, is an extension of the formation of the same name in the Liard River region to the north. In the subsurface east of the Sikanni Chief River - Pine Pass area, strata characteristic of the Grayling Formation have not been recognized. On the basis of a sparse fauna and similar lithology, it is tentatively correlated with the lower part of the Montney and Toad-Grayling Formations of Armitage (1962) and Hunt and Ratcliffe (1959), respectively. In the Jasper region of Alberta, a Grayling-like lithofacies containing Claraia stachei has been recognized and named the Phroso Siltstone Member (Gibson 1968). The Grayling Formation of the study region may therefore be equivalent to the Phroso Siltstone Member on the basis of similar lithology and relative stratigraphic position; however, based on the contained fauna it can be correlated with at least the upper part of the Phroso Siltstone Member and the lower part of the Vega Siltstone Member of the Sulphur Mountain Formation.

The Toad Formation, as now defined by the writer in the Foothills region of northeastern British Columbia, includes the Toad Formation, "Flagstones", and "Dark Siltstones" of McLearn and Kindle (1950), and the Toad Formation and Mount Wright Formation of Colquhoun (1962). On the basis of lithological similarity, fossil content, and stratigraphic position, the Toad Formation may be correlated with the upper two thirds of the Toad-Grayling Formation of Hunt and Ratcliffe (1959) and with at least the upper half of the Montney Formation, and all of the Doig Formation of Armitage (1962) in the subsurface.

A more precise correlation with the subsurface Montney and Doig Formations in the study region is not possible because of the absence of a distinctive phosphate horizon in surface exposures. The phosphate pebble horizon in the subsurface is used

as a contact criterion in separating the Montney and Doig Formations. The top of the subsurface Toad-Grayling or Doig Formations is characterized by a flagstone-like facies similar in composition and appearance to the Flagstone facies No. 1 of figure 6. In the Liard River region, the Toad Formation of the Sikanni Chief River - Pine Pass area is equivalent in age to the type Toad Formation and part of the Liard Formation. In the Sikanni Chief - Halfway River area the "Dark Silstones" facies of the Toad Formation contains the Nathorstites index fauna, whereas in the Liard River region this fauna is found in the Liard Formation. In the Jasper - Banff region to the south, the Toad Formation is correlated with most of the Vega Siltstone, Whistler, and lower part of the Llama Members of the Sulphur Mountain Formation (Gibson 1968). This correlation is based mainly on the occurrence of similar faunas; the general lithology between the two areas differs, with a major facies change occurring immediately south of the John Hart Highway (Fig. 1).

The Liard Formation, as defined in the Sikanni Chief - Pine Pass area, is equivalent to the Halfway Formation of Colquhoun (1962) and Pelletier (1964) and is equivalent to the upper part of the Toad Formation in the western Foothills (Figs. 4 and 6). In the subsurface of the Plains, the formation is equivalent to all of the Halfway Formation and probably to part of the Charlie Lake Formation. This relationship is based mainly on lithologic similarities, as fossil control between the two regions is lacking. The suggested equivalence to part of the Charlie Lake Formation is based on the nebulous placement of the Halfway - Charlie Lake Formation contact in some locations. The Liard Formation of the Sikanni Chief River - Pine Pass area is equivalent to the upper part of the type Liard Formation in the Liard River region, where the lower part of the type formation is correlated with the "Dark Siltstones" facies of the Toad Formation. In the Jasper - Banff region of Alberta, the Liard Formation is probably the stratigraphic equivalent of the upper two thirds of the Llama Member (Gibson 1968) and possibly part of the Starlight Evaporite Member of the Whitehorse Formation.

The Charlie Lake Formation in the Foothills is correlated with the Ludington Formation farther west, and interfingers with part of the Liard Formation as illustrated in figure 6. The Charlie Lake Formation is equivalent to the type formation in the subsurface Plains and possibly to part of the Baldonnel Formation. Because fossil control between the two regions is lacking, correlations must be made on the basis of lithologic similarity and relative stratigraphic position. The extent and distribution of the Charlie Lake Formation north of Sikanni Chief River is unknown; however, in the region immediately south of Liard River a facies similar to the Ludington Formation is exposed, which may be equivalent to the Charlie Lake Formation. In the Jasper - Banff region of Alberta, the Starlight Evaporite Member of the Whitehorse Formation (Gibson 1968) is considered equivalent to the Charlie Lake Formation. Both lithofacies are similar, and occupy comparable stratigraphic positions. Because of its equivalence to the Charlie Lake Formation, the Ludington Formation would be equivalent also to the Starlight Evaporite Member to the south.

The Baldonnel Formation, containing the Lima poyana fauna of McLearn and Kindle's (1950) "Grey Beds", is equivalent to most of the type formation in the subsurface. Part of the subsurface Baldonnel Formation, however, may be equivalent to a grey-weathering lithofacies at the top of the Charlie Lake Formation. The exact correlation of the Ducette Member is speculative because of the restricted distribution in the area of study and the absence of identifiable fossils. It may, however, be equivalent to the grey-weathering lithofacies of the upper part of the Charlie Lake Formation observed

at some localities north of Peace River. The correlative of the Baldonnel Formation in the Liard River region is uncertain. On the basis of a brief field excursion into the area, the Ludington Formation equivalent is thought to be overlain at some localities by a resistant, light weathering sequence of carbonates, similar to the main Baldonnel facies in the Sikanni Chief River region. This distinctive facies may be equivalent to the Baldonnel Formation. Correlation with the Jasper - Banff region is tentative until investigations have been concluded in the intervening region between Smoky River and Pine Pass. The occurrence of Lima poyana and Terebratula julica in strata around Jasper and Pine Pass suggests a correlation of the Baldonnel Formation with the Brewster Limestone Member and probably all or part of the Winnifred Member of the Whitehorse Formation (Gibson 1968).

The distinctive Pardonet Formation can readily be correlated throughout the Sikanni Chief River - Pine Pass region, and has been recognized by other workers in the western subsurface. In the Liard River area, the Pardonet Formation is similar and equivalent in age to the type formation on Peace River. The Pardonet Formation has not been identified, nor has any equivalence been demonstrated in the Jasper - Banff region of Alberta. If deposited, most strata of the formation were removed by pre-Fernie erosion.

The Bocock Formation of probable Triassic age has no known correlative in the Western Canada sedimentary basin.

## DEPOSITIONAL HISTORY

The following discussion of the depositional history of Triassic sediments in the report area is presented only as a preliminary interpretation of events and will be subject to possible revision, pending completion of the petrological phase of the investigation. The interpretation is general and no attempt is made to compare or equate the Triassic paleoenvironments with specific modern depositional environments. Barss et al., (1964) summarized ideas and hypotheses of other workers, as well as their own interpretations of the Triassic depositional history of Western Canada. The following interpretation is similar in part to that documented by Barss et al., (1964). Figure 6 is an interpretive sketch illustrating lithofacies relationships in the basin of deposition in the Foothills region of northeastern British Columbia.

In the Sikanni Chief River - Pine Pass area, Triassic strata were deposited in the Cordilleran Miogeosyncline of the Western Canada sedimentary basin. Prior to Triassic deposition, the region probably underwent uplift and erosion or nondeposition, although in the Foothills region no lithologic evidence has yet been found to indicate erosion. Conglomerate commonly found at the Paleozoic-Mesozoic stratigraphic contact in the Jasper region (Gibson 1968) has not been observed in the Sikanni Chief River - Pine Pass area of British Columbia.

The Triassic period began with a marine transgression, probably from the north or northwest, during which time the sediments of the Grayling Formation were deposited in relatively deep water. Fossil evidence suggests that the Grayling Formation in the type area of Liard River may be older than the Grayling Formation in the present study region. In addition the formation in the type area is much thicker than that in the Sikanni Chief River - Pine Pass area. In the Jasper region of Alberta, the Grayling Formation equivalent consists of similar lithology and contains a fauna as

old as that found in the Liard River area. This feature suggests that during the Early Triassic, the Sikanni Chief River - Pine Pass area may have been a topographic high or platform area, which restricted deposition of the older Claraia-bearing strata found north and south of the study area. Following deposition of the Grayling strata, the seas began to pulsate, resulting in minor fluctuations in sea level as shown by the cyclically bedded siltstones and silty shales sometimes found in the Toad Formation. The first significant regression in the area is indicated by the presence of Flagstone facies No. 1 (Fig. 6). This facies is interpreted as having been deposited by shallow water turbidity currents. The sediments of this lithic unit are slightly coarser grained than those in the underlying typical Toad Formation. Overlying this Flagstone facies is a thin veneer of fine- to medium-grained sandstone, which provides additional evidence of a regression and relatively shallow water deposition. With the deposition of this facies, the area again underwent transgression toward the east, resulting in further deposition of siltstones of the typical Toad Formation. Following this depositional phase, the seas again regressed and sediments of Flagstone facies No. 2 were deposited in a manner similar to those of Flagstone facies No. 1. The eastward transgression before deposition of Flagstone facies No. 2 was not as extensive as earlier transgressive stages. As a result, the eastern shoreline probably migrated westward toward the eastern Foothills. This migration might have resulted in the beginning of an interval of nondeposition or stratigraphic erosion in the eastern Plains, and could account for the stratigraphic hiatus postulated in some areas at the base of the subsurface Halfway Formation. Following deposition of Flagstone facies No. 2, the seas continued to withdraw, resulting in the deposition of a thin tongue of fine- to medium-grained sandstone similar to that of the Liard Formation. The seas again transgressed eastward, resulting in the deposition of the Nathorstites-bearing siltstones and limestones of the Toad Formation. Farther east, shallow water sandstones and bioclastic carbonates of the Halfway Formation were being deposited. Throughout most of Early and Middle Triassic time, the sediments were derived mainly from an east to northeast source area, as suggested by the lenticular nature and westward termination of the Flagstone facies (Fig. 6). The limited mineral variety and concentration suggest a source area of low relief probably consisting of pre-existing sediments. Following deposition of the "Dark Siltstone" facies of the Toad Formation, the region underwent a major regression with a consequential shallowing of the seas in the Sikanni Chief River - Pine Pass area resulting in the deposition of Flagstone facies No. 3, and the sandstones, siltstones, and carbonates of the upper Liard, Charlie Lake, and Ludington Formations. The Liard Formation was deposited under shallow water conditions as suggested by the occurrence of oscillation ripple-marks, fine and coarse crossbedding, and a notable grain size increase over sediments in the underlying formations. Paleocurrent observations recorded from the Liard and Charlie Lake Formations, although limited in number, indicate a current transport direction from the north to northwest, in contrast to the suggested transport direction for sediments of the Toad and Grayling Formations. The paleocurrent observations agree with those of Colquhoun (1960) and Armitage (1962), but do not agree with those recorded by Pelletier (1964, p. 10), who obtained paleocurrent values indicating sediment transport from the north to northeast. Deposition of Liard sediments may have been accompanied by tectonic disturbances in the eugeosynclinal region to the west. Wheeler (1966) suggests that evidence exists for Middle Triassic plutonism in the eastern tectonic belt of the Western Cordillera. The tectonism may have had some influence on the source area and the distribution of Liard and younger sediments and, furthermore, might account for the absence of Liard strata and the occurrence of the conglomerate horizon observed near Calnan Creek (Section 68-11). Following deposition of the Liard Formation in the eastern and central parts of the study area, the seas continued to regress with consequent shallowing. The light-

weathering evaporitic sediments of the Charlie Lake Formation were deposited in the east, and the grey-weathering, slightly deeper water sediments of the Ludington Formation were deposited in the west. Eastward transgression is again suggested for sediments of the Baldonnel Formation. The fragmented nature of the fossil shells and crinoid columnals, common constituents of the formation, indicates shallow water deposition, probably close to or above wave base. The sediments are carbonaceous-argillaceous, do not contain any obvious evaporite minerals, and suggest a probable change from a semi-arid to arid climate to one more temperate in nature. Most sediments of the Pardonet Formation were deposited under relatively deep water conditions in comparison to sediments of the Baldonnel Formation; however, at Pink Mountain and Carbon Creek (Sections 69-1 and 69-15) the basal Pardonet contained well fromed ooliths in algal-like laminations. The occurrence of ooliths suggests deposition under agitated shallow-water conditions, probably above wave base. The intact nature of Monotis and Halobia pelecypod shells, coupled with the large concentration of carbonaceous-argillaceous material, suggests that most deposition took place below effective wave base in an euxinic environment. Convection currents may at times have caused upwelling, bringing toxic water close to the surface, causing the extermination of the pelagic pelecypods. Following deposition of the Pardonet Formation, the seas underwent regression and most of the area was uplifted and probably subjected to some pre-Fernie erosion. South of Peace River, however, a shallow marine embayment remained and the light-weathering limestones of the Bocock Formation were deposited under shallow-water conditions. The Bocock Formation contains no carbonaceous-argillaceous matter and no obvious terrigenous detrital grains. The bioclasts in the formation have been fragmented and comminuted, probably as a result of wave action. The Triassic Period in the Sikanni Chief River - Pine Pass area was terminated by further marine regression, uplift, and probable erosion, as suggested by the contrasting sediments in the overlying Jurassic Fernie Formation.

## ECONOMIC GEOLOGY

### OIL AND GAS

Triassic rocks contain over 90% of the proved ultimate crude oil reserves and 34% of the proved ultimate natural gas reserves (Canadian Petrol. Assoc., 1969) of the subsurface Plains of northeastern British Columbia. Production is obtained mainly from the Halfway and Baldonnel Formations, with lesser but still economical quantities from two horizons in the Charlie Lake Formation, and a shore-line facies of the Montney Formation. Although a few wells have been drilled, only minor production has been obtained from the Sukunka River area of the Foothills belt in northeastern British Columbia.

Triassic rocks throughout most of the Foothills in the Sikanni Chief River - Pine Pass area occupy a high proportion of the total surface exposure, such that potential hydrocarbon entrapment is severely limited. The Grayling and Toad Formations, good hydrocarbon sources, are generally impervious and nonporous; however, in field exposures the sandstone unit overlying Flagstone facies No. 2 is friable, contains intergranular porosity and permeability, and where suitable traps exist might serve as a potential reservoir rock. The Liard Formation, the surface equivalent of the productive subsurface Halfway Formation, is generally tight and nonporous, with the exception of the area north of Peace River near Schooler Creek.

At this locality, some of the sandy coquina limestones and medium-grained sandstones seem to have good porosity. Around Sikanni Chief and Halfway Rivers, some friable and porous sandstones also have been observed in the Liard Formation. The Charlie Lake Formation, which contains the productive Inga and Coplin Members in the subsurface, does not look promising in the Foothills north of Peace River. However, some poorly indurated, friable sandstones, which under suitable conditions might serve as potential reservoirs, have been observed. Between the John Hart Highway and Peace River, the Charlie Lake Formation is dense and well indurated, with no obvious effective porosity. In the western Foothills around Mount Laurier, the Ludington Formation contains lenticular beds, pods, and "banks" of porous shell coquina. One "shell bank" on the north side of Laurier Pass was estimated to be over 200 feet thick. Under certain conditions, these limestone coquinas would serve as excellent hydrocarbon reservoirs. The Baldonnel Formation in the central and western Foothills is generally dense and well indurated, with no visible porosity. In the eastern Foothills, however, the formation emits a characteristic strong petroliferous odour upon fracture, and contains zones of bioclastic carbonates with vugular and intercrystalline porosity. In the vicinity of Cypress Creek, 15 miles southeast of Pine Mountain (Section 69-15), natural gas is produced from the formation. The Pardonet Formation is unfavourable as a hydrocarbon reservoir because of the shaly and impervious nature of the strata. The overlying Bocock Formation between Peace River and the John Hart Highway has an excellent reservoir potential, provided the formation extends into the subsurface of the eastern Foothills and western Plains. The most eastern exposures of the formation contain numerous very porous bioclastic interbeds. Coupled with an excellent source rock below, and a good cap rock above, the Bocock Formation has the prospect of being a good petroleum reservoir.

## PHOSPHATE

Phosphate occurs sparingly throughout much of the Grayling and Toad Formations in the Sikanni Chief River - Pine Pass area. However, at some western localities north of Peace River, and throughout the entire Foothills belt south of Peace River, the phosphate is fairly abundant although its economic exploitation may not appear feasible under present market conditions. The phopshate occurs in dolomitic and calcareous siltstones and shales as black nodules of variable shapes and sizes up to 2 inches in diameter. These nodules occur near the base of the Toad Formation and in some localities in the upper part of the Grayling Formation, usually ranging over a stratigraphic interval of approximately 100 to 350 feet. Sections examined that contained phosphate nodules were located at Mount Ludington, near Calnan Creek, and at all locations between Peace River and John Hart Highway. In the eastern Foothills the nodular phosphate interval was not observed; however, thin granular phosphatic beds were noted at Mount Withrow in the Toad Formation.

