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P. Harker

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*BULLETIN 95*

# CARBONIFEROUS AND PERMIAN ROCKS, SOUTHWESTERN DISTRICT OF MACKENZIE

By
P. Harker

DEPARTMENT OF
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# PREFACE

Carboniferous and Permian rocks of the southern Mackenzie Mountains form the northern continuation of a succession of strata of similar age in the provinces to the south. Much essential information for the geological mapping of the region has been gained from detailed stratigraphic studies of these rocks, and in this area of potential petroleum development such studies assume an economic significance in the search for oil and gas.

J. M. HARRISON,
*Director, Geological Survey of Canada*

OTTAWA, May 31, 1962

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# CARBONIFEROUS AND PERMIAN ROCKS, SOUTHWESTERN DISTRICT OF MACKENZIE


## *Abstract*

Carboniferous and Permian rocks of the southern Mackenzie Mountains total almost 6,000 feet of beds. Divisible into two major contrasting components, the lower part is shale, limestone, and minor sandstone, and comprises the Yohin, Clausen, and Flett Formations of Mississippian age. The upper part of the sequence consists of a thick sandstone, the Mattson Formation of Mississippian and Pennsylvanian age, overlain by Permian chert and sandstone, named the Fantasque Formation.

On Liard Range and elsewhere in the eastern part of the area the Flett is a competent, cliff-forming limestone unit. Westward the Flett and the two underlying formations lose their identity in a thick succession of shales and sandstones, named the Etanda Formation. The clear contact with the overlying Mattson Formation is retained but the base of the sequence is concealed and the Etanda facies probably continues downwards into pre-Mississippian strata.

A reasonable degree of faunal control serves to establish the overall age relationships of all the formations.



## *Résumé*

Les roches carbonifères et permiennes de la partie sud des monts Mackenzie se présentent sous forme de couches d'une épaisseur totale de près de 6,000 pieds. Elles se subdivisent en deux principaux constituants bien différents: la partie inférieure se compose de schist, de calcaire et d'un peu de grès, elle comprend les formations Yohin, Clausen et Flett, toutes d'âge mississippien; la partie supérieure de la succession consiste en un grès épais, à savoir la formation Mattson, d'âge mississippien et pennsylvanien, que recouvre du chert et du grès permiens auxquels on a donné le nom de formation Fantasque.

Dans la chaîne des montagnes Liard et ailleurs dans la partie orientale de la région, la formation Flett est un complexe de calcaire résistant caractérisé par des falaises. Vers l'ouest, la formation Flett et les deux formations sous-jacentes perdent leur identité et deviennent une succession épaisse de schistes et de grès à laquelle on a donné le nom de formation Etanda. Le contact de cette succession avec la formation sus-jacente Mattson est facile à reconnaître et a retenu sa position originelle, mais sa limite inférieure est dissimulée, tandis que les facies Etanda s'étend probablement vers le bas jusque parmi les assises pré-mississippiennes.

Un certain degré de vérification faunique permet d'établir les relations d'âge pour l'ensemble des formations.

# INTRODUCTION

Carboniferous and Permian rocks underlie parts of the Fort Liard (95B), La Biche (95C), Virginia Falls (95F), and Sibbeston Lake (95G) map-areas of the southwestern District of Mackenzie, and southeastern Yukon Territory. Fort Liard map-area is bounded by latitudes 60° and 61°N, and longitudes 122° and 124°W; La Biche map-area lies to the west between longitudes 124° and 126°W. The two other map-areas lie immediately to the north. These areas form part of the region investigated in 1957 on Operation Mackenzie. Preliminary accounts of the work accomplished on the Operation, including notes on the physiography of the area, have been prepared by R. J. W. Douglas (1958, 1959)[1].

## Field Work and Acknowledgments

Field work was carried out by the author and W. B. Brady of the Geological Survey, assisted in the field by D. A. Andrews, K. P. R. Cole, and R. N. McCowan. Air transportation was by Beaver aircraft (Pacific Western Airlines Ltd., pilot W. McKinney), and Bell helicopters (Associated Helicopters Ltd., pilots N. R. Staniland and R. Huff). Boat transportation was provided by G. P. J. Turner of South Nahanni; A. Konisenta acted as canoeman. To all who assisted, the writer is greatly indebted. The kind hospitality and welcome extended to the party by Mr. and Mrs. G. P. J. Turner on arrival and during subsequent visits to South Nahanni are gratefully acknowledged.

The party was flown by Beaver aircraft from the main base camp of Operation Mackenzie near Hay River to South Nahanni on June 4th. By that date the Liard and South Nahanni Rivers were well clear of ice and the party was moved up South Nahanni River by G. P. J. Turner in a shallow draught boat with inboard engine. Camp was established near the base of the section on The Twisted Mountain. Return to South Nahanni was by freighter canoe. Local knowledge is advisable for the safe navigation of the swift water in the complex stream channels of the lower South Nahanni.

A canoe traverse was made up Liard River to examine shoreline exposures and some of the outcrops on Liard Range that are accessible from the river. Dense vegetation extends down to the water's edge, and camp sites are hard to find. Ground traverses were made to Liard Range from a camp on the west bank of the river at the big island opposite the mouth of Rabbit Creek. Spring canoe travel up the Liard is slow but presents no serious difficulties; little or no broken water was encountered at Flett Rapids in June. The party returned to South Nahanni, where the main operation base had been established, the end of June.

[1] Names and/or dates in parentheses refer to those listed in the Bibliography.

Camp was established by helicopter at Jackfish Gap, and after completion of work at that section, two sub-parties—the author assisted by Andrews, and Brady assisted by Cole—were flown by helicopter to a series of camp sites previously selected by Beaver reconnaissance and air-photo study. The two sub-parties were taken out from Fisherman Lake and from Dendale Lakes by Beaver aircraft to Fort Liard. Day traverses and set outs were made on Beaver, La Biche, and Petitot Rivers by helicopter from Fort Liard.

Portable radios maintained two-way communication between the sub-parties and with the base camp. Ready exchange of geological information by this means greatly facilitated the field work and also resulted in maximum economy in the use of helicopters. The field operations, transportation, and supply problems of Operation Mackenzie have been described by R. J. W. Douglas (1959, pp. 21-32).

## Previous Geological Work

In June 1887 R. G. McConnell left the junction of Dease and Liard Rivers with instructions to descend Liard River and to make a geological examination of the valley. His party left Fort Liard on August 5th. Fossils were collected from flat-lying limestone in the river banks north of Fort Liard. Several species of Mississippian fossils from this collection were identified by Whiteaves, thus providing the first evidence of Carboniferous rocks in the area (McConnell, 1890, p. 56D). The same outcrops were visited by Hume (1923, p. 48) in 1922, who also made a short traverse into the Liard Range exposures, west of the river. In the summer of 1944, C. G. Hage completed an extensive geological reconnaissance in the mountains (Hage, 1945). He did not name any rock-units but he recognized a shale and limestone sequence of Mississippian age overlain by Pennsylvanian or Permian sandstones. In the previous year, Kindle worked on Beaver River and reported Permian chert and Carboniferous? sandstone at Mount Merrill (Kindle, 1944).

In recent years the search for petroleum has sent many oil company geologists into the region. A published report based on field work by British American Oil Company (Patton, 1958) described the succession west of Jackfish River. Patton proposed the name Mattson Formation for the sandstone sequence reported by Hage and Kindle.

Fossil spores from samples of coal collected by Patton from the Mattson Formation have been described by Hacquebard and Barss (1957), and some of the specimens collected by McConnell, Hume, and Hage were included by Sutherland (1958) in his description of the Carboniferous rugose corals of northeastern British Columbia. An account of the Cretaceous stratigraphy of the Liard and Mackenzie Rivers region based on observations made on Operation Mackenzie has been prepared by D. F. Stott (1961).