## GYPSUM-ANHYDRITE

Anhydrite occurs throughout the subsurface Charlie Lake Formation; however, in the surface strata of the Foothills evaporite minerals were not observed by the writer. In the Jasper region of Alberta, the Charlie Lake equivalent Starlight Evaporite Member of the Whitehorse Formation contains surface deposits of gypsum up to 145 feet thick (Gibson 1968).

REFERENCES

Armitage, J. H.
1962: Triassic Oil and Gas Occurrences in Northeastern British Columbia, Canada; J. Alta. Soc. Petrol. Geol., vol. 10, No. 2, pp. 35-56.

Barss, D. L., Best, E. W., and Meyers, N.
1964: in Geological History of Western Canada; edited by R. G. McCrossan and R. P. Glaister; Alta. Soc. Petrol. Geol., Calgary, Alberta, pp. 113-36.

Canadian Petroleum Association
1969: Statistical year book, 196; Canadian Petroleum Association, Calgary, Alberta, p. 57.

Clark, D. R.
1961: Primary Structures of the Halfway Sand in the Milligan Creek Oil Fields, British Columbia; J. Alta. Soc. Petrol. Geol., vol. 9, No. 4, p. 109.

Clark, L. M.
1957: Fort St. John Sets Pace for Peace River Gas Fields; The Oil and Gas Journal, vol. 55, No. 33, pp. 132-134.

Colquhoun, D. J.
1960: Triassic Stratigraphy of Western Central Canada; Univ. Illinois, Ph. D. Dissertation.

1962: Triassic Stratigraphy in the Vicinity of Peace River Foothills, British Columbia; Edmonton Geol. Soc., 4th Field Trip Guidebook, pp. 57-88.

Folk, R. L.
1959: Practical Petrographic Classification of Limestones; Am. Assoc. Petrol. Geol., vol. 43, No. 1, pp. 1-38.

Gibson, D. W.
1968: Triassic Stratigraphy Between the Athabasca and Smoky Rivers of Alberta; Geol. Surv. Can., Paper 67-65.

1968b: Triassic Stratigraphy Between Athabasca and Brazeau Rivers of Alberta; Geol. Surv. Can., Paper 68-11.

Goddard, E. N.
1951: Rock-Colour Chart; Geol. Soc. Am., Second Printing 1951.

Hughes, J. E.
1967: Geology of the Pine Valley, Mount Wabi to Solitude Mountain, Northeastern British Columbia; British Columbia Department of Mines and Petroleum Resources, Bull. 52.

Hunt, A. D., and Ratcliffe, J. D.
1959: Triassic Stratigraphy, Peace River Area, Alberta and British Columbia, Canada; Bull. Am. Assoc. Petrol. Geol., vol. 43, pp. 563-589.

Irish, E. J. W.
1963: Halfway River Map-Area, British Columbia; Geol. Surv. Can., Map 22-1963.

1970: Halfway River Map-Area, British Columbia; Geol. Surv. Can., Paper 69-11.

Kindle, E. D.
1944: Geological Reconnaissance Along Fort Nelson, Liard, and Beaver Rivers, Northeastern British Columbia and Southeastern Yukon; Geol. Surv. Can., Paper 44-16.

1946: The Middle Triassic of Liard River, British Columbia; Appendix I, see McLearn 1946.

McLearn, F. H.
1921: Mesozoic of Upper Peace River, B. C.; Geol. Surv. Can., Sum. Rept. 1920 pt. B, pp. 1-6.

1930: Preliminary Study of the Faunas of the Upper Triassic Schooler Creek Formation, Western Peace River, B. C.; Trans. Roy. Soc. Can., 3rd ser., vol. XXIV, sec. IV, pp. 13-20.

1940: Triassic of Beattie Hill, Peace River Foothills, B. C.; Can. Field - Nat., vol. LIV, pp. 79-82.

1941: Triassic Stratigraphy of Brown Hill, Peace River Foothills, B. C.; Trans. Roy. Soc. Can., 3rd ser., vol. XXXV, sec. IV, pp. 93-104.

1941a: Triassic Stratigraphy, Mahaffy Cliffs to Red Rock Spur, Peace River Foothills, B. C.; Can. Field - Nat., vol. LV, pp. 95-100.

1945: The Lower Triassic of Liard River; Geol. Surv. Can., Paper 45-28.

1946: A Middle Triassic (Anisian) Fauna in Halfway, Sikanni Chief, and Tetsa Valleys, Northeastern British Columbia; Geol. Surv. Can., Paper 46-1, Second edition 1948.

1947: Upper Triassic Faunas of Pardonet Hill, Peace River Foothills, British Columbia; Geol. Surv. Can., Paper 47-14.

1947a: The Triassic Nathorstites Fauna in Northeastern British Columbia; Geol. Surv. Can., Paper 47-24.

1960: Ammonoid Faunas of the Upper Triassic Pardonet Formation, Peace River Foothills, British Columbia; Geol. Surv. Can., Mem. 311.

McLearn, F. H., and Kindle, E. D.
1950: Geology of Northeastern British Columbia; Geol. Surv. Can., Mem. 259.

Muller, J. E.
1961: Geology of Pine Pass, British Columbia; Geol. Surv. Can., Map 11-1961.

Pelletier, B. R.

1963: Triassic Stratigraphy of the Rocky Mountains and Foothills, Peace River District, British Columbia; Geol. Surv. Can., Paper 62-26.

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

1965: Paleocurrents in the Triassic of Northeastern British Columbia; in Primary Sedimentary Structures and their Hydrodynamic Interpretation; edited by G. V. Middleton; Soc. Econ. Paleo. and Min., Sp. Publ. No. 12; pp. 233-245.

Tozer, E. T.

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

Westermann, G. E. G.

1962: Succession and Variation of Monotis and the Associated Fauna in the Norian Pine River Bridge Section, British Columbia (Triassic Pelecypoda); J. Paleontol., vol. 36, No. 4, pp. 745-792.

Wheeler, J. O.

1966: Eastern Tectonic Belt of Western Cordillera in British Columbia; C. I. M., Special Volume No. 8, pp. 27-45.

# APPENDIX

## Measured Sections

Section 1. Section measured up the east flank, across the top, and down the west flank of a steep ridge 1 1/2 miles south of Halfway River; 56°56'45"N., 123°25'W. Stratigraphic field section GK-68-5.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | PARDONET FORMATION (173 feet) | | |
| 45 | Limestone and siltstone: quartzose, very carbonaceous-argillaceous; limestone very fossiliferous, consisting of fragmented and whole pelecypod shells; siltstone very calcareous, dark grey, and weathering same; medium-bedded with laminations in upper part; beds dense and well indurated near Fernie contact; Monotis subcircularis Gabb, and Gryphaea sp. collected from upper 5 feet - GSC loc. 82659; upper 30 feet resistant, remainder recessive | 101 | 4,305 |
| 44 | Limestone: quartzose, very carbonaceous-argillaceous; bioclastic to finely crystalline; limestone very silty in part, may be classed as silty limestone; dark grey, and weathering same; thin- to medium-bedded; sulphurous odour upon fracture; large reptile bone fragments; Parajuvavites n. sp., Monotis scutiformis typica Kiparisova, and Halobia sp. collected from upper 10 feet - GSC loc. 82662; weathers shaly to flaggy; resistant to slightly recessive | 41 | 4,204 |
| 43 | Limestone: similar to unit 44; fine to coarse, wavy, crenulated laminations throughout; weathers very shaly in upper 7 feet; Juvavites magnus McLearn in upper 5 feet, with large reptile bones - GSC loc. 82663; strong petroliferous odour upon fracture; resistant; unit forms sharp contact with underlying Baldonnel Formation | 31 | 4,163 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | BALDONNEL FORMATION (268 feet) | | |
| 42 | Limestone: slightly carbonaceous-argillaceous, dolomitic; bioclastic to finely crystalline; medium dark grey, weathering light grey; unit contains profusion of crinoid ossicles and broken pelecypod-brachiopod shell fragments; thick-bedded; well indurated; nonporous; resistant | 80 | 4,132 |
| 41 | Limestone: slightly quartzose and dolomitic; carbonaceous, possibly argillaceous; finely crystalline and partly bioclastic; medium dark grey with brown mottling in part, and weathering medium to light grey; indistinctly bedded, but appears to be medium- to thick-bedded; fetid odour upon fracture; resistant | 50 | 4,052 |
| 40 | Limestone: slightly silty, very dolomitic in part, very argillaceous-carbonaceous in part; finely crystalline to bioclastic; medium dark grey with slight brown tint, and weathering medium grey; indistinctly bedded, but appears medium; some beds consist of broken pelecypod-brachiopod shells; dolomite present as a more coarsely crystalline mottling; limestone in lower half has subconchoidal fracture; strong fetid odour upon fracture; nonporous; resistant to slightly recessive; unit forms base of Baldonnel Formation | 138 | 4,002 |
| | CHARLIE LAKE FORMATION (1,072 feet) | | |
| 39 | Dolomite: very silty in part, and may be classed as dolomitic siltstone, very calcareous in part, possibly argillaceous; finely crystalline; medium grey, and weathering same; medium- to thick-bedded; fine, regular to wavy, dark grey laminations in part; well indurated; nonporous; resistant | 30 | 3,864 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 38 | Siltstone: very dolomitic, may be in part classed as finely crystalline silty dolomite, calcareous, carbonaceous-argillaceous; medium grey, and weathering dark brownish grey; thick-bedded; dense; well indurated; upper 1 foot consists of bioclastic limestone, containing patches of pyrobitumen matter; unit displays spheroidal weathering in part; resistant and cliff-forming | 70 | 3,834 |
| 37 | Covered interval, except for small exposure in centre, consisting of very silty, slightly calcareous, finely crystalline to granular-pelletoid dolomite; medium grey to yellowish grey, with in part orange-brown mottling; upper third of unit contains talus of white quartz- and chert-filled vugs; interval recessive | 130 | 3,764 |
| 36 | Dolomite: very quartzose, may be classed in part as dolomitic sandstone, calcareous, argillaceous; finely crystalline; yellowish grey, and weathering light grey; indistinctly bedded; weathers rubbly; well indurated; nonporous; resistant | 10 | 3,634 |
| 35 | Covered interval, except for small exposure of argillaceous, pyrobitumen-mottled, pelletoid dolomite; cement consists of sparry calcite | 50 | 3,624 |
| 34 | Dolomite and sandstone to siltstone: quartzose, argillaceous, slightly calcareous; carbonate very finely crystalline to aphanitic; sandstone very fine- to medium-grained; medium to very light grey to yellowish grey, and weathering same to yellowish orange in part; medium- to thick-bedded up to 3 feet, with most beds about 1 foot thick; beds wavy in part, with some displaying distinct colour mottling; dolomite contains white calcite-filled vugs in part; lower 50 feet inaccessible; dense; well indurated; nonporous; upper 25 feet very rubbly-weathering; resistant to slightly recessive | 150 | 3,574 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 33 | Sandstone and minor dolomite: quartzose, argillaceous, slightly calcareous; sandstone fine- to medium-grained; dolomite very finely crystalline to pelletoid; light grey to yellowish grey, and weathering light grey; medium- to thick-bedded, up to 3 feet, with most beds about 1 foot thick; coarse laminations in part; minor crossbedding in lower 30 feet; pyrobitumen-filled micro vugs in part; resistant and cliff-forming | 126 | 3,424 |
| 32 | Sandstone: quartzose, dolomitic, slightly argillaceous; very fine- to fine-grained; light grey to yellowish grey, and weathering medium grey to yellowish grey, with slight orange mottling; thick- to medium-bedded; worm burrows perpendicular to bedding; dense; well indurated; resistant | 145 | 3,298 |
| 31 | Sandstone and minor dolomite: quartzose, slightly argillaceous; sandstone dolomitic, very fine- to fine-grained; carbonate sandy, quartzose, very finely crystalline; medium grey to yellowish grey, and weathering yellowish grey-brown to light grey for dolomite; medium-bedded; intraformational breccia in lower 25 feet, with angular dolomite clasts up to 1 1/2 inches in diameter; lower 1 foot consists of slightly sandy, dense dolomite with subconchoidal fracturing; resistant | 71 | 3,153 |
| 30 | Sandstone to siltstone, and minor silty dolomite: quartzose, slightly calcareous in part, possibly argillaceous; dolomite very finely crystalline; yellowish grey to medium light grey, and weathering brownish grey to orange-brown; medium- to thick-bedded, up to 4 feet; well indurated; appears non-porous; worm tubes? in upper 40 feet; massive and cliff-forming | 140 | 3,082 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 29 | Sandstone and minor siltstone: quartzose, dolomitic; sandstone very fine grained; medium grey to yellowish grey, and weathering greyish brown to yellow-brown; medium- to thick-bedded; coarse dark grey laminations in part; very siliceous in part; dense, well indurated; nonporous; resistant | 150 | 2,942 |
| | LIARD FORMATION (92 feet) | | |
| 28 | Sandstone: quartzose, very dolomitic, argillaceous, possibly carbonaceous; very fine grained; medium grey with slight brown tint, and weathering greyish brown; medium-bedded, up to 8 inches; wavy to lenticular beds; wavy to lenticular, fine to coarse, dark grey laminations; in part micro cross-laminations; weathers rubbly in part; forms recessive notch near top of ridge | 29 | 2,792 |
| 27 | Siltstone to very fine-grained sandstone: quartzose, dolomitic, carbonaceous-argillaceous; medium dark grey, and weathering greyish brown; medium- to thick-bedded; fine to coarse, regular to lenticular, dark grey laminations; crossbedded in part; beds in part wavy to lenticular; resistant and cliff-forming | 63 | 2,763 |
| | TOAD FORMATION (2,700 feet plus) | | |
| 26 | Siltstone: quartzose, calcareous, very carbonaceous-argillaceous, dolomitic near top; may be classed in part as very fine-grained sandstone; medium dark grey, and weathering dark grey to orange-brown; thin- to medium-bedded, up to 15 inches; thin beds display fine to medium, regular, to wavy lenticular, dark grey laminations; thicker beds faintly laminated; partial alternation of resistant-recessive beds, typical of Flagstone facies; micro cross-laminations in part; resistant to slightly recessive | 182 | 2,700 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 25 | Siltstone, limestone, and shale: quartzose, very carbonaceous; siltstone and limestone very argillaceous; limestone finely crystalline to bioclastic; medium dark grey, and weathering same; appears to be medium-bedded; wavy to lenticular light grey laminations in part; talus fossils representing interval consist of Paratrachyceras sutherlandi McLearn, Asklepioceras laurenci McLearn, and Nathorstites mcconnelli (Whiteaves) - GSC loc. 82664; unit weathers shaly to flaggy; partly talus covered; recessive | 200 | 2,518 |
| 24 | Sandstone to siltstone, and minor limestone: quartzose, very carbonaceous-argillaceous; limestone finely crystalline to bioclastic; medium dark grey, and weathering greyish brown; medium- to thick-bedded, up to 4 feet; limestone occurs as lenticular beds replete with Terebratulid brachiopods; unit may represent base of "Dark Siltstones" facies; weathers rubbly; wavy laminations; resistant | 72 | 2,318 |
| 23 | Siltstone to very fine-grained sandstone: quartzose, calcareous, slightly dolomitic, carbonaceous-argillaceous; medium grey, and weathering same to greyish brown; thin- to medium-bedded; fine, regular to slightly wavy, light grey laminations; Terebratula liardensis Whiteaves collected from silty limestone bed in upper 1 foot - GSC loc. 82661; resistant | 31 | 2,246 |
| 22 | Sandstone: quartzose, calcareous, possibly argillaceous; very fine- to fine-grained; yellowish grey to greyish orange, and weathering same to medium grey; indistinctly to thick-bedded, up to 3 feet; colour banding and mottling in part; black vitreous pyrobitumen; dense; well indurated; nonporous; small, well rounded "cannon-ball" concretions up to 6 inches in diameter in lower 10 feet; massive, resistant, and cliff-forming | 100 | 2,215 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 21 | Siltstone: quartzose, very calcareous, carbonaceous-argillaceous; may be classed in part as very fine-grained sandstone; medium grey, and weathering yellowish grey-brown; thin- to medium-bedded, up to 15 inches; fine to coarse, wavy to lenticular, dark grey laminations; in part micro cross-laminated; few silty shale interbeds; weathers flaggy in part; unit represents top of lower Flagstone facies; siltstone dense; well indurated; non-porous; resistant | 82 | 2,115 |
| 20 | Siltstone, to silty limestone: quartzose, slightly dolomitic, carbonaceous-argillaceous; medium dark grey, and weathering same to orange-brown; thin- to medium-bedded, up to 18 inches; fine to coarse, regular to wavy lenticular, light grey and dark grey laminations; few non-laminated thicker interbeds; partly covered; weathers flaggy in part; recessive | 135 | 2,033 |
| 19 | Siltstone: quartzose, very calcareous in lower half, very carbonaceous-argillaceous, may be classed in part as silty shale, slightly dolomitic; medium grey, and weathering same to orange-brown; thin- to medium-bedded, up to 2 feet; thin beds well laminated as above, thicker beds faintly laminated; small load casts 40 feet from base; weathers shaly to flaggy; recessive; partly covered | 193 | 1,898 |
| 18 | Siltstone: quartzose, very calcareous, argillaceous-carbonaceous, with interbeds of silty shale; medium grey, and weathering same to orange-brown; thin- to thick-bedded; fine to coarse, light and dark grey, regular to lenticular laminations throughout; micro cross-laminations in part; shale interbeds fissile in part; unit represents base of Flagstone facies; slightly recessive | 87 | 1,705 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 17 | Sandstone: quartzose, very calcareous, possibly argillaceous; very fine- to fine-grained; light grey, and weathering same to orange-brown; thick-bedded, up to 6 feet; "cannon-ball" concretions up to 10 inches in diameter; worm? tubes parallel to bedding; very resistant | 12 | 1,618 |
| 16 | Siltstone to silty limestone: quartzose, slightly dolomitic, carbonaceous-argillaceous; medium dark grey, and weathering greyish brown; medium-bedded, up to 10 inches; medium to coarse, regular to wavy laminations in part; Daonella cf. D. subarctica Popov, collected from upper 10 feet - GSC loc. 82660; scattered calcispheres? in part; slightly recessive to resistant | 104 | 1,606 |
| 15 | Siltstone: similar to unit 16, except thicker bedded, up to 12 feet; coarse, regular to wavy lenticular laminae; weathers flaggy; resistant | 92 | 1,502 |
| 14 | Siltstone to silty limestone: quartzose, slightly dolomitic, carbonaceous-argillaceous; medium dark grey, and weathering same; medium- to thick-bedded, up to 3 feet; medium to coarse, regular to lenticular, light and dark grey laminations throughout; scattered calcispheres?; moderate induration; nonporous; slightly recessive to resistant | 112 | 1,410 |
| 13 | Siltstone to silty limestone: quartzose, slightly dolomitic, very carbonaceous-argillaceous; medium dark grey, and weathering same; medium- to thick-bedded, up to 3 feet; fine to coarse, regular to wavy lenticular, light grey laminations in part; upper half contains calcispheres? and brachiopod-pelecypod shell fragments; weathers flaggy in part; slightly recessive | 122 | 1,298 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 12 | Siltstone to silty shale: quartzose, calcareous, carbonaceous; medium dark grey, and weathering same to orange-grey-brown; mainly indistinctly bedded, but few beds up to 4 feet; laminated in part; weathers flaggy in 1 to 2 inch slabs; slightly recessive to recessive | 111 | 1,176 |
| 11 | Siltstone to silty shale, and silty limestone: similar to unit 12, except appears more calcareous and carbonaceous-argillaceous; indistinctly to thick-bedded, up to 5 feet; weathers shaly to flaggy; upper half recessive, and contains shell fragments and calcispheres ?; lower half slightly recessive to resistant | 149 | 1,065 |
| 10 | Siltstone, silty shale, and silty limestone: quartzose, very carbonaceous-argillaceous; dark grey, and weathering same; indistinctly bedded; poorly indurated; faint laminations; weathers flaggy to shaly; recessive | 74 | 916 |
| 9 | Siltstone: quartzose, very calcareous, carbonaceous-argillaceous; medium dark grey, and weathering same to orange-brown; medium- to thick-bedded, up to 8 feet thick; fine to coarse, regular to wavy, light grey laminations in part; cyclical development of resistant - recessive beds in part; Daonella cf. D. subarctica Popov, 40 feet from base - GSC loc. 82657; thinner beds laminated, weather flaggy; resistant to slightly recessive | 82 | 842 |
| 8 | Siltstone: quartzose, very calcareous, very carbonaceous-argillaceous, may be classed in part as silty shale and silty limestone; medium dark grey, and weathering same to dark orange-brown; thin- to thick-bedded, up to 8 feet, with most beds 2 to 3 feet thick; thicker beds dense, display moderate induration and spheroidal weathering; recessive shale "zones" between thicker beds; trace shell fragments in lower half of unit; resistant | 101 | 760 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 7 | Siltstone and silty shale: quartzose, calcareous, carbonaceous-argillaceous; dark grey, and weathering same to orange-brown; thin- to thick-bedded, up to 3 feet; alternation of resistant and recessive weathering beds; recessive zones most common; weathers flaggy in part; recessive | 88 | 659 |
| 6 | Siltstone to silty limestone: quartzose, dolomitic, carbonaceous-argillaceous; medium dark grey, and weathering same to dull orange-brown; indistinctly to thick-bedded; shell fragments in part; weathers flaggy in part; slightly recessive to resistant | 70 | 571 |
| 5 | Siltstone and silty shale: quartzose, calcareous, very carbonaceous-argillaceous; medium dark grey, and weathering same to greyish yellow to orange-brown; mainly indistinctly bedded, but one bed 11 feet thick at top; Daonella-like pelecypods in lower 50 feet; weathers shaly to flaggy; upper half less argillaceous, resistant to slightly recessive; lower half recessive | 155 | 501 |
| 4 | Siltstone: quartzose, calcareous, carbonaceous-argillaceous; dark grey, and weathering same; indistinctly bedded, but appears thin to medium; fine to medium, regular to slightly wavy, light grey laminations; weathers shaly to flaggy in plates 1/4 to 3/4 inches thick; resistant | 76 | 346 |
| 3 | Siltstone to silty shale, and minor silty limestone: quartzose, calcareous, very carbonaceous-argillaceous, slightly dolomitic; medium dark grey, and weathering same; mainly indistinctly bedded; fine to medium, regular to wavy lenticular, light grey laminations throughout; Daonella cf. D. moussoni Merian collected from lower 15 feet - GSC loc. 82658; upper half contains trace of very thin shell? fragments; weathers shaly to flaggy; slightly recessive | 104 | 270 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 2 | Siltstone to silty shale, and silty limestone: quartzose, carbonaceous-argillaceous; dark grey, and weathering same; indistinctly bedded; fine, regular to lenticular, light grey laminations; poorly preserved ammonite and pelecypod shell fragments; calcispheres? in part; weathers shaly; partly covered; recessive | 85 | 166 |
| 1 | Siltstone to silty shale: similar to unit 2; weathers very shaly to flaggy, in plates up to 1/2 inch thick; fine, regular laminations throughout; recessive; unit represents lowest outcrop | 81 | 81 |

Section 2. Calnan Creek; section measured from east to west up west side of mountain ridge 3 miles east of Calnan Creek near headwaters of Halfway River; 56°52 3/4'N., 123°31 1/4'W. Stratigraphic field section GK-68-11.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | LUDINGTON FORMATION (Incomplete) | | |
| 23 | Limestone: very quartzose in part, may be classed as calcareous sandstone to siltstone, very carbonaceous-argillaceous; finely crystalline; dark grey, and weathers medium grey; indistinctly bedded; fine to coarse, light grey laminations in part; weathers flaggy; numerous covered intervals; unit represents top of ridge and highest exposure; resistant | 365+ | 1,968 |
| 22 | Siltstone: quartzose, very calcareous, very argillaceous-carbonaceous, may be classed in part as silty limestone; dark grey, weathering medium to light grey; indistinctly bedded; coarse, regular, light grey bands in part; very dense; well indurated; subconchoidal fracture; resistant | 60 | 1,303 |
| 21 | Siltstone: quartzose, slightly calcareous, carbonaceous-argillaceous, may be classed in part as very fine-grained sandstone; medium dark grey, weathering medium grey; indistinctly bedded; fine to coarse, regular to lenticular, light grey laminations; micro cross-laminations in part; "tinny" sound underfoot; dense; well indurated; resistant | 41 | 1,243 |
| 20 | Siltstone to limestone: quartzose, very carbonaceous-argillaceous; carbonate finely crystalline; dark grey, weathering same; thin- to medium-bedded; fine, regular to wavy laminations in part; thicker beds dense; well indurated; recessive | 80 | 1,201 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 19 | Limestone: quartzose, dolomitic mottling, carbonaceous-argillaceous; finely crystalline to bioclastic; appears in part to have undergone penecontemporaneous slumping and brecciation; medium dark grey, weathering same; indistinctly bedded; bioclastic carbonate in lower half that consists of abraded and broken crinoid, and pelecypod-brachiopod shell fragments; Monotis montini McLearn collected from lower 1 foot - GSC loc. 82614; represents probable base; resistant | 25 | 1,121 |
| 18 | Conglomerate: quartzose, calcareous, dolomitic; consists of well rounded siltstone-sandstone pebbles and cobbles, up to 1 foot in diameter, in a very calcareous, ferruginous, sandstone matrix and cement; few scattered fossil fragments; unit represents base of Ludington Formation; recessive | 5 | 1,096 |
| | TOAD FORMATION (973 feet) | | |
| 17 | Siltstone: quartzose, very calcareous, very carbonaceous-argillaceous; dark grey, weathering same; thin- to medium-bedded, up to 2 feet; alternation of resistant and recessive beds; fine, regular to lenticular laminations; poorly preserved ammonite impressions; resistant and cliff-forming | 115 | 1,091 |
| 16 | Covered interval | 125 | 976 |
| 15 | Siltstone: quartzose, calcareous, carbonaceous-argillaceous; dark grey, and weathering same; thin- to medium-bedded; fine to medium, regular to lenticular, light grey laminations; weathers flaggy in plates 1/2 inch thick; slightly recessive | 30 | 851 |
| 14 | Covered interval | 25 | 821 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 13 | Siltstone: quartzose, very calcareous, carbonaceous-argillaceous; medium dark grey, weathering same; medium-bedded, up to 1 foot; fine to coarse, regular to wavy lenticular, light grey laminations; moderate induration; weathers flaggy; resistant | 85 | 796 |
| 12 | Siltstone: quartzose, calcareous, carbonaceous-argillaceous; medium dark grey, and weathering same to yellowish grey; indistinctly to medium-bedded, up to 1 foot; coarse to fine, lenticular, light grey laminations; black phosphate nodules in lower 5 feet; strata may be classed in part as shale; resistant | 78 | 711 |
| 11 | Siltstone: quartzose, calcareous, carbonaceous-argillaceous, slightly pyritiferous; dark grey, weathering same; indistinctly bedded; scattered black phosphate nodules throughout; fine to medium, lenticular, light grey laminations; slightly recessive to recessive | 55 | 633 |
| 10 | Covered interval except for scattered outcrops of siltstone, similar to unit 9; recessive | 75 | 578 |
| 9 | Siltstone: quartzose, slightly calcareous, carbonaceous-argillaceous, slightly phosphatic; medium dark grey, weathering same; indistinctly bedded; black phosphatic nodules up to 1 1/2 inches in diameter scattered throughout; "sooty" appearance; may be classed in part as shale; weathers very rubbly; recessive | 25 | 503 |
| 8 | Siltstone: quartzose, slightly calcareous, possibly dolomitic, carbonaceous-argillaceous; dark grey, weathering same; indistinctly bedded, but appears medium; scattered black phosphatic nodules; few very calcareous siltstone concretions up to 2 1/2 feet in diameter; weathers shaly to flaggy; unit represents probable base of phosphatic nodule beds; recessive | 50 | 478 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 7 | Siltstone: quartzose, very calcareous in part, carbonaceous-argillaceous; dark grey, weathering same; thin- to medium-bedded, up to 1 foot; fine to medium, regular to lenticular, light grey laminations; slightly phosphatic in upper 50 feet; poorly preserved indeterminate pelecypods in lower 10 feet; weathers shaly to flaggy; few large, laminated, very calcareous siltstone concretions, up to 2 1/2 feet in diameter; resistant | 100 | 428 |
| 6 | Siltstone: quartzose, dolomitic, carbonaceous-argillaceous, slightly calcareous in part; medium dark grey, and weathering same; thin- to medium-bedded, up to 1 foot; fine to medium, regular to lenticular laminations; few scattered very calcareous concretions; beds slightly contorted; resistant | 40 | 328 |
| 5 | Siltstone: quartzose, very calcareous and dolomitic in part, carbonaceous argillaceous, slightly pyritiferous; dark grey, and weathering same; thin- to medium-bedded, up to 1 foot; thin beds appear to be mainly dolomitic; fine to medium, light grey, regular to lenticular laminations; large "kettle" concretions up to 2 feet in diameter; upper half of unit folded, looks like tight anticline-syncline; resistant to slightly recessive | 100 | 288 |
| 4 | Siltstone: quartzose, dolomitic, calcareous, very carbonaceous-argillaceous, slightly pyritiferous; dark grey, weathering same; thin- to medium-bedded, up to 1 foot; fine, regular to lenticular, light grey laminations; large "kettle" concretions throughout, which are laminated, and very calcareous; weathers flaggy; resistant to slightly recessive | 70 | 188 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | GRAYLING FORMATION (118 feet) | | |
| 3 | Siltstone to shale: quartzose, slightly dolomitc and calcareous; medium dark grey, weathering same to brownish grey; indistinctly bedded; very calcareous siltstone to silty limestone concretions, up to 1 foot in diameter throughout, some containing ammonites; Prionolobus cf. P. lilangense (Krafft) - GSC loc. 82615, collected 20 feet from base; anticlinal axis through base of unit; laminated; weathers shaly to flaggy; resistant to slightly recessive | 43 | 118 |
| 2 | Covered interval: appears to be small anti-cline underlying interval; measurement approximate | 25 | 75 |
| 1 | Siltstone to shale: quartzose, slightly dolomitic and pyritiferous; dark grey and weathering same; indistinctly bedded; faint trace fine, regular to lenticular laminations; weathers shaly to flaggy; forms sharp contact with underlying Paleozoic chert; recessive | 50 | 50 |