Two reports by R. J. W. Douglas and D. K. Norris (1959 and 1960) give a preliminary account of the geology of the region. These reports include preliminary geological maps on a scale of 1 inch to 4 miles, map-units are given

number designations, and no new stratigraphic terms are introduced. The relationship of these numbers to the formations described in this report and to the subdivisions of Patton is shown in the following table, which is based on a short published summary of Carboniferous and Permian stratigraphy of the region (Harker, 1961, p. 2).

*Nomenclature of Stratigraphic Units*

| This Report | | Douglas and Norris (1959) Fort Liard and La Biche Map-areas | | Douglas and Norris (1960) Virginia Falls and Sibbeston Lake Map-areas | | Patton (1958) Jackfish Section |
|---|---|---|---|---|---|---|
| Fantasque Formation | | Map-unit 9 | | - - | | — |
| Mattson Formation | Upper member | Mattson Formation (8) | Upper (8c) | Mattson Formation (33) | Upper (33c) | Mattson Formation (unit 4) |
| | Middle member | | Middle (8b) | | Middle (33b) | |
| | Lower member | | Lower (8a) | | Lower (33a) | |
| Etanda Formation | Flett Formation | Map-unit 4 (part) | Map-unit 7 | Map-unit 29 (part) | Map-unit 32 | Unit 3 |
| | Clausen Formation | | Map-unit 6 | | Map-unit 31 | Unit 2 |
| | Yohin Formation | | Map-unit 5 | | Map-unit 30 | Unit 1 |

## STRATIGRAPHY

Carboniferous and Permian rocks comprise a thick sequence of sandstones, shales, and limestones, which at their maximum development total almost 6,000 feet. The succession is readily divisible into two major components: the lower one comprises shales, limestones, and minor sandstones, and the upper, mainly massive sandstones with subordinate shales and sandy shales. The upper sequence has been named the Mattson Formation (Patton, 1958, p. 319). Cherty beds, although not present at Patton's type locality, overlie the Mattson Formation and are named the Fantasque Formation (*see* Harker, 1961, p. 8). The lower sequence, much more variable, is assigned to four formations, named Yohin, Clausen, and Flett, and their stratigraphic equivalent the Etanda Formation (ibid., pp. 3-7).

*Table of Formations*

| Era | Period or epoch | Formation, lithology and thickness in feet | |
|---|---|---|---|
| Mesozoic | Lower Cretaceous | Buckinghorse: Sandstone and shale ± 2,800 | |
| Palaeozoic | Permian | Fantasque: Chert and sandstone ± 180 | |
| | Pennsylvanian | Mattson: Sandstone; minor shale, limestone, and dolomite ± 4,500 | |
| | Mississippian | Flett: Limestone and shale ± 1,500<br>Clausen: Shale ± 500<br>Yohin: Sandstone and shale ± 600 | Etanda: Shale; minor sandstone ± 2,300 |
| | Upper Devonian | Shale | |

### Regional Relationships of Pre-Mattson Formations

In Liard Range the Mattson Formation rests on a sequence of carbonate rocks (the Flett Formation), which are fairly resistant and form the prominent scarps bounding the western side of Liard Valley (*see* Pl. IIA). The base of

the limestone sequence is there generally obscured. North of South Nahanni River a more complete succession is exposed on Bluefish Mountain and in the anticline of The Twisted Mountain. In these sections the Flett Formation contains some shale and even minor sandstone beds, but it is still essentially a limestone unit. It is underlain by black shales of the Clausen Formation, which in turn rests on a rather variable sandstone sequence, the Yohin Formation. The Flett and Clausen Formations are well exposed in several sections in the general area of Yohin Ridge, and on the north-facing scarp of the Tlogotsho Plateau. A section on the west side of Yohin Ridge, about 14 miles south of the South Nahanni River (described by Patton as the Jackfish section, 1958, p. 311), is designated as the type for the Yohin, Clausen, and Flett Formations. It is referred to in this report as the Jackfish section.

The base of the Mattson Formation can be readily identified and mapped along the north side of the Tlogotsho Plateau and the underlying Flett and Clausen Formations also retain their identity. At Ram Creek the base of the Mattson Formation and about 600 feet of the underlying limestones of the Flett Formation are well exposed. Farther west, as the escarpment is followed around the northernmost extension of the Tlogotsho Plateau, the limestone sequence underlying the Mattson becomes more shaly. Two limestone units, corresponding with the upper and middle parts of the section at Ram Creek, persist but eventually these are lost in a thick succession of shales with sandy beds. This shale-sandstone development continues southwards over and into the La Biche Valley, and at Tika Creek, on the west side of the La Biche Valley, some 776 feet of sandstones and shales are exposed beneath the base of the Mattson Formation. These beds are named the Etanda Formation in this report, and the type section is on the west side of Kotaneelee Range near Etanda Lakes.

For the purposes of this discussion the sedimentary environment that resulted in deposition of the Etanda Formation is designated as the Etanda phase; the carbonate type which produced the Flett and Clausen Formations is called the Flett phase. Although there is much black shale in the Etanda phase it is not practicable to make a direct correlation of the Clausen Formation into the Etanda phase and the Clausen Formation is not recognized unless it is overlain by the limestones of the Flett.

The Flett phase is restricted to a belt around the eastern and northeastern parts of the area; the Etanda phase occurs in the interior. The change in facies going eastwards from the middle Liard Range is even more striking than that already described around the northern rim of the Tlogotsho Plateau. Liard Range is typically Flett phase; the middle and southern Kotaneelee Range typically Etanda.

At the Jackfish section the Clausen Formation rests on the Yohin Formation. There may be some structural complication at the base of the Clausen, and the actual contact is not clear. At other sections within the Flett phase there are one or more resistant units, some partly or wholly calcareous, which occur low in the Mississippian section. Two such resistant units can be traced along the

north side of the Tlogotsho Plateau where they eventually shale out into the Etanda phase and are lost. They cannot be traced directly into the Yohin Formation at the Jackfish section owing to north-south faulting that occurs just west of the Kotaneelee Range. A resistant unit with similar topographic expression occurs low in the section on Bluefish Mountain and can be traced northwards along the foot of the scarp facing the dip-slope of Nahanni Range, and is tentatively assigned to the Yohin Formation.

## Yohin Formation

The type section was measured on the west side of Yohin Ridge, from which the formation takes its name (Map 95G, lat. 61°06′N, long. 123°55′W). For location, access, and detailed lithology *see* Appendix, Section 1.

The Clausen, Hage, and Mattson Formations form the main cliffs of the west scarp of Yohin Ridge. The Clausen rests on a resistant, cliff-forming sequence whose talus-covered dip-slope forms an almost level platform beneath the main cliffs at the Jackfish section. This platform is partly occupied by a small lake and provides a helicopter landing and camp site. The Yohin Formation is well exposed in the cliffs that form the western edge of the platform and fall steeply to the lower terrain drained by Clausen Creek and its tributaries. The type section was measured down these cliffs.

About 600 feet of strata exposed in the type section is mainly sandstone, much of it thin bedded, dark coloured, and with various amounts of interbedded black shale. There are also several major black shale units, mostly non-calcareous or only slightly calcareous.

The base of the section is concealed beneath a slope of platy sandstone rubble; scattered exposures, having the rather characteristic brown weathering colours of these rocks, occur in some of the nearby creeks and they also form some of the low hills west of the main range. Actual contact with the overlying, soft shales of the Clausen Formation is not exposed. South of the small lake it would seem to be simple and normal; on the hillside on the north side of the lake it is less straightforward and there is some structural discordance. This may have resulted from differential movement between the competent sandstones of the Yohin Formation and the overlying incompetent shales of the Clausen Formation.