Section 3. Fiddes Creek; section measured from northeast to southwest along spur and up face of "Tropites Mountain" at headwaters of Fiddes Creek; 56°50 1/4'N., 123°25'W. Stratigraphic field section GK-68-6.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | LUDINGTON FORMATION (1,718 feet plus) | | |
| 26 | Limestone and minor sandstone: quartzose, carbonaceous-argillaceous; sandstone very fine grained, dolomitic in part; limestone very finely crystalline; medium grey, and weathering same; medium- to thin-bedded; lower 50 feet consists of sandstone; laminated in part; unit dense, well indurated; limestone has subconchoidal fracture; weathers rubbly; "tinny" sound underfoot; unit represents top of controllable outcrop; resistant | 150+ | 3,115 |
| 25 | Limestone: slightly quartzose, dolomitic, carbonaceous-argillaceous; very finely crystalline to aphanitic; dark grey and weathering same; thin- to medium-bedded; minor black chert bands and lenses; very dense; breaks with subconchoidal fracture; slightly recessive to resistant | 227 | 2,965 |
| 24 | Limestone: similar to unit 25, except very little exposure along ridge crest; strata mainly "frost heave"; slightly recessive | 300 | 2,738 |
| 23 | Limestone: quartzose, slightly dolomitic, very carbonaceous-argillaceous; very finely crystalline to aphanitic; medium dark grey, and weathering same to brownish grey; thin- to medium-bedded; fine, regular, light grey, quartz laminations in part; shaly to flaggy weathering; well indurated; subconchoidal fracture in part; resistant | 115 | 2,438 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 22 | Limestone: slightly siliceous, bioclastic, yellowish grey, and weathering same; medium-bedded, up to 1 foot; unit consists of coquina of crinoid columnals and brachiopod-pelecypod shell fragments; black, resinous, pyrobitumen residue throughout; well indurated; resistant | 14 | 2,323 |
| 21 | Limestone and siltstone: quartzose, dolomitic in part, carbonaceous-argillaceous; carbonate aphanitic to very finely crystalline; medium dark grey, weathering same; indistinctly bedded; fine, regular to lenticular, light grey laminations; very dense; well indurated; in part breaks with subconchoidal fracture; resistant | 127 | 2,309 |
| 20 | Siltstone and limestone: quartzose, carbonaceous-argillaceous; siltstone very dolomitic in part, but mainly calcareous; carbonate fine to very finely crystalline; medium dark grey, and weathering same; indistinct bedding; fine to medium, regular to lenticular, light grey laminations; lower 30 feet subconchoidally fracturing limestone, remainder of unit shaly- to flaggy-weathering siltstone; resistant | 100 | 2,182 |
| 19 | Siltstone to very fine-grained sandstone: quartzose, very dolomitic, slightly calcareous, carbonaceous-argillaceous; medium grey, weathering same to light grey; medium- to thick-bedded; fine, regular laminations throughout; dense; well indurated; resistant | 105 | 2,082 |
| 18 | Siltstone and minor silty limestone: quartzose, carbonaceous-argillaceous; siltstone very dolomitic, slightly calcareous; medium dark grey, and weathering same; thin- to medium-bedded; silty limestone occurs as cyclical interbeds with dolomitic siltstone; limestone has subconchoidal fracture; fine to medium, regular to lenticular, light grey laminations; few Lingula fragments in lower half; resistant | 187 | 1,977 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 17 | Siltstone and minor limestone: similar to unit 18, same regular to lenticular laminations; subconchoidal fracture; resistant | 74 | 1,790 |
| 16 | Siltstone to very fine-grained sandstone: quartzose, very dolomitic, very calcareous in part; may be classed as silty to sandy limestone, slightly argillaceous; carbonate finely crystalline; medium dark grey, and weathering same; thin- to thick-bedded; fine to medium, regular to wavy lenticular, light grey laminations throughout; weathers very flaggy in lower 100 feet; micro cross-laminations in part; ripple-marks in part; Halobia cf. H. ornotissima Smith, collected from upper 5 feet - GSC loc. 82653; well indurated; resistant | 166 | 1,716 |
| 15 | Siltstone: quartzose, calcareous, dolomitic, possibly argillaceous; medium grey, and weathering same to greyish brown; indistinctly bedded, but appears medium- to thin-bedded; fine, wavy to lenticular laminations throughout; weathers flaggy in 1/2 to 3/4 inch slabs; "tinny" sound underfoot; resistant | 53 | 1,550 |
| 14 | Siltstone to very fine-grained sandstone, and minor silty limestone: dolomitic, carbonaceous-argillaceous; siltstone slightly calcareous; medium dark grey, and weathering same to yellowish grey; medium- to thick-bedded, but in part bedding indistinct; fine, regular to wavy lenticular laminae throughout; large, poorly preserved, coarse-ribbed pelecypods in part; weathers flaggy; unit represents base of massive cliff and probable base of Ludington Formation; resistant and cliff-forming | 100 | 1,497 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | TOAD FORMATION (1,397 feet plus) | | |
| 13 | Limestone to siltstone: quartzose, slightly dolomitic, very carbonaceous-argillaceous; medium dark grey, and weathering same; numerous covered intervals within unit; medium-bedded where exposed; indeterminate Halobiid pelecypods in part - GSC loc. 82654; slightly recessive to recessive | 77 | 1,397 |
| 12 | Limestone: quartzose, may be classed in part as calcareous siltstone, slightly dolomitic, very carbonaceous-argillaceous; medium dark grey, and weathering same; carbonate appears to be finely crystalline, but in part bioclastic, consisting of whole and fragmented indeterminate brachiopod and pelecypod shells from upper 2 feet; unit indistinctly bedded; weathers rubbly to flaggy; slightly recessive | 100 | 1,320 |
| 11 | Covered interval | 100 | 1,220 |
| 10 | Limestone: quartzose, very carbonaceous-argillaceous, may be classed in part as calcareous siltstone; medium dark grey, and weathering same to brownish orange in a few very dense subconchoidal fracturing beds; mainly indistinctly bedded; scattered pelecypods throughout, similar to those of unit 9; coarse laminations in part; soft, poorly indurated; weathers shaly to flaggy; recessive | 100 | 1,120 |
| 9 | Limestone to siltstone: quartzose, very carbonaceous-argillaceous; carbonate finely crystalline and partly bioclastic; dark grey, and weathering same; medium- to thick-bedded where exposed; fine to coarse, lenticular laminations; unit partly talus-covered; Paratrachyceras sutherlandi McLearn, and Daonella cf. D. elegans McLearn collected from upper 10 feet - GSC loc. 82651; unit poorly indurated; slightly recessive to recessive | 40 | 1,020 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 8 | Covered interval, although talus representative of lithology; siltstone to very fine-grained sandstone: quartzose, very calcareous, may be classed in part as silty to sandy limestone, dolomitic in part, carbonaceous-argillaceous; medium dark grey, and weathering same; laminated in part; poorly indurated; scattered indeterminate ammonite fragments; recessive | 160 | 980 |
| 7 | Siltstone: quartzose, very calcareous, slightly carbonaceous-argillaceous; medium dark grey, and weathering same to brownish grey; only sporadic outcrops in interval; indistinctly bedded; weathers flaggy; coarse to fine, regular to lenticular laminations; unit represents top of Flagstone facies; recessive | 100 | 820 |
| 6 | Siltstone: quartzose, calcareous, possibly carbonaceous-argillaceous, may be classed in part as very fine-grained sandstone; medium grey, and weathering same; medium- to thin-bedded, up to 1 foot; fine to coarse, regular to lenticular laminations; in part micro cross-laminated; few, thin shale interbeds; unit dense, well-indurated; weathers flaggy; few bounce casts in upper 100 feet; upper half recessive, lower half resistant to slightly recessive | 200 | 720 |
| 5 | Siltstone: quartzose, calcareous, slightly dolomitic in part, very argillaceous, possibly carbonaceous; medium grey, and weathering same to orange-grey-brown; thin- to medium-bedded; fine to coarse, regular to wavy lenticular, light grey and orange-grey laminations; scattered shale interbeds; weathers flaggy; poorly preserved pelecypods in upper half; slightly recessive to resistant | 200 | 520 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 4 | Covered interval, except for minor scattered outcrops; similar to unit 5; fine to coarse, wavy to regular laminae throughout; Daonella cf. D. elegans McLearn - GSC loc. 82652, collected 50 feet above base; weathers flaggy; recessive | 100 | 320 |
| 3 | Siltstone: quartzose, calcareous, argillaceous, slightly ferruginous; medium dark grey with orange tint, and weathering medium grey-brown to orange-brown; medium- to thick-bedded; well laminated in part; weathers flaggy; dense; well-indurated; resistant | 25 | 220 |
| 2 | Covered interval, except for minor outcrops near top; similar to unit 3; very recessive | 95 | 195 |
| 1 | Siltstone: quartzose, calcareous, possibly argillaceous-carbonaceous, slightly ferruginous; medium dark grey with orange tint in part, and weathering orange-grey-brown; medium- to thick-bedded, up to 4 feet; unit may be classed in part as very fine-grained sandstone; coarse to fine, wavy to lenticular laminations in upper 50 feet; flute casts and oscillation ripple-marks in talus; approximately 50 feet below unit Daonella cf. degeeri Boehm collected from small rib of Flagstone facies - GSC loc. 82656; unit resistant | 100+ | 100 |

Section 4. Mount Ludington; section measured from east to west up spur and cliff face of Mount Ludington; 56°27 3/4'N., 123°14 3/4'W. Stratigraphic field section GK-68-10.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | PARDONET FORMATION (Incomplete) | | |
| 31 | Limestone: very silty in part, very carbonaceous-argillaceous; finely crystalline to bioclastic; medium dark grey, and weathering light grey; medium- to thin-bedded; bioclastic material consists of broken and abraded pelecypod shells, in places forming a dense coquina; fine, wavy laminations in part; lower 15 feet contains wavy, lenticular, medium grey chert bands; bedding contorted near base, may form faulted contact with underlying Ludington Formation; strong fetid odour upon fracture; resistant | 70 | 2,599 |
| | LUDINGTON FORMATION (type section) (1,640 feet) | | |
| 30 | Siltstone to sandstone: quartzose, dolomitic, very calcareous in part, may be classed as silty limestone; medium grey with slight brown tint, and weathering same; thin- to medium-bedded; fine to medium, regular to lenticular, light grey laminations; white coarsely crystalline calcite veinlets in lower half of unit, suggesting possibility of tight folding in underlying covered intervals; beds weather flaggy; slightly recessive | 167 | 2,529 |
| 29 | Covered interval, except for minor outcrops similar to lithology of unit 30; outcrop dips opposite to underlying strata indicating possibility of tight folding | 165 | 2,362 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 28 | Sandstone: quartzose, very calcareous in part, may be classed as sandy limestone, dolomitic and argillaceous in part; very fine grained; medium to medium dark grey, and weathering same; thin- to medium-bedded; medium to coarse, regular to lenticular, light grey laminations and banding; single bed containing silicified fossil fragments; weathers flaggy; slightly recessive | 95 | 2,197 |
| 27 | Sandstone and minor limestone: quartzose, slightly argillaceous; limestone bioclastic, silicified in part; sandstone very fine grained, carbonaceous, very calcareous; medium to medium dark grey, and weathering same to light grey; thin- to medium-bedded up to 1 foot, with most beds approximately 3 inches thick; coarse, wavy, light grey laminations; bioclastic limestone composed of pelecypod and gastropod shells, and shell fragments; weathers flaggy; slightly recessive to resistant | 124 | 2,102 |
| 26 | Limestone: very quartzose, may be called in part calcareous siltstone, very carbonaceous-argillaceous; finely crystalline; medium dark grey, and weathering light grey; thin- to medium-bedded; fine, regular to lenticular laminations; weathers shaly to flaggy; slightly recessive to resistant | 50 | 1,978 |
| 25 | Covered interval | 27 | 1,928 |
| 24 | Siltstone to limestone: quartzose, carbonaceous-argillaceous; limestone appears to be very finely crystalline; medium dark grey, and weathering light grey to yellowish grey; thin- to medium-bedded, up to 10 inches; beds in part wavy to lenticular; faint trace of fine, regular to lenticular, light grey laminations; weathers shaly to flaggy; dense; well indurated; resistant | 107 | 1,901 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 23 | Siltstone to limestone: similar to unit 24; weathers shaly to flaggy; scattered thin brachiopod-pelecypod shell fragments in limestone; few covered intervals; recessive | 130 | 1,794 |
| 22 | Siltstone to limestone: quartzose, carbonaceous-argillaceous; carbonate finely crystalline; dark grey, and weathering same to medium grey; mainly indistinctly bedded, but a few beds to 3 inches thick; fine, regular to lenticular, light grey laminations; weathers shaly to flaggy; thicker beds very dense, well indurated; partly covered; recessive | 48 | 1,664 |
| 21 | Siltstone to very fine-grained sandstone, and sandy limestone: quartzose, carbonaceous-argillaceous; limestone finely crystalline to bioclastic; medium dark grey, and weathering same; bioclastic limestone slightly siliceous, has dolomite cement, and is interbedded with very calcareous siltstone-sandstone; thin- to medium-bedded, up to 4 inches; poorly preserved ripple-marks on some carbonate interbeds; siltstone-sandstone contains fine to medium, regular, light grey laminations; slightly recessive to resistant | 30 | 1,616 |
| 20 | Siltstone to limestone: quartzose, carbonaceous-argillaceous; limestone finely crystalline to bioclastic, latter slightly dolomitic and siliceous; mainly indistinctly bedded; limestone contains crinoid, pelecypod and echinoid fragments and occurs as interbeds up to 6 inches thick; weathers flaggy to shaly, except for bioclastic strata; slightly recessive to resistant | 60 | 1,586 |
| 19 | Siltstone to sandstone, and minor bioclastic limestone: quartzose, very carbonaceous-argillaceous in part, possibly dolomitic; sandstone-siltstone very calcareous, in part contains lenses and pockets of bioclastic carbonate; medium dark grey, and weathering light grey; indistinctly bedded, but appears thin- to medium-bedded; fine to coarse, regular to lenticular laminations; weathers | | |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 19 (cont'd.) | flaggy to shaly in part; dense; well indurated; resistant to slightly recessive | 91 | 1,526 |
| 18 | Siltstone to very fine-grained sandstone: same as unit 19, except no bioclastic limestone interbeds; resistant to slightly recessive | 50 | 1,435 |
| 17 | Sandstone: quartzose, very calcareous, may be classed in part as sandy limestone, possibly argillaceous, slightly dolomitic; few siliceous, bioclastic limestone interbeds in lower 14 feet; sandstone very fine to fine grained; medium to light grey, and weathering light grey; thin- to medium-bedded; coarse, regular to lenticular, coarser grained quartz laminations; well indurated; nonporous; unit forms ridge crest; resistant | 43 | 1,385 |
| 16 | Sandstone and minor interbedded bioclastic limestone: quartzose, possibly argillaceous; sandstone very calcareous, very fine to fine grained; bioclastic limestone consists of fragmented and abraded pelecypod shells; medium to medium light grey, and weathering same with slight orange tint; coarse, regular to lenticular, sand laminations; sandstone moderate to good induration; bioclastic limestone slightly siliceous; resistant | 123 | 1,342 |
| 15 | Sandstone to siltstone: quartzose, very calcareous, slightly carbonaceous-argillaceous; medium grey with slight brown tint, and weathering same; medium-bedded, up to 8 inches; bedding in part wavy and lenticular; coarse, lenticular, dark grey argillaceous laminations; weathers shaly to flaggy; resistant | 100 | 1,219 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 14 | Siltstone to very fine-grained sandstone: quartzose, very calcareous, carbonaceous-argillaceous, slightly dolomitic in part; medium dark grey, and weathering same; medium- to thin-bedded, up to 15 inches; coarse, lenticular to wavy, light grey laminations; in part cross-laminated; dense; well indurated; weathers flaggy to shaly; resistant | 150 | 1,119 |
| 13 | Covered interval, except for minor exposure in upper 10 feet, consisting of very finely crystalline, slightly silty, carbonaceous-argillaceous limestone; few limestone concretions; devoid of fossil matter; displays subconchoidal fracture; faint trace of thin, regular laminations; weathers shaly; recessive | 35 | 969 |
| 12 | Limestone: quartzose, carbonaceous-argillaceous; finely crystalline to bioclastic; medium grey, and weathering same to light grey; medium- to thick-bedded; laminated in part; bioclastic matter consists of broken and abraded pelecypod shells and crinoid columnals; unit forms probable base of Ludington Formation; resistant | 45 | 934 |
| | TOAD FORMATION (889 feet plus) | | |
| 11 | Limestone and sandstone: quartzose, carbonaceous-argillaceous; limestone bioclastic; sandstone very fine grained; medium grey, and weathering same to yellowish grey; medium-bedded; abundance of large concretions containing Daonella sp. in upper 10 feet; lower 5 feet contains Pratrachyceras sutherlandi McLearn, Asklepioceras laurenci McLearn, Nathorstites mcconnelli (Whiteaves), Megaphyllites sp. and Daxatina sp. - GSC locs. 82612 and 82613; slightly recessive to resistant | 20 | 889 |
| 10 | Covered interval | 43 | 869 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 9 | Siltstone to very fine-grained sandstone, and minor limestone: quartzose, very carbonaceous-argillaceous; siltstone-sandstone very calcareous; limestone very finely crystalline; medium dark grey with slight brown tint, and weathering brownish grey; indistinctly bedded, but appears medium-bedded; fine to coarse, regular to wavy laminations; limestone has subconchoidal fracture; resistant | 75 | 826 |
| 8 | Siltstone: quartzose, calcareous, very argillaceous-carbonaceous; medium grey with slight brown tint, and weathering same to orange-brown; appears medium-bedded; coarse, regular to lenticular laminations throughout; weathers flaggy to rubbly; sparse outcrop; recessive | 95 | 751 |
| 7 | Siltstone: quartzose, very calcareous, carbonaceous-argillaceous; medium dark grey, and weathering same to bright orange-brown; thin- to thick-bedded, up to 5 feet; fine to coarse, regular to lenticular laminations; poorly preserved Protrachyceras sp. collected from lower 5 feet - GSC loc. 82610; weathers flaggy and rubbly; upper 5 feet cross-laminated; resistant | 105 | 656 |
| 6 | Siltstone: quartzose, calcareous, possibly dolomitic in part, very carbonaceous-argillaceous; medium dark grey, and weathering same to orange-brown; thin- to thick-bedded, up to 3 feet; alternation in part of resistant and recessive strata; fine, regular to lenticular laminations in part; scattered thin shell fragments in upper two thirds; few black phosphate nodules and lenticles, 80 feet from base; weathers flaggy in part; resistant to slightly recessive | 147 | 551 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 5 | Siltstone: quartzose, calcareous, very carbonaceous-argillaceous, slightly phosphatic, dolomitic in part; dark grey, and weathering same; indistinct bedding, but appears thin- to medium-bedded; fine, regular to lenticular laminations; dark grey to black phosphatic nodules throughout lower 25 feet; weathers shaly to flaggy; resistant to slightly recessive | 78 | 404 |
| 4 | Siltstone: quartzose, dolomitic, slightly calcareous, very carbonaceous-argillaceous, may be classed in part as silty shale, slightly phosphatic; dark grey, and weathering same; fine, regular, light grey laminations in part; scattered black phosphatic nodules throughout; partly covered; weathers shaly; recessive | 63 | 326 |
| 3 | Siltstone and silty shale: quartzose, dolomitic, slightly calcareous in part, carbonaceous; dark grey, and weathering same to orange-brown; thin- to medium-bedded, up to 1 foot; thicker beds lenticular and wavy; thin beds contain fine, regular, light grey laminations; scattered black phosphatic nodules throughout, up to 2 inches in diameter; few very calcareous concretions; scattered pyrite cubes and microaggregates; weathers shaly to flaggy; slightly recessive to resistant | 135 | 263 |
| 2 | Siltstone to silty shale, and minor silty limestone: quartzose, dolomitic, carbonaceous; dark grey, and weathering same to orange-brown; thin- to medium-bedded up to 1 foot, with some thicker beds pinching to zero; fine, light grey, regular to lenticular laminations common throughout thin beds; calcispheres? in limestone; orange-brown beds very calcareous; weathers shaly to flaggy; slightly recessive | 53 | 128 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 1 | Siltstone and shale: quartzose, dolomitic, very calcareous in part, may be classed as silty limestone, carbonaceous; dark grey, and weathering same; thin- to medium-bedded; thicker beds calcareous, very lenticular; calcareous, laminated concretions up to 1 foot in diameter scattered throughout unit, some of which contain fossils; from lower 10 feet, Euflemingites cirratus (White) and Posidonia mimer Oeberg - GSC loc. 82608; from upper 5 feet, Wasatchites sp. and Posidonia mimer Oeberg - GSC loc. 82609; limestone in part bioclastic; weathers shaly to flaggy; unit represents base of section and terminates at west limb of anticline; resistant to slightly recessive | 75 | 75 |

Section 5. White Creek (Crying Girl Prairie Creek); section measured along east bank of west fork of White Creek; 56°28'N., 122°54'W. Stratigraphic field section GK-69-6. Section measured by D. W. Gibson; fossils collected by E. T. Tozer.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | PARDONET FORMATION (241 feet) | | |
| 10 | Limestone to siltstone: quartzose, slightly dolomitic, very carbonaceous; carbonate very finely crystalline to aphanitic; medium dark grey, and weathering same; medium- to thick-bedded, up to 2 1/2 feet; unit becomes more quartzose toward upper contact; scattered Monotis shells; few shaly weathering interbeds; faint, fine to coarse, regular to lenticular laminations; very dense; breaks with subconchoidal fracture; unit forms unconformable contact with overlying Jurassic Fernie Formation; resistant | 13 | 241 |
| 9 | Limestone: very quartzose in part, may be classed as calcareous siltstone, very carbonaceous, slightly dolomitic; very bioclastic, but in part finely crystalline; medium dark grey, and weathering same; thin- to medium-bedded; upper 18 feet consists mainly of shell coquina of Monotis subcircularis; unit in part dense, well indurated; breaks with subconchoidal fracture; strong fetid odour upon fracture; unit forms part of large waterfall; resistant | 27 | 228 |
| 8 | Limestone and minor calcareous siltstone: quartzose, very carbonaceous, possibly argillaceous; very finely crystalline to aphanitic; medium dark to dark grey, and weathering same; medium- to thick-bedded, up to 2 1/2 feet; faint, lenticular laminations in part; scattered Monotis shells in very dense subconchoidally fracturing limestone beds; siltstone very calcareous and occurs as interbeds; penecontemporaneous slump structures in upper 12 feet; recessive | 29 | 201 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 7 | Siltstone to limestone: quartzose, dolomitic, very carbonaceous, possibly argillaceous; carbonate very finely crystalline; medium dark grey, and weathering same; medium- to indistinctly bedded; bottom of unit capped by 12 inch bed of dense, very calcareous subconchoidally fracturing siltstone, containing isolated well preserved Monotis sp. shells; Monotis sp. and Monotis pinensis collected 5 feet and 17 feet below top, respectively; faint trace of lenticular laminations in part; unit weathers flaky; upper 17 feet partly covered; recessive to slightly recessive | 36 | 172 |
| 6 | Siltstone: quartzose, slightly calcareous and dolomitic, carbonaceous-argillaceous; medium dark grey, and weathering same; unit forms single bed and base of small waterfall; dense; well indurated; few scattered Monotis shells; resistant | 4 | 136 |
| 5 | Limestone and minor siltstone: quartzose, dolomitic, very carbonaceous-argillaceous; carbonate finely crystalline to bioclastic; medium dark grey, and weathering same; thin- to thick-bedded, up to 3 feet; bioclastic limestone consists of coquina of pelecypod shells, and gives rock crenulated, laminated appearance; few large concretions 10 feet from top; Monotis typica collected 4 feet above base; Monotis pinensis, Halobia sp. and Himavatites sp. collected 2 feet below top; unit represents probable base of Monotis beds; weathers shaly to flaggy; resistant to slightly recessive | 30 | 132 |
| 4 | Limestone: very silty in part, may be classed as calcareous siltstone, very carbonaceous-argillaceous, slightly dolomitic; mainly bioclastic, consisting of compressed pelecypod shells; few beds very finely crystalline; thin- to medium-bedded; fine, wavy, crenulated laminations throughout; 11 feet from base concretions up to 10 inches in diameter; strong fetid odour upon fracture; 2 feet, 10 | | |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 4 (cont'd.) | feet, and 24 1/2 feet respectively above base, Drepanites sp., Cyrtopleurites sp., Metacarnites sp., and Himavatites sp. were collected; weathers shaly to flaggy; slightly recessive to resistant | 27 | 102 |
| 3 | Limestone: silty, carbonaceous-argillaceous, slightly dolomitic; bioclastic to finely crystalline; medium dark grey, and weathering same; medium- to thin-bedded; 3 feet from top are large concretions between 6 and 10 inches in diameter containing Halobia sp. and an indeterminate ammonite; Drepanites sp. and Juvavites magnus collected 1 foot and 8 1/2 feet below top, respectively; phosphatic bone fragments 5 feet from base; strong fetid odour upon fracture; resistant | 11 | 75 |
| 2 | Limestone to siltstone: quartzose, very carbonaceous-argillaceous, slightly dolomitic; finely to very finely crystalline, with few interbeds of bioclastic coquinoid limestone consisting of compressed Halobia sp. shells; medium dark grey, and weathering same; thin- to thick-bedded, up to 3 feet; fine, wavy to lenticular laminations in part; strong fetid odour upon fracture; phosphatic vertebrate bone fragments in upper bed; thin beds weather shaly to flaggy; unit represents base of exposure; resistant | 39 | 64 |
| 1 | Covered interval: thickness to Baldonnel Formation contact estimated | 25 | 25 |

Section 6. Pink Mountain; section measured up south cliff face on west side of Pink Mountain below radio relay transmitter; 57°03 3/4'N., 122°52 1/2'W. Stratigraphic field section GK-69-15.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | PARDONET FORMATION (126 feet) | | |
| 22 | Limestone and minor siltstone: quartzose, very carbonaceous-argillaceous; siltstone very calcareous and dolomitic; carbonate finely crystalline to bioclastic; medium dark grey, and weathering dark brown; indistinctly bedded; limestone in part consists of laminated coquina of Monotis scutiformis typica and Halobia sp. - GSC loc. 84272; weathers shaly; very strong fetid odour upon fracture; unit forms probable contact with Jurassic Fernie Formation; resistant | 12 | 560 |
| 21 | Limestone: slightly silty, very carbonaceous-argillaceous; bioclastic, consisting of coquina of compressed, whole and broken pelecypod shells; in part finely crystalline; dark grey, and weathering light grey to orange-brown in upper 5 feet; pelecypod shells impart laminated appearance; pyrobitumen matter filling small vugs; strong fetid odour upon fracture; resistant | 18 | 548 |
| 20 | Limestone: quartzose, very carbonaceous-argillaceous, slightly dolomitic, may be classed in part as calcareous siltstone; finely crystalline to bioclastic; medium dark to dark grey, and weathering medium to light grey to orange-brown; thin- to medium-bedded; limestone in part replete with Grypheids, Halobia sp., and indeterminate brachiopods; scattered vertebrate fragments in lower 20 feet; fetid odour; weathers shaly to flaggy; resistant | 67 | 530 |
| 19 | Covered interval | 17 | 463 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 18 | Limestone: carbonaceous-argillaceous, slightly silty in part; bioclastic, consisting of fragmented pelecypod shells; medium dark grey, and weathering medium to light grey; medium-bedded, up to 1 foot; wavy crenulated laminations throughout; lowest bed contains white oolites and pisolites; vertebrate bone fragments throughout; fetid odour upon fracture; unit forms sharp, conformable contact with underlying Baldonnel Formation; resistant | 12 | 446 |
| | BALDONNEL FORMATION (329 feet) | | |
| 17 | Dolomite and minor bioclastic limestone: quartzose, carbonaceous-argillaceous; dolomite very calcareous, silty in part, finely crystalline; medium dark grey with slight brown tint, and weathering same to orange-brown; thin- to medium-bedded, up to 1 foot; very lenticular in part; fine, wavy laminations in lower half; unit has slight physical resemblance to Pardonet Formation; bioclastic limestone vuggy, and contains black, vitreous pyrobitumen matter; fetid odour upon fracture; slightly recessive to resistant | 25 | 434 |
| 16 | Limestone and minor dolomite: slightly siliceous in part; dolomite same as unit 15, occurring as 4 foot interbed; limestone dolomitic, and bioclastic to finely crystalline; medium light grey to yellowish grey, and weathering light grey; medium- to thick-bedded; scattered light grey chert nodules and lenses; bioclastic material mainly shell and crinoid columnal fragments; dolomite slightly porous, and contains black, vitreous pyrobitumens; resistant | 22 | 409 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 15 | Dolomite: slightly calcareous and silty; finely to medium crystalline, to bioclastic in part; medium to medium light grey with brown tint, and weathering same to yellowish grey; medium- to thick-bedded; bioclastic material unrecognizable; porous in part; contains black vitreous pyrobitumens; large light grey chert nodules and lenses 5 feet from base; resistant | 24 | 387 |
| 14 | Limestone: slightly silty and dolomitic, very carbonaceous-argillaceous; very fine to finely crystalline; medium dark grey, and weathering medium grey; indistinctly bedded; fine to coarse, regular to wavy laminations; dark grey chert bands and lenses up to 2 inches thick scattered throughout, but mainly concentrated 20 feet above base; pelecypod shells in lower 5 feet; dense; well indurated; weathers flaggy in part; resistant | 38 | 363 |
| 13 | Limestone: slightly silty, very dolomitic in part; finely crystalline to bioclastic; yellowish grey to pale yellowish brown, and weathering medium to light grey; medium- to thick-bedded, up to 3 feet; medium and dark grey chert bands and nodules in lower 10 feet; bioclastic material composed of shell and crinoid fragments, silicifed in part; fetid odour upon fracture; dense; well indurated; scattered vertebrate bone fragments near top; resistant | 24 | 325 |
| 12 | Limestone: slightly silty and dolomitic, very carbonaceous-argillaceous; very finely crystalline with few bioclastic and pelleted interbeds, especially in lower 3 feet; medium dark grey to pale yellowish brown, and weathering same; thin- to medium-bedded, up to 10 inches; fine to coarse laminations in part; scattered phosphatic grains and vertebrate bone fragments 40 feet from base; minor dark grey chert bands and nodules in upper half; strong fetid odour upon fracture; dense; well indurated; breaks with subconchoidal fracture in part; resistant | 44 | 301 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 11 | Sandstone: quartzose, very dolomitic, slightly calcareous; very fine grained, may be classed in part as siltstone; yellowish grey with dark grey mottling, and weathering medium grey to yellow; medium-bedded; wavy, lenticular laminations in part; slight porosity in part; well indurated; resistant | 29 | 257 |
| 10 | Sandstone and minor limestone: quartzose; sandstone very dolomitic, slightly calcareous, very fine grained, may be classed in part as siltstone; limestone very dolomitic in part, finely crystalline to bioclastic, latter consisting mainly of crinoid columnal fragments; yellowish grey, and weathering orange-brown; medium- to thick-bedded; dense; well indurated; bioclastic limestone forms upper 10 feet; resistant and cliff-forming | 40 | 228 |
| 9 | Limestone: dolomitic, slightly quartzose; bioclastic, consisting of fragmented brachiopod-pelecypod shells, and crinoid ossicles; yellowish grey, and weathering medium to light grey; medium- to thick-bedded; permeated in part by black, vitreous pyro-bitumens; dense; well indurated; resistant | 8 | 188 |
| 8 | Dolomite: slightly calcareous; very fine to finely crystalline; yellowish grey, and weathering same; medium-bedded, up to 1 foot; well indurated; slightly recessive to resistant | 19 | 180 |
| 7 | Limestone and minor dolomite: limestone slightly dolomitic and quartzose, mainly bioclastic, consisting of fragmented shells and crinoid columnals; dolomite very fine to finely crystalline, in part very silty; unit yellowish grey, and weathering medium grey to orange-grey; medium- to thick-bedded, up to 5 feet; few chert nodules in centre of unit; limestone contains Gryphea; dense; well indurated; small fault within interval; resistant and cliff-forming | 33 | 161 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 6 | Limestone and minor dolomite: slightly quartzose, possibly argillaceous; limestone finely crystalline, in part brecciated, with angular clasts up to 1 inch in diameter; dolomite very finely crystalline, calcareous; medium grey to yellowish grey, and weathering same to orange-brown; thin- to medium-bedded; dolomite occurs as thin interbeds; zone 5 feet thick, containing white coarsely crystalline calcite suggesting tectonic disturbance; slightly recessive | 23 | 128 |
| | CHARLIE LAKE FORMATION (Incomplete) | | |
| 5 | Sandstone and minor dolomitic limestone: quartzose; sandstone very fine to fine grained, calcareous to dolomitic; carbonate very fine to finely crystalline; yellowish grey to greyish orange, and weathering same; indistinctly bedded; coarse wavy laminations in part; white calcite-filled vugs; well indurated; slightly recessive to resistant | 11 | 105 |
| 4 | Covered interval | 12 | 94 |
| 3 | Limestone: coarsely crystalline; yellowish grey, and weathering same; coarse colour laminations and banding; appears to represent cavity filling; very porous and vuggy; recessive | 5 | 82 |
| 2 | Covered interval | 43 | 77 |
| 1 | Dolomite, sandstone, and dolomitic limestone: quartzose, possibly argillaceous; carbonate very fine to finely crystalline; sandstone very calcareous, very fine grained; greyish orange to yellowish grey, and weathering same; medium-bedded; coarse, wavy laminations in part; white calcite-lined and filled vugs up to 4 inches in diameter; moderate induration; slightly recessive to resistant; unit represents base of section, with only sporadic exposure below | 34 | 34 |