The formation is almost unfossiliferous, the only fossils present were found in talus near the base but are almost certainly from the Yohin Formation. The fossils are fragmentary and occur as moulds in a sandy matrix; they include *Leptaena, Rhipidomella, Chonetes,* productid fragments, and crinoid stems. None is specifically identifiable. Some carbonaceous fragments, believed to be plant remains, were also found. The Yohin Formation, so named in this report, corresponds exactly with Unit 1 of Patton's Jackfish section (Patton, 1958, p. 312).

The Yohin Formation can be mapped northeastwards from its type locality along the scarp face of the range. About 6 miles along strike from Jackfish Gap, however, the range takes a slight displacement to the east. Some structural com-

plexity occurs in the lower part of the Mississippian section, and the strong, cliff-forming aspect of the Yohin Formation is obscured. On the south side of South Nahanni River, where the river crosses the north end of Kotaneelee Range (Yohin Ridge), there are some partly concealed, thin-bedded sandstones containing carbonaceous fragments and a small *Chonetes*. These beds are equivalent to some part of the Yohin Formation.

There are few sections in the whole area where the lower part of the Mississippian is exposed, and the Yohin Formation as developed at the Jackfish section is unique to the immediate vicinity. At both Clausen Creek and on Bluefish Mountain (*see* Appendix, Sections 4 and 5) there is a resistant unit that forms a mappable base for the Clausen Formation. In each section this unit occupies an exactly comparable stratigraphic position to the Yohin Formation. Topographic expression is similar, but the resistant units are thinner and comprise calcareous siltstones in contrast to the dominantly sandstone sequence of the type Yohin.

Along the north side of the Tlogotsho Plateau the lower resistant unit is about 100 feet thick and has a slightly recessive unit in the middle. It is underlain by black shale. Only the uppermost beds were examined; they consist of yellowish weathering, dark coloured, argillaceous, slightly silty limestone. A few fragmentary fossils including *Leptaena* sp., *Chonetes* sp., and *Spirifer* sp. were obtained from these beds.

On Bluefish Mountain a prominent resistant unit at the base of the Clausen Formation swings round the southeast flank of the mountain and continues northwards along the west side of the valley, opposite the dip-slope of Nahanni Range. This unit, consisting of limestones with silty beds, is 120 feet thick (*see* Appendix, Section 5) and contains the following fossils:

*Chonetes* sp.
*Productella* cf. *P. pyxidata* Hall
*Spirifer* cf. *S. marionensis* Shumard
*Punctospirifer* sp.
*Composita* sp.
*Dielasma* sp.

It is underlain by black, non-calcareous shale.

The resistant units described above at Clausen Creek and on Bluefish Mountain are provisionally assigned to the Yohin Formation on the basis of their stratigraphic position and on a somewhat slender similarity of faunal content.

*Age and correlation.* Elsewhere in this report (*see* p. 9) the Clausen Formation, which overlies the Yohin, is shown to be of early Mississippian (Kinderhook) age. Patton (1958, p. 312) states "The age of this lower unit (Yohin Formation) is uncertain and may be early Mississippian". Stratigraphic position together with the rather meagre faunal evidence from the type section tends to confirm an early Mississippian age for the formation. The faunas from Clausen Creek and Bluefish Mountain have a distinctly Kinderhook aspect. Sparse faunas including



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*Spirifer* cf. *S. marionensis, Productella* sp., *Composita* sp. have been reported from Mississippian strata close to the Mississippian/Devonian boundary in the northwestern United States, as for example in the Sappington Formation of Montana (Holland, 1952, p. 1707). Holland (op. cit., p. 1709) claims similarity of these faunas with the Louisiana limestone fauna of Missouri.

In Alberta, the Exshaw Formation consists of an upper siltstone and a lower black, non-calcareous shale. The siltstone contains fossils, and Harker and McLaren (1958, p. 253) state "Some of the forms resemble specimens from the Louisiana limestone of Missouri".

It would be absurd to make any direct correlation of the Yohin Formation, and its possible local correlatives, with the upper member of the Exshaw and with the Sappington by means of tenuous faunal relationships with the Louisiana limestone. It is, however, worth pointing out a possible time equivalence in so far as it concerns the position of the Devonian/Mississippian boundary in our area.

No section in the area provided satisfactory exposures spanning the Devonian/Mississippian boundary. The youngest Devonian rocks form a thick recessive sequence in which dark shales predominate. As a consequence, the upper part of the Devonian is a valley former and exposures are poor. In the western part of the area the situation is even more obscure. There the relief tends to be lower and furthermore the Mississippian is in the shaly Etanda phase which with the underlying Devonian forms a long sequence of soft weathering beds that are obliterated by their own talus in vegetation-covered valleys.

As already stated, the resistant unit outcropping on the lower slopes of Bluefish Mountain, and provisionally assigned to the Yohin Formation, contains a fauna interpreted as being early Mississippian. Several hundred feet of unfossiliferous black shales are exposed beneath this unit and there are no further exposures until the next resistant unit is encountered which forms an intermittent ridge projecting from the valley floor and running parallel with the dip-slope of Nahanni Range. The rocks forming the ridge are exposed in several gullies opposite Granger Gap, and fossils collected just west of the ridge are of Upper Devonian age. The Devonian/Mississippian boundary must therefore lie somewhere in the stratigraphic interval, consisting of about 1,400 feet of beds, between the ridge in the valley and the resistant unit (Yohin Formation?) at the foot of Bluefish Mountain. Furthermore, it is probable that stratal equivalents of the Exshaw black shale would lie beneath the Yohin Formation.

## Clausen Formation

This formation is named after Clausen Creek which rises in the northern edge of Tlogotsho Plateau and drains much of the low-lying area west of Yohin Ridge. For location, access, and detailed lithology *see* Appendix, Section 1.

At its type section, the Clausen Formation consists of about 550 feet of strata. The actual contact with the sandstones of the underlying Yohin Formation is obscured and there is some possibility of error in measurement of the concealed interval at the base of the formation. The formation consists almost entirely

of thinly laminated, non-calcareous black shales, with a few calcareous layers and some beds of more resistant black mudstone. At intervals throughout the formation, many rusty weathering pyritic mudstone nodules occur, commonly in layers. The shales at the top of the formation contain thin bands of nodular, orange weathering mudstone with some cone-in-cone layers. The Clausen Formation is overlain with angular conformity by limestone and calcareous shales of the Flett Formation. No fossils were found in the type section of the Clausen Formation.

About 500 feet of beds on Bluefish Mountain (Appendix, Section 5) are assigned to the Clausen Formation. As in the type section, the sequence is essentially non-calcareous. There are some slightly calcareous layers in a short sequence of arenaceous beds near the middle of the section, which forms a conspicuous resistant band in the shales. Some unidentifiable fossil fragments were found in these beds. The formation rests conformably on the silty limestone beds already provisionally referred to the Yohin Formation in this report. It is overlain by fossiliferous limestone and shale of the Flett Formation.

At the Clausen Creek section (Appendix, Section 4) a sequence of black shales, siltstones, and mudstones rests on a resistant, cliff-forming unit of silty limestone. These shales, though similar in topographic expression and overall lithology with those of the type section of the Clausen are distinctly more calcareous. The 565 feet of strata in this section is assigned to the Clausen Formation. North of Mattson Creek (Appendix, Section 6) about 550 feet of black shales, siltstones, and silty limestones is tentatively assigned to the Clausen Formation. In this section, as also at Clausen Creek, overlying limestone and shale of the Flett Formation contain representatives of Fauna A.