Section 7. Eleven Mile Creek; section measured from east to west up cliff face and across ridge containing topographic cairn "6266", at headwaters of Eleven Mile and Ducette Creeks; 55°47 3/4'N., 122°55 3/4'W. Stratigraphic field section GK-68-16.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | BOCOCK FORMATION (196 feet) | | |
| 37 | Limestone: very finely crystalline to aphanitic, in part bioclastic, consisting of abraded recrystallized crinoid columnals; light grey, and weathering same; indistinctly bedded, appears medium- to thick-bedded; mottled in part; very dense; well indurated; subconchoidal fracture; unit forms sharp, abrupt contact with Jurassic shale; contact has relief estimated at 25 feet thick; resistant | 46 | 2,374 |
| 36 | Limestone: very finely crystalline to aphanitic in part; pale yellowish brown to light grey, and weathering light grey; medium- to thick-bedded; few silicified crinoid columnals; lower half has fibre-like structures; few vugs filled with black, vitreous pyrobitumen matter; very dense; well indurated; subconchoidal fracture in part; resistant | 100 | 2,328 |
| 35 | Limestone: similar to unit 36, except slightly sandy and carbonaceous-argillaceous in part; unit has siliceous mottling in part; unit forms sharp, probably unconformable contact with Pardonet Formation; dense; well indurated; resistant | 50 | 2,228 |
| | PARDONET FORMATION (451 feet) | | |
| 34 | Siltstone to limestone: quartzose, very carbonaceous-argillaceous, slightly dolomitic; carbonate finely crystalline to bioclastic in part; medium dark grey with slight brown tint, and weathering same; thin- to medium-bedded; crenulated laminations in part; Monotis subcircularis Gabb, collected 20 feet from base, but occurs throughout unit - GSC loc. 82633; unit weathers flaggy; resistant to slightly recessive | 51 | 2,178 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 33 | Limestone and minor siltstone: quartzose, very carbonaceous-argillaceous; carbonate finely crystalline to bioclastic; medium dark grey, and weathering same; thin- to medium-bedded; fine, regular to wavy laminations; upper 25 feet consists mainly of coquinoid beds of Monotis subcircularis Gabb - GSC loc. 82635; weathers shaly to flaggy; partly covered; resistant to slightly recessive | 125 | 2,127 |
| 32 | Limestone: slightly silty-quartzose, very carbonaceous-argillaceous; bioclastic to very finely crystalline; medium dark grey, and weathering same; thin- to medium-bedded; very fine, wavy to crenulated, silt-shell laminations throughout; large kettle concretions in upper 25 feet, up to 2 feet in diameter; scattered pelecypod shells throughout; strong fetid odour upon fracture; weathers shaly to flaggy; partly covered; recessive | 125 | 2,002 |
| 31 | Limestone and minor calcareous siltstone: quartzose, very carbonaceous-argillaceous; siltstone dolomitic in part; medium dark grey, and weathering same to light grey; thin- to medium-bedded, up to 1 foot; very fine, wavy to crenulated laminations throughout; Sirenites? sp. and Halobia sp. collected from lower 5 feet - GSC loc. 82634; very strong fetid odour upon fracture; few vugs and fractures filled with white calcite, and minor black pyrobitumen matter; few large concretions in lower half; weathers shaly to flaggy; resistant to slightly recessive | 100 | 1,877 |
| 30 | Covered interval, except for small exposure 25 feet from base consisting of silty limestone similar to unit 31; strong fetid odour upon fracture; very dolomitic in part; unit represents probable base of Pardonet Formation; recessive | 50 | 1,777 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | BALDONNEL FORMATION (477 feet) | | |
| 29 | Limestone: quartzose, carbonaceous-argillaceous; very fine to finely crystalline; medium dark grey, and weathering same to dark grey-brown; thin- to medium-bedded; black chert lenses and bands up to 1 inch thick in lower 25 feet; resistant | 50 | 1,727 |
| 28 | Dolomite to siltstone: quartzose, very calcareous, may be classed in part as dolomitic limestone, slightly carbonaceous-argillaceous; finely crystalline; medium grey, and weathering light grey; thin- to medium-bedded; lenticular laminations in part; dense; well indurated; slightly recessive to resistant | 40 | 1,677 |
| 27 | Limestone and dolomite: quartzose, carbonaceous-argillaceous; dolomite mainly in lower half of unit, same as unit 28; limestone very finely crystalline; unit dark grey, and weathering dark grey-brown; thin- to medium-bedded; fine to medium, lenticular laminations; dolomite contains chert-filled vugs, with black vitreous pyrobitumen material; weathers flaggy; slightly recessive to resistant | 100 | 1,637 |
| | Ducette Member (type section) (287 feet) | | |
| 26 | Siltstone to very fine-grained sandstone: quartzose, very dolomitic, calcareous in part, slightly argillaceous; carbonate finely crystalline; medium grey, and weathering dark greyish brown; medium- to thick-bedded, up to 3 feet thick; fine, regular to lenticular, light grey laminations in part; very dense; well indurated; spheroidal weathering; massive in part; resistant | 140 | 1,537 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 25 | Siltstone and limestone: quartzose, very carbonaceous-argillaceous in part; siltstone very dolomitic; limestone very finely crystalline to bioclastic; medium dark grey, and weathering dark grey-brown to yellow-brown; indistinctly bedded; bioclastic limestone consists of abraded crinoid columnals, and whole and fragmented brachiopod shells - GSC loc. 82636; few vugs filled with white calcite and black pyrobitumen; in places brachiopods form coquina; slightly recessive to resistant; unit forms sharp contact with underlying lighter weathering strata | 54 | 1,397 |
| 24 | Siltstone to dolomite: quartzose, calcareous; carbonate finely crystalline; medium grey, and weathering light grey; indistinctly bedded; very dense; well indurated; resistant | 38 | 1,343 |
| 23 | Limestone: quartzose, very dolomitic, and may in part be classed as calcareous dolomite, slightly carbonaceous-argillaceous; finely crystalline to bioclastic in part; medium dark grey, and weathering same to light grey; medium- to thick-bedded; bioclastic limestone consists of abraded and dolomitized crinoid columnals in a finely crystalline cement; dense; well indurated; resistant and cliff-forming | 55 | 1,305 |
| | CHARLIE LAKE FORMATION (878 feet) | | |
| 22 | Dolomite: very quartzose, slightly calcareous; very finely crystalline; quartz, silt-size to very fine grained; yellowish grey to light grey, and weathering same; indistinctly bedded; fine to medium, regular laminations in part; dense; well indurated; resistant and cliff-forming | 75 | 1,250 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 21 | Dolomite and minor very fine-grained sandstone: quartzose, slightly calcareous, slightly argillaceous; carbonate very finely crystalline to granular and fossiliferous in part; medium to yellowish grey, and weathering same; medium-bedded, up to 2 feet thick; planar crossbedding in part; dense; well indurated; resistant and cliff-forming | 50 | 1,175 |
| 20 | Covered interval | 140 | 1,125 |
| 19 | Dolomite: very sandy in part, may be classed as dolomitic, fine-grained sandstone; carbonate very finely crystalline to aphanitic; medium grey with slight yellow tint, and weathering same; indistinctly bedded; coarse laminations, and colour banding in part; well indurated; slightly recessive | 10 | 985 |
| 18 | Dolomite and minor fine-grained sandstone: slightly argillaceous; very finely crystalline to aphanitic; thin- to medium-bedded; fine to medium, regular laminations; very dense; well indurated; subconchoidal fractures; slightly recessive to recessive | 50 | 975 |
| 17 | Covered interval: talus similar to unit 18 | 22 | 925 |
| 16 | Dolomite and minor fine-grained sandstone: quartzose, slightly calcareous and argillaceous in part; dolomite very finely crystalline to aphanitic, sandy; yellowish grey to light grey, and weathering light grey; medium-bedded; fine to coarse, regular to lenticular laminations; dense; well indurated; resistant | 64 | 903 |
| 15 | Dolomite: very quartzose in part, may be classed as dolomitic sandstone, slightly argillaceous; very finely crystalline; detrital quartz grains very fine to fine grained; yellowish grey, and weathering light grey; medium- to thick-bedded, up to 2 1/2 feet; crossbedded near base; dense; well indurated; slightly recessive to resistant | 50 | 839 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 14 | Sandstone: quartzose, dolomitic, slightly argillaceous; fine grained; yellowish grey to greyish orange-pink, and weathering same; medium- to thick-bedded; coarse, regular to wavy laminations; crossbedded in base; laminations weather in relief; well indurated; resistant | 66 | 789 |
| 13 | Sandstone and dolomite: quartzose, slightly calcareous and argillaceous in part; sandstone very fine to fine grained, cemented by very finely crystalline dolomite; dolomite very finely crystalline and very sandy; yellowish grey to very pale orange, and weathering light yellowish grey; medium- to thick-bedded, up to 3 feet; coarse laminations and banding in part; few, white calcite-filled vugs in upper half; dense; well indurated; resistant | 100 | 723 |
| 12 | Sandstone and minor interbedded sandy dolomite: quartzose, slightly calcareous and argillaceous in part; sandstone very fine to fine grained, and very dolomitic; carbonate very finely crystalline; yellowish grey, and weathering same; medium-bedded, up to 1 1/2 feet thick; fine to coarse, regular laminations; dolomite mottled in part, and contains white calcite-filled vugs; unit dense; well indurated; no obvious porosity; resistant | 102 | 623 |
| 11 | Sandstone: quartzose, very dolomitic, slightly argillaceous; very fine to fine grained; yellowish grey to very pale orange, and weathering yellowish grey; medium-bedded; crossbedded; becomes more dolomitic toward top; dense; well indurated; resistant and cliff-forming | 50 | 521 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 10 | Sandstone and minor dolomite: quartzose, slightly argillaceous; sandstone same as unit 11; dolomite slightly silty, very finely crystalline; medium- to thick-bedded; sandstone crossbedded; dense; well indurated; resistant and cliff-forming | 54 | 471 |
| 9 | Dolomite: calcareous, slightly quartzose and argillaceous; very finely crystalline; yellowish grey, and weathering same; indistinctly bedded; unit permeated by irregular patches of calcite; moderately to well indurated; recessive | 5 | 417 |
| 8 | Covered interval | 32 | 412 |
| 7 | Sandstone and minor collapse breccia: quartzose, argillaceous; sandstone very dolomitic, very fine to fine grained; collapse breccia consists of angular clasts up to 2 inches in diameter in a coarsely crystalline, sandy, dolomite-calcite matrix and cement; breccia in places associated with fibrous calcite up to 1 foot thick; unit yellowish grey, and weathering same to light grey; indistinctly bedded, but looks medium- to thick-bedded; breccia porous, vuggy, found in upper half of unit; sandstone moderate induration; recessive | 10 | 380 |
| | LIARD FORMATION (Incomplete) | | |
| 6 | Siltstone to very fine-grained sandstone: quartzose, dolomitic; yellowish grey, and weathering same; medium- to thick-bedded; very dense; well indurated; unit gradational to overlying Charlie Lake Formation; resistant to slightly recessive | 50 | 370 |
| 5 | Siltstone: quartzose, dolomitic; medium dark grey, and weathering orange-grey-brown; medium- to thick-bedded; very dense; well indurated; appears to have dolomitic and siliceous cement; resistant and cliff-forming | 70 | 320 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 4 | Siltstone: same as unit 5, except more dolomitic; carbonate finely crystalline; faint trace of regular to lenticular laminations; resistant and cliff-forming | 100 | 250 |
| 3 | Siltstone: quartzose, dolomitic, slightly carbonaceous-argillaceous; carbonate finely crystalline; medium grey, and weathering light grey; medium- to thick-bedded, up to 4 feet thick; dark grey chert nodules near base; few white quartz-calcite-filled vugs up to 1 inch in diameter; very dense; well indurated; resistant | 50 | 150 |
| 2 | Siltstone and minor limestone: quartzose, possibly carbonaceous-argillaceous; siltstone very dolomitic, slightly calcareous in part; limestone silty, slightly dolomitic, very finely crystalline; unit may be classed in part as very fine-grained sandstone; medium dark grey, and weathering light grey to yellowish brown; medium- to thick-bedded; limestone occurs as lenses and thin interbeds, in upper 20 feet contains indeterminate bivalves and brachiopods - GSC loc. 82632; scattered white quartz-calcite-filled vugs, with few vugs containing trace of purple fluorite; carbonate has subconchoidal fracture; slightly recessive | 50 | 100 |
| 1 | Siltstone to very fine-grained sandstone, and minor sandy limestone: quartzose, carbonaceous-argillaceous; siltstone-sandstone same as unit 2, except more calcareous; limestone quartzose, very finely crystalline to aphanitic; medium dark grey, and weathering medium grey to orange-brown; medium- to thick-bedded; limestone in part contains poorly preserved, indeterminate brachiopods; small white calcite-quartz-filled vugs throughout; very dense; well indurated; limestone has subconchoidal fracture; resistant; unit represents base and lowest exposure of section | 50 | 50 |

Section 8. Clearwater Creek; section measured from east to west along steep ridge on east side of Clearwater Creek near Clearwater Lake; 55°40 1/4'N., 122°55'W. Stratigraphic field section GK-69-3