*Age and correlation.* The Clausen Formation underlies, without apparent disconformity, beds containing a predominantly late Kinderhook and Osage fauna. It is underlain by beds whose faunas although scanty are almost certainly of Mississippian age. Consequently the stratigraphic position indicates an early Mississippian age for the formation. A few fossil fragments from a calcareous mudstone in the Clausen Creek section, 200 feet above the base, consist of *Torynifer* sp. and *Spirifer* sp., and are consistent with a Mississippian age for the formation.

The Clausen Formation as defined here corresponds approximately with Patton's Unit 2 (Patton, 1958, p. 312). On stratigraphic position and lithological grounds, Patton suggested a correlation with the Exshaw Formation of Alberta, but, considering the age of the overlying fauna, it would be more appropriate to correlate the Clausen with the lower part of the Banff Formation of Alberta.

In the Halfway River area of northeastern British Columbia, Sutherland (1958, p. 24) described an unfossiliferous Basal Shale unit underlying his Prophet Formation. The stratigraphic relationship of this shale to the Prophet Formation is analogous with that of the Clausen to the Flett, and suggests a correlation between the Basal Shale unit of Sutherland and the Clausen Formation of this report.



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## Flett Formation

This formation is named after Flett Creek, an east-flowing tributary of Liard River that rises in the Flett Formation on the east side of Liard Range. For location, access, and detailed lithology *see* Appendix, Section 1.

At its type section the Flett Formation is 1,982 feet thick and corresponds almost exactly with Patton's Unit 3 described from this same locality (Patton, 1958, p. 312). In gross lithology the formation consists of thin-bedded limestones and shales; two well-developed sandstone zones occur in the upper half and there is some dolomite near the top. Viewed obliquely upwards from the small lake at the base of the section, the formation appears to be much more massive and calcareous than it really is. The same illusion appears in some of the vertical air photographs. Along strike the formation appears in its proper perspective and the limestone-shale alternation is clearly apparent (*see* Pl. IIIA).

The Flett Formation overlies the Clausen Formation and the junction is placed at the top of a thick sequence of paper-thin, non-calcareous black shales. The contact is fairly clear; the lower beds of the Flett are all distinctly calcareous and although dominantly shaly they include some limestone bands. These lower beds, comprising 288 feet of strata, are recessive and form the only easily separable unit of the Flett. Above this lower unit there is an increase in limestone content, and the formation becomes more resistant. Much of it is thin bedded, dark coloured and bioclastic, with high argillaceous content. There are, however, several prominent lighter coloured units of medium-grained, partly crinoidal limestone, some with fairly abundant chert. Shale increases upwards, at the expense of the limestone, and this part of the sequence is terminated by a thick unit (103 feet) of alternating shale and limestone overlain by a prominent sandstone unit (45 feet).

Above the sandy zone, the shale-limestone alternation continues through about 180 feet of strata to another sandy zone consisting of two main sandstone beds separated by thin, non-calcareous shales.

The remainder of the Flett Formation, consisting of 390 feet of beds, includes the most massive limestone units of the whole formation and shaly units, though still present, are less conspicuous. Near the top are two dolomite beds and some minor, non-calcareous shales. The whole sequence weathers to lighter colours than the rest of the formation and the uppermost 60 feet assumes a distinctly yellowish appearance.

The contact with the overlying Mattson Formation is sharp. A bed of grey dolomite at the top of the Flett Formation is overlain by 2 feet of sandy shale. The amount of sand in this bed increases towards the top and it grades into the overlying sandstones of the Mattson Formation. The top of this sandy shale is taken as the junction between the two formations.

The type section of the Flett Formation is moderately fossiliferous and fossil collections, all of Mississippian age, were made at intervals throughout its thickness. These fossils have been grouped into five groups, designated by the letters A-E, starting with the oldest.

*Fauna A*. The fossils listed below have been identified from collections made from the lower 288 feet of the Flett Formation, type section:

*Dictyoclostus burlingtonensis* (Hall)
*Echinoconchus alternatus* (Norwood and Pratten)
*Chonetes illinoisensis* Worthen
*Chonetes* sp. E
*Camarotoechia allani* Warren
*Spirifer centronatus* of authors
*Spirifer rowleyi* Weller
*Platyrachella? rutherfordi* (Warren)
*Brachythyris* cf. *B. chouteauensis* Weller
*Cleiothyridina* cf. *C. obmaxima* McChesney
*Phillipsia* sp.

To these fossils, which were collected in situ, the following species identified from talus collections can be fairly safely added:

"*Michelinia*" sp.
*Lingula* sp.
*Rhipidomella* cf. *R. missouriensis* (Swallow)
*Schizophoria* cf. *S. sedaliensis* Weller
*Schellwienella inequalis* (Hall)
*Pseudosyrinx gigas* Weller
*Punctospirifer* cf. *P. subtexta* (White)
*Athyris*? sp.
*Imitoceras*? sp.
"*Leda*" sp.
*Grammysia* cf. *G. longwelli* Branson

The following ostracod species were identified by M. J. Copeland from 19 feet of shale at the top of this sequence:

*Cribroconcha* aff. *C. costata* Cooper
*Graphiadactyllis* cf. *G. spinosus* Moery
?*Amphissites* sp.
?*Seminolites* sp.
*Glyptopleurina* n. sp.

A single collection, 123 feet above the ostracod-bearing bed, yielded large specimens of *Spirifer* cf. *S. rowleyi* Weller.

*Fauna B*. Four rather fragmentary fossil collections were made from 256 feet of strata lying beneath the lowest sandstone zone, 1,052-1,308 feet above the base. The following fossils have been identified from these collections:

*Kakwiphyllum* sp.
*Ekvasophyllum* sp.
*Orthotetes* cf. *O. keokuk*? (Hall)
*Orthotetes* sp.

*Chonetes* sp.
*Dictyoclostus* indet.
*Buxtonia* sp.
*Camarotoechia* sp.
*Spirifer* sp. A
*Spirifer* cf. *S. bifurcatus* Hall
*Platyrachella*? *rutherfordi*? (Warren)
*Torynifer* cf. *T. pseudolineata* (Hall)
*Composita* sp.
*Pentremites* cf. *P. godoni* De france

*Fauna C.* No fossils were found in the interval between the two sandstone zones. The following were collected from the limestone immediately overlying the higher sandstone, 1,645 feet above the base:

*Diphyphyllum* sp.
*Lyropora* sp.
*Dictyoclostus* cf. *D. tenuicostatus* (Hall)
*Camarotoechia* sp. A

*Fauna D.* 150 feet below base of Mattson Formation:

*Amplexi-Zaphrentis* sp.
*Rhipidomella* sp.
*Dictyoclostus* cf. *D. inflatus* (McChesney)
*Dictyoclostus* cf. *D. parvus* (Meek and Worthen)
*Spirifer* cf. *S. pellaensis* Weller
*Brachythyris* cf. *B. subcardiformis* (Hall)
*Dimegelasma* sp.
*Torynifer* cf. *T. setigera* (Hall)

*Fauna E.* 109 feet below base of Mattson Formation:

*Glyptopleuroides perplexus* Croneis and Gutke
*G. girtyi* Croneis and Gutke
*Paraparchites nicklesi* (Ulrich)
*Kirkbyella quadrata* Croneis and Gutke
*Cribroconcha* cf. *C. costata* Cooper
*Cavellina* cf. *C. parallela* Croneis and Gutke
*Polytilites* cf. *P. wilsoni* Croneis and Gutke
*Chesterella* cf. *C. exuta* Croneis and Gutke
*Oliganisus* cf. *O. geisi* Croneis and Gutke
*Oliganisus*? sp.
*Bairdia* cf. *B. golcondensis* Croneis and Gale
*Graphiadactyllis* (*Bassleria*) cf. *lineatus* (Ulrich and Bassler)
*Bairdia* sp.
*Acratia* sp.