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | BALDONNEL FORMATION (Incomplete) | | |
| | Ducette Member (Incomplete) | | |
| 62 | Limestone: very dolomitic, slightly silty; finely crystalline, in part bioclastic; medium dark grey with slight brown tint, and weathering dark brownish grey; medium-bedded, up to 10 inches; unit in part replete with Spiriferina abichi group brachiopods - GSC loc. 84195; recessive, synclinal axis within overlying covered interval | 10 | 3,018 |
| 61 | Covered interval: talus consists of slightly calcareous, dolomitic siltstone; medium dark grey, and weathering dark brownish grey; fine, wavy laminations in part; scattered angular to rounded phosphate grains; interval recessive; unit forms sharp contact with underlying resistant weathering sandstones and dolomites of the Charlie Lake Formation | 25 | 3,008 |
| | CHARLIE LAKE FORMATION (490 feet) | | |
| 60 | Dolomite: very sandy quartzose in part, may be classed as dolomitic very fine-grained sandstone, calcareous in part; carbonate finely crystalline; medium light grey to light olive-grey, and weathering light grey to light brownish grey; medium-bedded, up to 2 feet; fine to coarse, regular sand laminations, cross laminations in upper half; dense; well indurated; subconchoidal fracture in part; siliceous mottling in upper half; lower 25 feet partly covered, but rest of unit resistant | 90 | 2,983 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 59 | Dolomite: quartzose, slightly calcareous in part; very fine to finely crystalline; light grey, and weathering same; medium-bedded, up to 1 foot; dense; well indurated; quartz sand laminations in part; unit partly covered; slightly recessive | 50 | 2,893 |
| 58 | Dolomite and minor dolomitic quartz sandstone: dolomite quartzose, very fine to finely crystalline, in part forms intraformational conglomerate in upper 25 feet with angular clasts up to 1/2 inch in diameter in a sandy dolomite matrix; sandstone confined to lower 25 feet, very fine to fine grained; medium-bedded, up to 15 inches; pink; siliceous laminations and mottling in part; dense; well indurated; subconchoidal fracture in part; lower 25 feet has coarse wavy laminations in part; slightly recessive | 50 | 2,843 |
| 57 | Dolomite: very quartzose; very finely crystalline; light grey and weathering same, with orange-brown, siliceous mottling in part; medium- to thick-bedded, up to 2 1/2 feet; fine to coarse, regular silt-sand laminations in part; resistant | 25 | 2,793 |
| 56 | Dolomite: very quartzose, may be called in part very fine- to fine-grained sandstone; carbonate very finely crystalline; light grey, and weathering same to yellow grey; medium- to thick-bedded; coarse sand laminations in lower 5 feet; dense; well indurated; resistant | 50 | 2,768 |
| 55 | Covered interval: talus similar to unit 56 | 25 | 2,718 |
| 54 | Sandstone and minor dolomite: quartzose; sandstone very fine to fine grained; carbonate sandy and finely crystalline; very light grey, and weathering same; medium- to thick-bedded; sandstone coarsely laminated; moderate induration but no obvious porosity; resistant | 25 | 2,693 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 53 | Dolomite: sandy quartzose; finely crystalline; very light grey, and weathering same; medium-bedded, up to 1 foot; minor micro-vugs but no obvious porosity; resistant | 20 | 2,668 |
| 52 | Covered interval: talus similar to unit 53; recessive | 35 | 2,648 |
| 51 | Dolomite: very quartzose in part; fine to very coarse grained to finely crystalline; carbonate grains well-rounded, cemented by finely crystalline dolomite; very light grey with pink tinting in part, and weathering same; medium- to thick-bedded; dense; well indurated; resistant and cliff-forming | 20 | 2,613 |
| 50 | Sandstone: quartzose, very dolomitic in part and may be classed as sandy dolomite; very fine to fine grained; carbonate finely crystalline; light grey to yellowish grey, and weathering same; medium- to thick-bedded, up to 3 1/2 feet; coarse, regular laminations and cross-laminations in part; dense; well indurated; unit forms conspicuous contact with underlying, darker weathering rocks; resistant | 100 | 2,593 |
| | LIARD FORMATION (1,368 feet) | | |
| 49 | Limestone and minor dolomitic siltstone: limestone very dolomitic in part, finely crystalline to bioclastic; medium grey, and weathering same; medium-bedded; siltstone occurs as interbeds; dense; well indurated; breaks in part with subconchoidal fracture; few scattered phosphatic Lingula shell fragments; slightly recessive to resistant | 35 | 2,493 |
| 48 | Limestone and sandstone: limestone dolomitic, finely to medium crystalline; sandstone quartzose, dolomitic, slightly calcareous, very fine grained, occupies upper 10 feet; medium dark grey to yellowish grey, and weathering same; medium-bedded; minor empty vugs; limestone dense, with subconchoidal fracture; slightly recessive | 22 | 2,458 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 47 | Siltstone to very fine-grained sandstone, and minor bioclastic limestone in upper 15 feet: siltstone-sandstone quartzose, very dolomitic, slightly calcareous in part; yellowish grey to medium grey, and weathering greyish yellow to brownish orange; indistinctly bedded; limestone consists of broken crinoid fragments in a coarsely to medium crystalline dolomite matrix and cement; sandstone weathers rubbly; scattered lingulid and orbiculoidid shells in sandstone talus; strata dense; well-indurated; recessive to slightly recessive | 77 | 2,436 |
| 46 | Limestone, and minor calcareous dolomite in upper half: very fine to finely crystalline; medium dark grey, and weathering medium grey; medium-bedded, up to 1 foot; small, white calcite-lined vugs; poorly preserved indeterminate bivalves; breaks with subconchoidal fracture; resistant | 18 | 2,359 |
| 45 | Limestone and minor calcareous sandstone: quartzose; limestone brecciated in part, consisting of angular limestone clasts in a sandy limestone matrix and cement; clasts up to 2 inches in diameter; sandstone slightly porous; "honeycomb" texture in part; unit yellowish grey to greyish orange, and weathering same; recessive | 21 | 2,341 |
| 44 | Limestone: very finely crystalline to aphanitic; medium grey, and weathering same; medium-bedded, up to 10 inches; well indurated; breaks with subconchoidal fracture; scattered phosphatic Lingula shells in talus; resistant | 10 | 2,320 |
| 43 | Sandstone: quartzose, very dolomitic, in part classed as slightly calcareous; very fine grained; yellowish grey, and weathering same to greyish orange; indistinctly bedded; moderate induration; chalky in part; slightly recessive to recessive | 66 | 2,310 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 42 | Limestone and minor calcareous dolomite: siliceous, slightly silty in part; very fine to finely crystalline; medium dark to dark grey, and weathering same; medium-bedded, up to 10 inches; breaks with subconchoidal fracture; dark grey chert nodules up to 10 inches long scattered throughout upper 30 feet; limestone in part dolomitic; nonporous; slightly recessive | 53 | 2,244 |
| 41 | Dolomite to sandstone: quartzose, slightly calcareous in upper 10 feet; sandstone very fine grained; carbonate finely crystalline; yellowish grey to light grey, and weathering greyish orange; medium- to thick-bedded, up to 3 feet; dense; well indurated; resistant | 30 | 2,191 |
| 40 | Limestone: dolomitic, carbonaceous, slightly silty, very sandy in lower 10 feet; very finely crystalline to bioclastic in part; medium dark to dark grey, and weathering medium grey to orange-brown near base; silicified brachiopods throughout upper 20 feet; pelecypods and ammonites 10 feet below top; Spirogmoceras? sp. - GSC loc. 84200; minor white, quartz-filled vugs in upper 20 feet; orange mottling in part; dense; well indurated; slightly recessive to resistant | 34 | 2,161 |
| 39 | Sandstone: quartzose, very dolomitic, slightly carbonaceous; very fine grained, may in part be classed as siltstone; medium grey, and weathering dull orange-grey; medium- to thick-bedded, up to 4 feet; laminated and cross laminated in part; dense; well indurated; slightly recessive | 53 | 2,127 |
| 38 | Limestone: very dolomitic in part, silty, carbonaceous; finely crystalline to bioclastic; medium dark grey, and weathering medium grey; thin- to medium-bedded; fine regular laminations in part; indeterminate bivalves collected from lower and upper 5 feet; bioclastic limestone consists of fragmented brachiopod-pelecypod shells, and crinoid ossicles; dense; well indurated; weathers shaly to flaggy in part; recessive to slightly recessive | 60 | 2,074 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 37 | Siltstone to very fine-grained sandstone: quartzose, very dolomitic, calcareous in upper 20 feet; carbonate finely crystalline; medium to medium dark grey, and weathering same to yellowish grey-brown; medium- to thick-bedded; minor quartz-filled vugs and silicified fossil fragments; scattered dark grey chert nodules and lenses in upper 10 feet; weathers spheroidal, and flaggy in part; dense; well indurated; subconchoidal fracture in part; resistant | 60 | 2,014 |
| 36 | Siltstone to very fine-grained sandstone: quartzose, dolomitic, very calcareous in part, may be classed as silty dolomitic limestone; medium grey, and weathering same to yellow-grey; medium- to thick-bedded, up to 3 feet, with most beds averaging 10 inches; scattered rhynchonellid and spiriferid brachiopods throughout, some silicified; dense; well indurated; resistant | 40 | 1,954 |
| 35 | Covered interval: talus similar to unit 34 | 20 | 1,914 |
| 34 | Siltstone to very fine-grained sandstone and minor sandy limestone: quartzose, very dolomitic; carbonate finely crystalline to bioclastic; medium grey with slight brown tint, and weathering orange-grey to brownish grey; indistinctly bedded, but looks medium to thick; fine to coarse, regular laminations; limestone occurs as thin flaggy-weathering interbeds containing rhynchonellid and spiriferid brachiopods; dense; well indurated; scattered Lingula shells in lower 30 feet; resistant to slightly recessive | 60 | 1,894 |
| 33 | Covered interval: talus consists of orange-brown weathering calcareous siltstone to sandstone | 54 | 1,834 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 32 | Siltstone to very fine-grained sandstone, and minor sandy limestone: quartzose, dolomitic, siltstone-sandstone calcareous, and slightly carbonaceous; medium dark grey, and weathering same to brownish grey with orange tint; indistinctly bedded; fine, wavy laminations in part; limestone interbeds contain brachiopods similar to those of unit 34; unit weathers flaggy in part, in 1/2 inch to 1 inch plates; dense; well indurated; resistant to slightly recessive | 57 | 1,781 |
| 31 | Sandstone: quartzose, dolomitic, very calcareous in part, slightly carbonaceous; very fine grained; medium to medium dark grey, and weathering yellowish grey to orange-brown; medium- to thick-bedded; fine to medium regular laminations; weathers flaggy in part; unit very calcareous near base; well indurated; resistant | 45 | 1,724 |
| 30 | Limestone: slightly dolomitic, very carbonaceous; very finely crystalline; medium dark grey, and weathering medium grey; medium- to thin-bedded; scattered dark grey chert nodules up to 3 inches in diameter; weathers shaly in part; recessive | 12 | 1,679 |
| 29 | Siltstone to very fine-grained sandstone and minor dolomite and limestone: siltstone-sandstone quartzose, dolomitic, very calcareous in lower 35 feet; dolomite and limestone quartzose, partly bioclastic; medium to medium dark grey, and weathering brownish grey with orange tint in part; thin- to medium-bedded, up to 2 feet; fine to coarse, regular laminations; weathers flaggy to shaly in part; moderate induration; nonporous; recessive to slightly recessive | 76 | 1,667 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 28 | Siltstone to very fine-grained sandstone: quartzose, dolomitic, very calcareous, may be classed in part as sandy limestone; carbonate very finely crystalline; medium dark grey, and weathering same with orange-grey mottling in part; thin- to medium-bedded; wavy, lenticular laminations; in part cross-laminated; upper 10 feet contains pelecypods and rhynchonellid brachiopods; recessive | 23 | 1,591 |
| 27 | Limestone: dolomitic, very sandy in upper half, may be classed as calcareous, very fine-grained sandstone; medium dark to dark grey, and weathering medium to light grey; carbonate finely crystalline; thin-bedded; well laminated lower 10 feet contains thin coquinoid laminations of thin-shelled pelecypods; few dark grey chert lenses; weathers shaly to flaggy; scattered pelecypods similar to those in unit 28; recessive | 27 | 1,568 |
| 26 | Limestone: siliceous; bioclastic consisting of broken brachiopod-pelecypod shells and crinoid debris; medium light grey, and weathering same to white; unit forms single bed and serves as distinctive marker unit; scattered black phosphate grains; nonporous; resistant | 3 | 1,541 |
| 25 | Siltstone and minor silty limestone: siltstone quartzose, dolomitic, very calcareous, slightly carbonaceous; medium dark grey, and weathering same to yellow-grey; indistinctly bedded; fine to coarse, regular light grey laminations, few dark grey siliceous lenticles; squashed brachiopods in upper half; weathers shaly to flaggy; slightly recessive to recessive | 40 | 1,538 |
| 24 | Covered interval: talus consists of calcareous, very fine-grained sandstone | 20 | 1,498 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 23 | Siltstone to very fine-grained sandstone: quartzose, dolomitic, very calcareous, may be classed in part as sandy limestone; carbonate finely crystalline; medium dark grey, and weathering same to orange-grey; indistinctly bedded; fine, regular to lenticular laminations; Daonella sp. and Trachyceras cf. T. desatoyense Johnson - GSC loc. 84212, collected 30 feet from top; unit partly covered; weathers shaly to flaggy; recessive | 53 | 1,478 |
| 22 | Siltstone to very fine-grained sandstone, and minor sandy carbonaceous bioclastic limestone: unit similar to unit 23, except higher calcite content and more carbonaceous; weathers shaly to flaggy; partly covered; recessive to slightly recessive | 55 | 1,425 |
| 21 | Sandstone to limestone: quartzose, very dolomitic and carbonaceous in part; sandstone very fine grained, may be classed in part as siltstone; carbonate finely to medium crystalline; medium dark grey, and weathering same to dull orange-grey; indistinctly bedded; fine to coarse, regular to lenticular laminations throughout; micro cross-laminations in upper 10 feet; scattered black siliceous lenticles in lower 20 feet; weathers shaly to flaggy; moderate to well indurated; slightly recessive | 80 | 1,370 |
| 20 | Sandstone: quartzose, very dolomitic and calcareous, may be classed in part as sandy limestone; sandstone very fine grained; carbonate finely to medium crystalline; medium dark grey, and weathering same to greyish orange; indistinctly bedded; fine to coarse, regular to lenticular laminations throughout; weathers shaly to flaggy; moderate induration; no obvious porosity; slightly recessive to recessive | 125 | 1,290 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 19 | Sandstone: similar to unit 20, except contains dark grey recessive shaly siltstone interbeds; unit gradational with underlying Toad Formation; present unit slightly recessive to resistant | 40 | 1,165 |
| | TOAD FORMATION (900 feet) | | |
| 18 | Siltstone to silty shale: quartzose, very carbonaceous, dolomitic, very calcareous, may be classed in part as silty carbonaceous limestone; carbonate finely crystalline; dark grey, and weathering same to dull greyish orange; indistinctly bedded; fine laminations throughout; Daonella sp. and Daxatina? sp. - GSC loc. 84216, collected 25 feet from top; alternation of resistant and recessive strata; weathers shaly to flaggy; lower 5 feet forms resistant orange-weathering rib; slightly recessive to resistant | 50 | 1,125 |
| 17 | Siltstone to silty shale: similar to unit 18, except contains a few prominent orange-weathering silty dolomite interbeds; unit very calcareous, may be classed in part as carbonaceous-argillaceous limestone; poorly preserved Daonella sp. 60 feet from top; recessive to slightly recessive | 120 | 1,075 |
| 16 | Silty shale: quartzose, carbonaceous-argillaceous, very calcareous, may be classed in part as shaly limestone; dark grey, and weathering same; thin-bedded; poorly preserved pelecypod shells; fine regular laminations throughout; slightly recessive | 30 | 955 |
| 15 | Siltstone: quartzose, dolomitic, carbonaceous-argillaceous, very calcareous, may be classed in part as silty limestone; dark grey, and weathering same to greyish orange; indistinctly bedded, except for scattered lenticular interbeds of orange-weathering silty dolomite up to 10 inches thick; fine to coarse, regular to lenticular laminations throughout; Daonella sp. collected 23 feet above base, but scattered throughout unit; shaly- to flaggy-weathering; resistant to slightly recessive | 60 | 925 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 14 | Siltstone: similar to unit 15, except laminations not as prominent; unit consists of alternating resistant and recessive strata, with few dense orange-weathering silty dolomite interbeds; poorly preserved pelecypods throughout; only recessive shaly intervals laminated; slightly recessive to resistant | 55 | 865 |
| 13 | Siltstone: quartzose, dolomitic, carbonaceous-argillaceous, very calcareous, may be classed in part as silty limestone; carbonate finely crystalline to granular; dark grey, and weathering same to greyish brown; mainly indistinctly bedded, except for orange-grey weathering bed of silty dolomite in lower 20 feet; fine, regular, carbonaceous laminations; more resistant beds non-laminated; poorly preserved ammonites Maclearnoceras ?? sp. - GSC loc. 84213, 25 feet from top; weathers shaly to flaggy; recessive | 60 | 810 |
| 12 | Siltstone to silty shale: quartzose, dolomitic, very calcareous, very carbonaceous-argillaceous, may be classed in part as silty carbonaceous limestone; carbonate finely crystalline to granular; dark grey, and weathering same to orange-brown; unit appears thin- to medium-bedded; lower 2 feet consists of a single bed of orange-brown weathering silty dolomite; fine, regular to lenticular, carbonaceous laminations; few poorly preserved pelecypod and ammonite impressions; weathers shaly to flaggy; slightly recessive | 102 | 750 |
| 11 | Siltstone to silty shale: similar to unit 12, except more carbonaceous-argillaceous, and contains Daonella sp. throughout, with collection taken from upper 10 feet - GSC loc. 84211; wavy, crenulated laminations 40 feet from top; poorly preserved ammonite impressions; partly covered; recessive | 100 | 648 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 10 | Siltstone to silty shale: same as unit 12; contains orange-grey weathering, silty dolomite beds in upper and lower 20 feet; compressed Protrachyceras sp. and Daonella lomelli group collected 40 feet from top - GSC loc. 84207; weathers very shaly; soft and friable in part; partly covered; recessive | 140 | 548 |
| 9 | Covered interval, except for small exposures at base and 20 feet from top consisting of very carbonaceous, calcareous, dolomitic siltstone; similar to unit 10; very recessive | 40 | 408 |
| 8 | Siltstone: quartzose, carbonaceous-argillaceous, very dolomitic in upper 40 feet, very calcareous in lower 20 feet; carbonate finely crystalline and bioclastic in part; dark grey, and weathering same, with a few zones of orange-brown weathering strata; indistinctly bedded, but looks thin-bedded; fine, regular to wavy laminations in part; crushed Protrachyceras sp. from upper 10 feet; weathers shaly to flaggy; recessive | 60 | 368 |
| 7 | Covered interval | 23 | 308 |
| 6 | Siltstone to silty limestone: quartzose, very carbonaceous, slightly dolomitic and phosphatic; dark grey, and weathering same; indistinctly bedded; black, siliceous phosphate nodules up to 1 1/2 inches in diameter throughout lower 40 feet; weathers very shaly; partly talus covered; siltstone in lower 20 feet only slightly calcareous; recessive | 60 | 285 |
| | GRAYLING FORMATION (225 feet) | | |
| 5 | Siltstone: quartzose, carbonaceous-argillaceous, very dolomitic may be classed in part as silty dolomite; slightly phosphatic; dark grey, and weathering same to brownish grey and greyish orange; mainly thin-bedded, but few lenticular resistant beds up to 6 inches; fine to coarse, | | |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 5 (cont'd.) | regular to lenticular laminations; black bulbous nodules and lenses of phosphate scattered in parts of interval; weathers flaggy; slightly recessive | 80 | 225 |
| 4 | Siltstone to silty dolomite: similar to unit 5, except no obvious phosphatic nodules or lenses, and less carbonaceous than overlying unit; strata weathers medium grey to bright orange; weathers shaly to flaggy; slightly recessive to resistant | 45 | 145 |
| 3 | Covered interval | 20 | 100 |
| 2 | Siltstone and limestone: quartzose, carbonaceous-argillaceous; siltstone dolomitic; limestone finely crystalline - looks bioclastic in part; medium dark grey with bluish tint, and weathering same to greyish orange; thin- to medium-bedded; limestone predominantly in lower 30 feet; fine, regular to lenticular laminations throughout; Posidonia mimer Oeberg and Arctoceras sp. collected 10 feet from top - GSC loc. 84197; limestone dense, well indurated; siltstone weathers shaly; slightly recessive to recessive | 55 | 80 |
| 1 | Covered interval: unit forms unconformable contact with underlying Permian strata; recessive | 25 | 25 |