*Glyptopleura* sp.
*Graphiadactyllis*? sp.
*Healdia* sp.

90 feet below base of Mattson Formation:

*Rhipidomella* sp.
*Spirifer* sp. indet.
*Spirifer* cf. *S. leidyi* Norwood and Pratten
*Composita* cf. *C. trinuclea* (Hall)

Partial or complete sections of the Flett Formation were measured on the north scarp of the Tlogotsho Plateau at Ram Creek (Section 3) and near the headwaters of Clausen Creek (Section 4), The Twisted Mountain (Section 2), Bluefish Mountain (Section 5), and on the east face of Liard Range just west of Mount Flett (Section 7). Location, access, and detailed lithology of these sections are given in the Appendix.

In all these sections there is a variable but distinct limestone development, and the broad lithological features of the Flett Formation can be readily discerned. There is, however, very considerable local variation of shale-limestone proportions and detailed lithological correlation cannot easily be made. Fossils offer some means of correlation with the type section. The faunas listed under the type section and designated by letters A to E can be recognized wholly or in part in other sections. Here again, however, local lithological variation, which reflects different conditions at time of deposition, has affected the preservation and content of these assemblages of fossils.

Measured sections at The Twisted Mountain, Ram Creek, and on Liard Range all span the Flett-Mattson junction and, like the type section, have dolomitic beds just below the contact. No fossils were collected at Ram Creek, but the other sections have representatives of Faunas D and E in the uppermost 200 feet of the formation. *Spirifer* cf. *S. leidyi* occurs near the top at The Twisted Mountain, together with *Dictyoclostus* cf. *D. parvus,* also present at the Liard section. In slightly older beds *Spirifer pellaensis* (Fauna D) was found at both sections, at The Twisted Mountain it is associated with *D.* cf. *inflatus, Girtyella* aff. *G. turgida* (Hall), and *Camarotoechia* cf. *C. mutata* (Hall). Two sandstone beds are present at The Twisted Mountain, the presence of *Dictyoclostus* cf. *D. tenuicostatus* (Fauna C) in talus just above the lower one suggests that it may correlate approximately with the upper sandstone of the type section. General similarity of fauna, together with the occurrence of dolomite in the beds just beneath the Mattson, lends some justification to the use of the base of the Mattson Formation as a datum. This is of some significance in equating the Flett and Etanda Formations and in dating the Mattson Formation.

Representatives of Fauna B can be readily recognized in the Liard and The Twisted Mountain sections where the fauna is perhaps more fully developed than in the type section. It is especially characterized by the distinctive coral *Kakwiphyllum* sp. and the abundance of specimens of *Spirifer* sp. A. The occurrence of

typical Fauna B fossils at the top of the incomplete section on Bluefish Mountain permits correlation of this section and indicates that it lacks 700-800 feet of the upper part of the Flett Formation as compared with the type section. The incomplete section at Clausen Creek can be similarly related to the others by means of this fauna. Distribution of species of Fauna B for the various sections is shown below:

| | Jackfish Gap (type section) (1) | The Twisted Mountain (2) | Bluefish Mountain (5) | Liard Range (7) | Clausen Creek (4) |
|---|---|---|---|---|---|
| *Syringopora* sp. | | | x | x | |
| *Kakwiphyllum* sp. | x | x | x | | |
| *Ekvasophyllum* sp. | ? | | | | |
| *Amplexi-Zaphrentis enniskilleni* (Lewis) | | x | | x | x |
| *Diphyphyllum* sp. | | | x | x | |
| *Lithostrotion* sp. | | | x | | |
| *Lithostrotion* cf. *L. pauciradiale* (McCoy) | | x | | | |
| *Orthotetes* cf. *O. keokuk* (Hall) | x | | | x | |
| *Orthotetes* sp. | x | | | | |
| *Chonetes* sp. | x | | | | |
| *Dictyoclostus* cf. *D. altonensis* (Norwood and Pratten) | | x | | x | |
| *Dictyoclostus* sp. | x | | x | x | |
| *Buxtonia* sp. | x | | | | |
| *Camarotoechia* cf. *C. purduei* Girty | | | | x | |
| *Spirifer* sp. A | x | x | x | x | x |
| *Spirifer* aff. *S. carinatus* Rowley | | | | x | |
| *Spirifer* cf. *S. bifurcatus* Hall | x | | | | |
| *Platyrachella? rutherfordi* (Warren) | x | | x | | |
| *Dimegelasma* sp. | | | | x | |
| *Brachythyris* cf. *B. subcardiformis* (Hall) | | x | x | x | x |
| *Torynifer* cf. *T. pseudolineata* (Hall) | x | | | | x |
| *Torynifer* cf. *T. salemensis* (Weller) | | | x | x | |
| *Composita* sp. | x | x | | x | |
| *Naticopsis* sp. | | | | x | |
| *Allorisma* sp. | x | x | | x | |
| *Pentremites* cf. *P. godoni* De france | | | | | |

Fauna A, especially characterized by *Spirifer* cf. *S. rowleyi* occurs in all the sections. In the Liard section, the base of the Flett is obscured but the section certainly extends down into the zone containing Fauna A. At Bluefish Mountain, where the lower part of the Flett Formation contains much shale and some sandy beds, the presence of Fauna A suggests that the base of the formation be placed above the thick shale sequence although these beds differ considerably from the Clausen Formation at its type section. At The Twisted Mountain, shales under-

lying the sequence of beds containing Fauna B are unfossiliferous. That they should be considered as a part of the Flett Formation rather than Clausen Formation is indicated by the presence of Fauna A fossils in some limestone beds underlying them. Thin-bedded sandstones in the core of the fold at The Twisted Mountain may be an equivalent of the lower part of the Flett or could even be a sandy phase of the Clausen Formation

Outcrops of limestone on the east bank of Liard River, south of Flett Rapids are assigned to the Flett Formation. Collections were made from these outcrops by McConnell (1890, p. 55D) and by Hume (1923, p. 48). Hume considered that his fossils were of Kinderhook age. Our collection includes *Dictyoclostus burlingtonensis, Camarotoechia allani, Spirifer* sp. A?, *Spirifer rowleyi, Brachythyris* cf. *B. chouteauensis, Pseudosyrinx* cf. *P. gigas,* and *Cleiothyridina* cf. *C. obmaxima.* The fauna is predominantly that of Fauna A and the riverside exposures correlate with limestones low in the exposed section on Liard Range.

On the north side of Petitot River, south of Bovie Lake about 160 feet of west-dipping limestone is exposed. These beds are assigned to the Flett Formation. The fossils collected do not permit precise correlation with the Flett Formation on Liard Range or with the type section.

Outcrops of flat-lying limestone on the banks of the Petitot River about 25 miles farther east, containing *Platyrachella? rutherfordi* and *Brachythyris* sp., represent a horizon low in the Flett Formation of the type section.

*Age and correlation.* The Flett Formation contains a sequence of Mississippian faunas of Kinderhook/Osage to Chester age. Some of the species can be related directly with the standard succession of the Mississippi Valley, others can be compared with the Alberta Mississippian faunas whose age relationships with the standard succession have now been demonstrated (Harker and Raasch, 1958, p. 216, etc.)

Fauna A contains many late Kinderhook species, in addition the occurrence of *Echinoconchus alternatus, Dictyoclostus burlingtonensis, Pseudosyrinx gigas, Spirifer rowleyi,* and *Cleiothyridina obmaxima* suggests a partial equivalence with slightly younger beds of the Mississippi Valley region. This admixture of Burlington and Chouteau elements plus elements of exclusively Osage age has already been shown to occur in the Mississippian of Alberta (Harker and Raasch, 1958, p. 226). Similar conclusions were made by Patton (1958, p. 312) regarding the lowest fauna from his Unit 3 which corresponds approximately in content and stratigraphic position with our Fauna A.

Fauna A includes species common to the *Spirifer rowleyi* and the *Camarotoechia cobblestonensis* zones of Alberta (Harker and Raasch, 1958). The lower beds of the Flett Formation are therefore equivalent to highest Banff and lower Rundle Groups of Alberta. This correlation is supported by the lowest of the two ostracod faunas from the Flett type section. M. J. Copeland states that this fauna is upper Kinderhook to Osage; the occurrence of abundant *Cribroconcha*

aff. *C. costata* Cooper may indicate a correlation with the *Cribroconcha* zone of Loranger, stated by her to occur within the lower Rundle (Loranger, 1958, p. 234).

Fauna B includes a few long-ranging elements from the older Mississippian faunas but it contains some younger elements, the most notable perhaps are the various colonial rugose coral species and *Spirifer bifurcatus*. The fauna has distinct Meramec affinities. Faunas C and D have younger Meramecian forms such as *Spirifer pellaensis* and *Dictyoclostus tenuicostatus*. The sequence of beds of the Flett Formation, which contains Faunas B, C, and D (about 900 feet of strata in the type section), would therefore correlate approximately with the Mount Head Formation of the Rundle Group (Douglas and Harker, 1958, p. 179).

The youngest Mississippian faunas of the Flett, from the beds immediately below the Mattson Formation, contain fossils of Chester aspect (Fauna E). In addition to *Spirifer leidyi* and *Dictyoclostus parvus* (which range into the underlying fauna), a large ostracod fauna was collected at the type section. According to M. J. Copeland the fauna includes many lower Chester species. These beds (approximately the top 100 feet of strata in the type section) are probably equivalent to the lower part of the Etherington and possibly some part of the underlying Mount Head Formation of the Rundle Group (Douglas and Harker, 1958, p. 188). Although the faunas indicate that the Flett includes some beds of Chester age, there is no reason to suppose that the Mississippian/Pennsylvanian boundary occurs at the top of the formation.

The Prophet Formation, described by Sutherland on Halfway River, northeastern British Columbia (Sutherland, 1958, p. 25), contains faunas whose biostratigraphic range is comparable with those of the Flett Formation. Like the Flett, the Prophet Formation carries a well-developed Meramec fauna, but no Chester faunas have yet been reported. The Kindle Formation, as restricted by Sutherland (1958, p. 29), would be equivalent to the upper part of the Flett. The Nizi Formation (Gabrielse, 1954), also described from northeastern British Columbia, is a partial correlate of the Flett Formation.

## Etanda Formation

The type section of this formation is on the west flank of Kotaneelee Range (*see* Pl. IIB) about 1½ miles north of Etanda Lakes. A few miles farther north Kotaneelee Range loses its identity and coalesces with the southeast side of Tlogotsho Plateau. For location, access, and detailed lithology *see* Appendix, Section 8.

At its type section this formation consists of 2,302 feet of siltstones, sandstones, and shales. The whole sequence is dark coloured and essentially noncalcareous, although there are some minor impure limestones and calcareous siltstones. Some of the thicker black shale units contain prominent parallel layers of nodules and nodular mudstone.

The junction with the overlying Mattson Formation is placed at the lowest major sandstone unit. A complete section of the Mattson was not measured on Kotaneelee Range but in the vicinity the three major units of the Mattson are mappable from air photographs and it can be assumed that the Etanda Formation is overlain by a Mattson sequence comparable with that in its type area. Exposures are sporadic near the base of the Etanda Formation. The lowest beds exposed are calcareous siltstones, but their relationships to underlying rocks are not known.

A section comparable in lithology with the type section was measured about 18 miles to the south, on the north side of Kotaneelee River (Appendix, Section 9). There, 1,959 feet of beds are assigned to the Etanda Formation. Equivalents of the lowest beds of the type section are probably not exposed.

Continuous exposures of the pre-Mattson beds only occur in favoured locations, where relatively high structural features have permitted erosion to proceed far enough down. It seems likely, however, that the Etanda phase of sedimentation persisted southwestwards, and at Tika Creek, west of La Biche River, 776 feet of shales and thin sandstones are assumed to be the Etanda Formation.

*Age and correlation.* The Etanda Formation contains few fossils. Near the base of the type section *Dictyoclostus burlingtonensis* (Hall), *Spirifer* cf. *S. keokuk* (Hall), *Brachythyris* sp., and fragments of *Camarotoechia* sp. were found. *Spirifer* cf. *S. pellaensis* Weller and *Leiorhynchus* cf. *L. carboniferum* Girty were found about 500 feet higher in the section. This fauna, with the addition of *Martinia* sp. and some small pelecypods, was found between 1,200 and 1,400 feet above the base in the Kotaneelee River section. Fragments of *Chonetes, Syringothyris,* and *Spirifer,* and possibly *S. keokuk* were collected from the lower beds of the same section. No fossils were found in the Etanda Formation at Tika Creek.

Faunal evidence, though scanty, shows the Etanda Formation to be Mississippian, probably Osage and Meramec, thus confirming its approximate time equivalence with the Flett Formation. The lateral change from Flett to Etanda has already been discussed in the Introduction. The oldest fossils from the Etanda Formation are probably younger than the Clausen and Yohin Formations. Whether or not stratal equivalents of these two formations were deposited in the Etanda phase of sedimentation cannot be demonstrated from surface exposures examined.

The Etanda Formation forms the upper part of map-unit 4 of Douglas and Norris (1959, pp. 8-10) and map-unit 29 (1960, p. 17). Their unit 4 includes beds of Devonian age and they show that it is underlain by the Devonian Nahanni Formation. They have included in their unit 4 those beds lying between the Devonian Nahanni Formation and the Yohin Formation, as for instance in northern Liard Range and on the east side of Bluefish Mountain. They also used the unit in a broader stratigraphic sense to include the very considerable thickness of beds to the west, underlying the Mattson Formation where the Nahanni Formation has graded into shales and shaly limestones. There, the unit has no recognizable base and the age of the lower part is uncertain.

## Mattson Formation

*Occurrence and distribution.* The thick sequence of sandstones with shales, minor carbonate beds and coal that overlies the Mississippian Flett Formation at the Jackfish section was named the Mattson Formation by Patton (1958, p. 319). Similar beds were described by Hage (1945, p. 15) on Liard Range, Sawmill Mountain, Pointed Mountain, and at the south end of Kotaneelee Range. From the southwestern part of the area, an unspecified thickness of sandstones and chert, stated to be of Carboniferous? and Permian age, was reported by Kindle (1944, p. 5) on Mount Merrill north of Beaver River. These sandstone occurrences belong to a widespread complex stratigraphic unit that is assigned in this report to the Mattson Formation. It is shown that the Mattson Formation as used here embraces strata additional to that described by Patton at the type section and includes beds ranging in age from late Mississippian to Permian.

The Mattson Formation is mappable from northeastern British Columbia into southwestern Yukon and the southern part of Mackenzie Mountain area to just beyond South Nahanni River. The massive and resistant sandstones of the formation form and cap the ridges of Liard, Kotaneelee, and La Biche Ranges and also Tlogotsho Plateau. The formation is characteristically a dip-slope former, and consequently its area of outcrop far exceeds that of the older Carboniferous formations which are less resistant. Indeed, but for the protection afforded by the overlying Mattson many of the Flett, Clausen, and Etanda scarp faces would long since have passed into talus in the valley bottoms. The Mattson dip-slopes tend to weather back in a series of big step-like units appearing as distinctive 'flat irons' from the air and on the geological map.