Section 9. Headwaters of Carbon Creek; section measured along base of cliff near headwaters of north fork of Carbon Creek; 55°41 1/2'N., 122°46 1/4'W. Stratigraphic field section GK-69-1.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | BOCOCK FORMATION (type section) (208 feet) | | |
| 37 | Limestone: similar to unit 36, but inaccessible for sampling; resistant and cliff-forming | 25 | 1,021 |
| 36 | Limestone: siliceous in part; medium to coarsely crystalline, to bioclastic in part; medium light grey, and weathering same; thick-bedded; permeated by black, vitreous pyrobitumen in part; small amber wood-like fibres throughout; dense; well-indurated; no obvious porosity; upper 10 feet has siliceous mottlings; resistant | 22 | 996 |
| 35 | Covered interval | 9 | 974 |
| 34 | Limestone: coarsely crystalline to bioclastic in part; light grey, and weathering same to medium grey; bioclastic material mainly recrystallized; permeated by black, vitreous pyrobitumen giving rock mottled appearance; indistinctly bedded; only scattered exposure; no obvious porosity; dense; well indurated; few scattered brachiopod shell fragments; wood-like fibres throughout; slightly recessive to recessive | 30 | 965 |
| 33 | Covered interval, except for small exposure near top of bioclastic limestone consisting mainly of white to light grey crinoid ossicles; may be classed as nonporous encrinite; recessive | 45 | 935 |
| 32 | Limestone: siliceous; very finely crystalline to bioclastic, latter consisting mainly of crinoid columnals; medium dark grey, and weathering light grey; medium-bedded; dense; well indurated; upper 5 feet very siliceous; resistant | 12 | 890 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 31 | Limestone: medium to coarse grained, to bioclastic; very difficult to identify fossil fragments; medium dark grey to yellowish grey, and weathering same; medium-bedded; amber wood-like fragments in part; dense; well indurated; no obvious porosity; interval partly bush covered; recessive to slightly recessive | 25 | 878 |
| 30 | Limestone: siliceous; very fine to finely crystalline, to bioclastic in part; medium dark grey to light grey with slight brown tint, and weathering light grey; medium-bedded; siliceous mottling in part; bioclastic carbonate mainly crinoid and brachiopod fragments, but also contains amber plant or wood fragments; minor permeation of black, vitreous, pyrobitumen material in bioclastic limestone; dense; well indurated; unit forms probable contact with Pardonet Formation; resistant | 40 | 853 |
| | PARDONET FORMATION (417 feet) | | |
| 29 | Covered interval: contact with Bocock Formation may lie within interval, but assumed to occur at top; very recessive | 15 | 813 |
| 28 | Limestone: very carbonaceous, slightly silty and dolomitic; bioclastic, consisting of coquina of Monotis sp. shells; medium dark grey, and weathering same to brownish grey; indistinctly bedded; resistant | 3 | 798 |
| 27 | Covered interval | 35 | 795 |
| 26 | Limestone: very quartzose, may be classed in part as calcareous siltstone, dolomitic, carbonaceous; finely crystalline; medium dark grey, and weathering greyish brown; indistinctly bedded; scattered Monotis sp. shells; dense; well indurated; resistant | 16 | 760 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 25 | Limestone: slightly quartzose and dolomitic, very carbonaceous; bioclastic, consisting of dense coquina of Monotis subcircularis; dark grey, and weathering same to brownish grey; indistinctly bedded; wavy crenulated laminations throughout; fossil collection from upper foot; porous; resistant | 22 | 744 |
| 24 | Covered interval | 37 | 722 |
| 23 | Limestone: very quartzose in part, may be classed as calcareous siltstone, carbonaceous, slightly dolomitic; mainly bioclastic, but partly finely crystalline; medium dark to dark grey, and weathering same to brownish grey; indistinct to medium-bedded; wavy, crenulated laminations in part; silty strata display spheroidal weathering; bioclastic carbonate consists mainly of Halobia sp. shells and a few of Monotis cf. pinensis from upper 1 foot; ammonite collected from lower 10 feet; upper 10 feet mainly talus covered; slightly recessive to recessive | 32 | 685 |
| 22 | Covered interval | 33 | 653 |
| 21 | Limestone: slightly silty, dolomitic, very carbonaceous; bioclastic to finely crystalline; dark grey with slight brown tint, and weathering medium to light grey; thin-bedded; wavy crenulated laminations throughout; consists in part of coquina of compressed Halobia sp. shells; Cyrtopleurites sp. collected 4 feet below top; strong fetid odour upon fracture; resistant | 22 | 620 |
| 20 | Covered interval | 25 | 598 |
| 19 | Limestone and minor calcareous siltstone: quartzose, very carbonaceous, slightly dolomitic; limestone very silty in part, mainly finely crystalline but in part bioclastic, consisting of coquina of compressed pelecypod shells; siltstone occurs as dense interbeds up to 2 feet thick; medium dark | | |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 19 (cont'd.) | grey, and weathering same; vertebrate bone fragments in upper 5 feet; strong fetid odour upon fracture; wavy, crenulated laminations in part; weathers shaly to flaggy; slightly recessive to resistant | 60 | 573 |
| 18 | Limestone: silty and dolomitic in part, very carbonaceous; bioclastic, consisting mainly of a compressed coquina of pelecypod shells; dark grey, and weathering same to brownish grey; indistinctly bedded; crenulated, wavy laminations throughout; poorly preserved ammonites 5 feet from top; fetid odour upon fracture; resistant | 40 | 513 |
| 17 | Limestone: slightly silty, very carbonaceous; appears bioclastic, consisting mainly of fragmented and compressed pelecypod shells; medium dark grey with brown tint, and weathering light grey; medium-bedded; fine, wavy, crenulated laminations throughout, some of possible algal origin; 32 feet from base is 1 foot zone containing oolites and pisolites; scattered vertebrate bone fragments in upper 20 feet; fetid odour upon fracture; resistant | 40 | 473 |
| 16 | Limestone to siltstone: quartzose, dolomitic, carbonaceous; finely crystalline; medium dark to dark grey, and weathering greyish brown; medium- to thick-bedded up to 3 1/2 feet; fragmented pelecypod shells throughout lower 4 feet; Guembelites cf. jandianus and "Thisbites" cf. dawsoni from lower 5 feet; vertebrate bone bed 4 feet from base; dense; well indurated; displays subconchoidal fracture in part; unit form sharp conformable contact with underlying Baldonnel Formation; resistant | 37 | 433 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | BALDONNEL FORMATION (363 feet) | | |
| 15 | Limestone: slightly silty and dolomitic; very finely crystalline; medium dark grey, and weathering light grey; medium- to thick-bedded; large medium grey chert nodules and lenses throughout lower 15 feet; very dense; well indurated; breaks in part with subconchoidal fracture; resistant | 23 | 396 |
| 14 | Limestone: slightly dolomitic; bioclastic to coarsely crystalline; unit consists mainly of crinoid columnal fragments; medium to medium dark grey, and weathering light grey; thick- to medium-bedded to indistinctly bedded; lower 20 feet contains abundant black, vitreous, pyrobitumen coated fossil fragments; may be minor repetition due to faulting; massive and resistant | 80 | 373 |
| 13 | Covered interval | 12 | 293 |
| 12 | Limestone: siliceous; bioclastic to granular; medium light grey, and weathering same; medium-bedded; bioclastic material consists of shell and crinoid fragments, some of which are silicified; well indurated; resistant | 9 | 281 |
| 11 | Dolomite and minor limestone: dolomite very quartzose in part, may be classed as dolomitic siltstone, calcareous, finely crystalline; limestone bioclastic, consisting of crinoid ossicles; medium grey, and weathering same; thick- to medium-bedded; siliceous patches in part; nonporous; resistant | 25 | 272 |
| 10 | Limestone: bioclastic, consisting of fragmented crinoid ossicles and brachiopod-pelecypod shells; light grey to yellowish grey, and weathering same; medium-bedded; coarse, wavy laminations in part; small, white quartz-filled vugs throughout; resistant | 12 | 247 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 9 | Limestone: quartzose, very dolomitic, may be classed in part as calcareous dolomite; finely crystalline; medium grey, and weathering light grey; medium- to thick-bedded; light grey chert nodules in upper 10 feet; scattered calcite-lined and filled vugs in lower 25 feet; unit forms sharp conformable contact with darker weathering strata below; resistant | 57 | 235 |
| | Ducette Member (145 feet) | | |
| 8 | Limestone: very quartzose and dolomitic, slightly carbonaceous; finely to medium crystalline; medium dark to dark grey, and weathering dark brownish grey; thin- to medium-bedded, up to 6 inches; fine, regular to wavy laminations with micro cross-laminations in part; weathers shaly to flaggy; recessive | 15 | 178 |
| 7 | Limestone: very carbonaceous, slightly silty; very finely crystalline to aphanitic; dark grey, and weathering same; medium-bedded, up to 1 foot; dense; well indurated; weathers rubbly; resistant to slightly recessive | 25 | 163 |
| 6 | Siltstone to limestone: quartzose, very dolomitic, slightly carbonaceous; carbonate finely to medium crystalline; pale yellowish brown to medium dark grey, and weathering brownish grey; medium- to thin-bedded; scattered fossil fragments in limestone; resistant to slightly recessive | 25 | 138 |
| 5 | Covered interval | 15 | 113 |
| 4 | Siltstone: quartzose, calcareous, dolomitic; carbonate medium to finely crystalline; medium to medium dark grey, and weathering brownish grey; medium- to thick-bedded; wavy lenticular laminations in part; spheroidal weathering; dense; well indurated; resistant and cliff-forming | 50 | 98 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 3 | Covered interval | 5 | 48 |
| 2 | Limestone: quartzose, very carbonaceous, slightly dolomitic; finely crystalline; medium dark grey, and weathering same; medium-bedded; upper 5 feet contains vertebrate bone fragments; minor non-collectable brachiopods; minor vugs near base; dense; well indurated; subconchoidal fracture in part; unit forms sharp contact with underlying light weathering strata of Charlie Lake Formation; resistant | 10 | 43 |
| | CHARLIE LAKE FORMATION (Incomplete) | | |
| 1 | Dolomite: slightly quartzose and calcareous; very finely crystalline to medium grained near upper contact; light olive-grey to medium light grey, and weathering light grey; medium-bedded, up to 1 foot; granular carbonate contains abundant well-rounded quartz grains; dense; well indurated; represents base of section; resistant | 33 | 33 |

Section 10. Callazon Gap; section measured up steep cliff face near east fork of Callazon Creek; 55°35 1/2'N., 122°45 1/4'W. Stratigraphic field section GK-69-14.

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| | CHARLIE LAKE FORMATION (Incomplete) | | |
| 17 | Sandstone and dolomite: quartzose; sandstone very dolomitic, very fine to fine grained; dolomite very finely crystalline, very silty in part; medium light grey to yellowish grey, and weathering same; medium- to thick-bedded, up to 4 feet; fine to coarse, regular to lenticular laminae in part; scattered white quartz-calcite-filled vugs up to 1 inch in diameter in lower 10 feet; dense; well indurated; unit overlain by yellow-weathering sandstones, siltstones, collapse breccias, dolomites and minor limestones typical of Charlie Lake facies; resistant | 31 | 953 |
| | LIARD FORMATION (922 feet plus) | | |
| 16 | Covered interval: talus consists of dolomitic sandstone similar to unit 15 | 38 | 922 |
| 15 | Siltstone to very fine-grained sandstone: quartzose, very dolomitic; yellowish grey, and weathering same; thick-bedded, over 4 feet; upper 10 feet porous, rest of unit dense, well indurated; resistant and cliff-forming; unit gradational to overlying Charlie Lake facies | 35 | 884 |
| 14 | Siltstone: may be classed in part as very fine-grained sandstone, quartzose, dolomitic; yellowish grey with orange tint in part, and weathering greyish orange to medium grey-brown; thick-bedded; coarse, regular to wavy, lenticular laminations in part; dense; well indurated; slightly recessive to resistant | 55 | 849 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 13 | Siltstone to very fine-grained sandstone: quartzose, dolomitic; yellowish grey, and weathering dark orange-brown; thick-bedded; dense; well indurated; slightly recessive to resistant | 66 | 794 |
| 12 | Sandstone: quartzose, very dolomitic in part; very fine grained; yellowish grey to medium light grey, and weathering same to greyish brown; thick-bedded; fine to coarse laminations in part; dense; well indurated; slightly recessive | 37 | 728 |
| 11 | Siltstone to very fine-grained sandstone in part: quartzose, dolomitic, slightly calcareous toward base; yellowish grey to pale yellowish brown, and weathering dark orange-brown; thick-bedded, up to 10 feet at base, with few medium beds to 1 foot; faint trace of fine, lenticular, dark grey laminations; few white quartz-filled vugs in upper 25 feet; dense; well indurated; resistant | 75 | 691 |
| 10 | Limestone: slightly quartzose, carbonaceous-argillaceous; very finely crystalline to aphanitic; medium dark grey, and weathering medium to light grey; medium-bedded; very fine, wavy to lenticular, dark grey laminations; dark grey chert nodules up to 6 inches in diameter; dense; well indurated; subconchoidal fracture; weathers rubbly in part; forms prominent marker horizon; slightly recessive to resistant | 8 | 616 |
| 9 | Siltstone and minor limestone: quartzose; siltstone very dolomitic, slightly calcareous especially in lower 25 feet; limestone very dolomitic, quartzose; finely crystalline to bioclastic in part; unit medium grey to yellowish grey, and weathering dark orange-brown; thick-bedded, up to 8 feet; lenticular, discontinuous laminations in part; limestone contains many crinoid columnal fragments; dense; well indurated; resistant and cliff-forming | 67 | 608 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 8 | Siltstone and minor silty bioclastic limestone: quartzose, dolomitic, carbonaceous-argillaceous in part; siltstone calcareous; medium to medium dark grey, and weathering dark grey-brown to orange-brown; medium- to thick-bedded, up to 4 feet; limestone occurs as interbeds throughout unit, contains spiriferid and rhnychonellid shells and shell fragments - lower 5 feet forms coquina; dense; well indurated; resistant and cliff-forming | 25 | 541 |
| 7 | Siltstone: quartzose, dolomitic, very calcareous in part; medium dark grey, and weathering brownish grey; indistinctly bedded, looks medium to thick; lower 1 foot replete with spiriferids and rhynchonellids, and few blue-black Lingula sp. shells; dense; well indurated; resistant and cliff-forming | 58 | 516 |
| 6 | Siltstone and minor interbeds and lenticles of silty limestone: quartzose, very dolomitic, slightly carbonaceous-argillaceous; siltstone very calcareous; limestone finely to medium crystalline, and bioclastic in part consisting of broken brachiopod shells, some silicified; medium dark to dark grey, and weathering dark orange-brown; medium- to thick-bedded, up to 4 feet; faint trace of fine, wavy to discontinuous laminations; upper 15 inches forms marker unit, consisting of silicified bioclastic limestone; strata have ribbon-like appearance; dense; well indurated; resistant | 113 | 458 |
| 5 | Siltstone and minor silty bioclastic limestone: dolomitic, carbonaceous-argillaceous; siltstone quartzose and calcareous; medium dark grey, and weathering same to orange-brown; indistinctly bedded, but few beds to 3 inches; poorly preserved pelecypod shells and ammonite impressions in lower half; scattered limestone lenses containing rhynchonellids in upper 25 feet; fossils partly silicified; dense; well indurated; resistant | 50 | 345 |

| Unit | Lithology | Thickness (feet) | Height Above Base (feet) |
|---|---|---|---|
| 4 | Siltstone and minor silty limestone: similar to unit 5; limestone occurs as thin interbeds and bioclastic lenses; Trachyceras? sp., Badiotites sp. and indeterminate pelecypods collected from lower 5 feet; upper 5 feet contains silicified brachiopods; scattered Lingula sp. fragments in lower half; resistant | 50 | 295 |
| 3 | Siltstone: quartzose, dolomitic, very calcareous in part, may be classed as silty limestone, carbonaceous in part; medium dark grey, and weathering greyish brown; medium- to thick-bedded; fine to coarse, regular to wavy laminations in part; Trachyceras obesum, Halobia sp. and undetermined brachiopods collected 25 feet from base - GSC loc. 84269; calcareous facies bioclastic in part; resistant and cliff-forming | 50 | 245 |
| 2 | Siltstone and minor silty limestone: quartzose, dolomitic, carbonaceous-argillaceous; carbonate finely crystalline to bioclastic; medium dark to dark grey, and weathering same to greyish brown; medium- to thick-bedded; fine to coarse, regular to lenticular laminations in part; limestone occurs in part as bioclastic pods containing Daxatina cf. canadensis, Clionitites cf. wheeleri, and C. cf. reesidei - GSC loc. 84271 and pelecypods, collection obtained 25 feet from base; few dark grey chert lenses in lower 25 feet; unit weathers flaggy in part; dense; well indurated; resistant | 75 | 195 |
| 1 | Siltstone: quartzose, very calcareous, slightly dolomitic, slightly carbonaceous; medium dark grey, and weathering dark greyish brown; indistinctly bedded, but looks medium- to thick-bedded; fine to coarse, regular to wavy lenticular, dark grey laminations; scattered silicified brachiopods and poorly preserved pelecypod fragments 55 feet from base; dense; well indurated; weathers flaggy; unit represents base of exposure and possible base of Liard Formation; resistant and cliff-forming | 120 | 120 |