The thickest section of the Mattson Formation was measured at Tika Creek (Appendix, Section 10). The formation thins to the south and southwest. It also thins towards the plains, and the eastern limit of deposition may lie not far to the east of Bovie Lake. The present eastward limit is controlled by the pre-Cretaceous unconformity, although there is apparently some depositional thinning or pre-Fantasque bevelling to the east, as there is some indication that the relatively thin section at Bovie Lake includes some of the overlying Fantasque Formation. In the northeastern part of the area the formation is subject to rapid bevelling and the lower Cretaceous rests on progressively older beds until it lies on upper Devonian strata.

*Type area.* The type section of the Mattson Formation as proposed by Patton (1958, p. 323) forms part of the Jackfish section; detailed lithology is given in the Appendix, Section 1. Patton measured 3,734 feet of strata compared with 3,161 feet as measured by W. B. Brady. This discrepancy may be in part due to cumulative error, particularly on the dip-slope part of the section east of the summit of the range where measurement becomes difficult. There is also a possibility that measurement may not have terminated at precisely the same point in

Jackfish Valley. However, there is broad agreement in overall lithology in so far as comparison can be made with Patton's rather generalized lithological description.

At the type section, the Mattson is divisible into three members. The lower member comprises 1,130 feet of strata; the lower part contains some massive sandstones, but there is a predominance of thin- to medium-bedded units, commonly with black carbonaceous streaks and black carbonaceous material along bedding planes. The sandstones are generally quartzitic and clean, ripple-marks and small-scale crossbedding are common. There is some minor interbedded shale which increases in amount upwards and the upper beds are distinctly thin bedded, shaly, and contain some coal seams.

No marine fossils were found in the lower member. The only identifiable organic remains are fragments of *Lepidodendron* stems. Samples of coal collected by Patton from this section have been studied by P. A. Hacquebard and M. S. Barss. The petrography and spore flora of this coal is the subject of a Geological Survey Bulletin (Hacquebard and Barss, 1957). The age of this spore assemblage has some bearing on the age of the Mattson Formation and is considered elsewhere in this report.

The middle member comprises 797 feet of strata. It contains some major massive sandstones which contrast with the banded, thin-bedded sequence of the higher part of the lower member, however, again there are shaly interbeds, especially in the upper part. Large-scale crossbedding is common in the massive beds. No fossils were found in the middle member.

The upper member comprises 1,233 feet of strata at the Jackfish section. Like the rest of the formation it is predominantly arenaceous, but it is a recessive sequence consisting of a varied assortment of thin-bedded sandstones and shales. It differs from the two lower members in that it includes the only truly carbonate rocks of the Mattson Formation. These consist of thin, arenaceous limestone and dolomite beds, and though they form a small fraction of the total thickness they occur near the base of the member, near the middle, and again rather more strongly towards the top.

Fossils found near the base of the upper member include *Spirifer rockymontanus* Marcou, *Spirifer boonensis* Swallow, and *Composita* cf. *C. subtilita* (Hall). Another collection 160 feet below the top contains productid fragments and *Spirifer rockymontanus*. These collections are all of Pennsylvanian age.

The type Mattson is overlain by the Cretaceous Buckinghorse Formation, but the contact was not seen and there may be some additional beds assignable to the Mattson concealed beneath the talus on the lower slope of the west side of Jackfish Valley.

Three other sections of the Mattson Formation in the general region of the type section were examined: on The Twisted Mountain, on Liard Range at the head of Mattson Creek, and at the head of Ram Creek. For details of these sections *see* Appendix, Sections 2, 6, and 3. In all these sections, as at the type section, the Mattson rests on the Flett Formation and the contact at the base is

clearly defined. At The Twisted Mountain, 1,066 feet of the Mattson is exposed. These beds correspond lithologically with the lower member at the type section. No coal seams were found but carbonaceous matter and fossil wood fragments, followed by a concealed interval, occur in sandstones 870-885 feet above the base. If this carbonaceous zone corresponds with the coal-bearing beds at the type section, and the stratigraphic position suggests that it does, then the sequence at The Twisted Mountain consists only of the lower member, the rest of the formation having been removed by erosion.

On the north scarp of the Tlogotsho Plateau at Ram Creek 1,542 feet of Mattson is exposed (Appendix, Section 3). There is good overall lithological similarity with the type section, including seams of coal. The lower member is fully represented and is very slightly thicker than at the type section. The section also includes just over 300 feet of the middle member.

In the Mattson Creek section some 3,200 feet of Mattson is exposed in a continuous section. The section is readily subdivided into three members each of almost exactly comparable thickness with the corresponding members of the type section. No coal seams were found in this section, but carbonaceous and woody material occurs in thin-bedded shales and sandstones 800-900 feet above the base. In addition to this continuous section a further 800 feet of beds was measured just south of the main section. This section includes thin limestones, shales, and thin-bedded sandstones. Precise correlation could not be made with the main section but the field relations suggest that almost all the beds of this subsidiary section are younger than the main section. If this be so, there are at Mattson Creek a total of some 4,000 feet of the Mattson Formation. The Mattson Creek section is only a few miles southeast of the type section and considering the almost exact correspondence of the two lower units in both sections it is probable that younger beds occur at the Mattson Creek section. This change in thickness is due to pre-Cretaceous bevelling and gives some indication of the rapid changes that take place in this part of the area. The process continues northwards until, at The Twisted Mountain, Cretaceous rocks rest on the lower member of the Mattson Formation.

*Other sections.* As already stated, the Mattson Formation in the general area of the type section rests on the Flett Formation and the base is clearly defined. Similar conditions prevail along most of the scarp face of Liard Range and on the outliers of Sawmill and Flett Mountains. Farther to the southeast, and away from the mountain front, just south of Bovie Lake, Flett limestone and Mattson sandstone are exposed on the north side of Petitot River where the river cuts across the Bovie Lake anticline. The limestone is separated from the overlying sandstone by a concealed interval equivalent to a thickness of about 400 feet of beds. The Mattson Formation is poorly exposed. Bedded chert, possibly of the overlying Fantasque Formation, has been reported by oil company geologists from the east flank of the anticline but was not observed in the scattered exposures near the river. The computed stratigraphic interval between the youngest exposed beds of the Flett Formation and the first exposure of Cretaceous shale is about 1,400 feet. This represents

a maximum thickness for the combined Mattson and Fantasque Formations at this locality. If the chert does represent the Fantasque Formation a considerable part of this interval must be occupied by Cretaceous rocks. The Bovie Lake structure was drilled and a summary of this well (Texaco Northern Foothills Agreement, Bovie Lake No. 1 well), prepared by H. R. Belyea, is included in Douglas and Norris (1959, p. 12). The log shows 120 feet of chert and 1,260 feet of sandstone and shale. The well is reported to have deviated from the vertical, and the stratigraphic thickness is probably considerably less than the drilling thickness shown in the log. However, it would be reasonable to assign the two major lithological types encountered in the well to the Fantasque and Mattson Formations respectively.

West of Liard Range and to the south and west of the type area, the Mattson rests on the Etanda Formation. In gross lithology the Etanda is shale with sandstone whereas the Mattson is sandstone with shale. At the western end of the north scarp of Tlogotsho Plateau, the resistant sandstone of the lower Mattson can be traced by air observations onto the Etanda phase of the pre-Mattson beds and the contact is clear and distinct. Elsewhere, as already discussed under the Etanda Formation, the junction between the two formations is somewhat arbitrary.

At Tika Creek, 4,672 feet of Mattson Formation was measured (Appendix, Section 10). The three members of the type area are probably present but cannot be readily recognized on the ground. However, if the presence of carbonate beds is any indication of correlation with the upper member then about 1,848 feet should be assigned to the upper member. The only fossils from the Tika Creek section were found in this upper sequence. A collection from limestone beds 750 feet from the base of this upper sequence was identified as follows:

*Juresania nebrascensis* (Owen)
*Dictyoclostus gallatinensis* Girty
*Marginifera* sp.
*Spirifer opimus*? (Hall)
*Composita* cf. *C. subtilita* (Hall)
*Eumetria* sp.

This fauna is almost certainly of Pennsylvanian age.

A series of collections from the uppermost 700 feet of the section yielded a rather different fauna, of Permian age:

*Orbiculoidea* sp.
*Kochiproductus* sp.
*Dictyoclostus* sp. ex gp. *D. neoinflatus* Licharew
*Linoproductus* sp. ex gp. *L. cora* (d'Orbigny)
*Cancrinella*? sp.
*Spiriferella* sp.
*Pterospirifer* cf. *P. alatus* (Schlotheim)
*Dielasma* cf. *D. elongatum* Schlotheim

A Permian fauna with *Muirwoodia* cf. *M. mammatus* (Keyserling) and *Spiriferella* was found in dark grey sandstones, just beneath the Cretaceous on the west flank of Liard Range, near the headwaters of Sully Creek.

A partial section of the Mattson Formation, comprising some 1,400 feet of sandstone with minor black shale, was measured at Etanda Lakes (Appendix, Section 8). There the Mattson overlies the type section of the Etanda Formation. No fossils were found. The Mattson continues down the dip-slope on the east side of the Kotaneelee Range. The upper part was not examined, nor was the upper contact seen.

At Kotaneelee Gap, where Kotaneelee River crosses Kotaneelee Range, the junction between the Mattson and Etanda Formations is well exposed (Appendix, Section 9). Good exposures of the Mattson occur in the cliffs on both sides of Kotaneelee River. The rocks are rather inaccessible and the section was not measured. On the east side of Kotaneelee Range the Mattson is overlain by chert and mudstone of the Fantasque Formation. Limestone beds immediately beneath the Fantasque Formation yielded *Krotovia* cf. *K. meeki* Dunbar and Condra, *Dictyoclostus* cf. *D. portlockianus* (Norwood and Pratten), and *Wellerella* sp. This fauna is of Pennsylvanian age.

In the southwestern part of the area the upper beds of the Mattson Formation can be seen beneath the Fantasque Formation in scattered exposures along Beaver and La Biche Rivers. At Mount Merrill, on the north side of Beaver River some 38 miles from the mouth, sandstone and sandy limestones beneath the Fantasque Formation yielded Pennsylvanian fossils, including *Juresania* sp. and *Neospirifer cameratus*? (Morton). Other collections from Mount Merrill were made by Kindle (1944, p. 6) and are discussed in connection with the age of the Mattson Formation.

On La Biche River there are almost continuous exposures of the Fantasque Formation and upper beds of the Mattson in the deep canyon where the river crosses La Biche Range. The exposures are, however, difficult to reach by helicopter. To the west of the canyon, the valley opens and landings are possible in the valley bottom. There, black shales and dark siltstones with glauconite lie beneath the chert and some thin bands of combustible bituminous shale. Unidentifiable marine fossils (*Orthoceras* and productid fragments) were found in close association with the bituminous shale. Well-preserved palaeoniscid fish scales were also found in these beds. Spore analysis on the bituminous shale was negative. Calcareous sandstone underlying the shale yielded *Juresania* cf. *J. ovalis* Dunbar and Condra and *Echinoconchus* cf. *E. semipunctatus* Shephard, and are of Pennsylvanian age.

*Age and correlation.* In the type area, the Mattson Formation cannot be older than Chester as it rests on the Flett Formation whose upper beds contain Chester, and probably lower Chester, fossils. No invertebrate fossils were found in the lower member of the Mattson, however, spores from the coal near the top were shown by Hacquebard and Barss (1957, p. 12) to include some Chester species. They placed the coal within the Mississippian but stated (op. cit., p. 3) that the coal "may well occur near the Mississippian-Pennsylvanian boundary". The middle member is unfossiliferous. The upper member contains Pennsylvanian

fossils that first occur near the base of the member; they also occur near the top. The lower member, therefore, is of Chester age and the Mississippian-Pennsylvanian boundary lies within the formation, possibly at or near the base of the middle member.

At Tika Creek and on Liard Range the formation includes some beds of Permian age. It is likely that the fossils from these beds are not of earliest Permian age. However, no regional disconformity between them and the underlying Pennsylvanian is demonstrable from the field data now available. Further field studies may indicate more precise relationships and it may eventually be more appropriate to assign these Permian beds to a new formation.

The Mattson Formation includes strata equivalent in age to the uppermost beds of the Rundle Group (the Etherington Formation) of Alberta. The stratigraphic position of the Mattson may well be almost exactly analogous with that of the Tunnel Mountain Member of the Rocky Mountain Formation (Warren, 1947, p. 1238; 1956, p. 243). The Mattson is considerably thicker but there is similarity in gross lithology with the lower part of the Rocky Mountain Formation and it may reflect on a grander scale, similar conditions of deposition.

In the subsurface of the Fort St. John gas field of northeast British Columbia a varied sequence of beds, lying between Mississippian limestones and the so-called Permo-Pennsylvanian, were named the Stoddart Formation by Rutgers (1958, pp. 327-330). This formation consists of slightly more than 2,000 feet of sandstones, siltstones, limestones, and shales. It conformably overlies the Mississippian Debolt Formation and is in turn unconformably overlain by the Permo-Pennsylvanian. No direct correlation, either by fossils or by other stratigraphic means, can be made between the Stoddart Formation and the rocks described in this report. However, on general stratigraphic position it would be reasonable to assume that the Stoddart is approximately equivalent to the Mattson Formation.

## Fantasque Formation

This formation consists of bedded chert and sandstone. The type section is on the north side of Beaver River on the southwestern side of Mount Merrill, where the formation is about 180 feet thick (*see* Pl. IVA). Kindle (1944, p. 5) studied the type section but did not give the beds a formal name. His description is as follows: "The chert occurs both massive and roughly laminated, and is in beds that vary from 1 to 10 feet or more in thickness. The beds are separated by layers of shale from 1 to 3 inches thick. The chert is grey to black, rust stained on weathered surfaces and is a brittle, highly fractured rock, traversed by numerous joint planes. It is overlain by about 30 feet of calcareous sandstone." No fossils were found in the chert. Permian fossils were collected by Kindle from talus of the sandstone that overlies the chert.

Exposures of the Fantasque Formation occur at many places along Beaver and La Biche Rivers and in the country around Fantasque Lake. The formation is overlain by a sequence of sandstone, part of which is Cretaceous and part may



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include some Triassic beds. It seems almost certain, however, that one or more of these sandstone units is of Permian age and should be included with the Fantasque Formation. On Pointed Mountain, eighty-five feet of chert was reported by Hage (1945, p. 16). On the west side of La Biche River the formation forms a narrow sinuous outcrop, it is thinned by the Cretaceous overstep, and disappears at a point south of Tika Creek. Similar relationships show on the flanks of La Biche, Kotaneelee, and Liard Ranges. On the east side of Kotaneelee Range the chert beds of the Fantasque Formation form the walls of a prominent canyon where Kotaneelee River turns westwards and crosses Kotaneelee Range (*see* Pl. IVB). The chert continues northwards from the Kotaneelee Gap, until, as in the other ranges, it is cut out by the Cretaceous at about the latitude of Flett Creek. At the south end of Kotaneelee Range, facing Pointed Mountain, a prominent sandstone unit is separated from the chert and associated beds by a recessive interval. Reconciliation of this unit with the succession across the valley on Pointed Mountain and to the post-chert sequence in the southwestern part of the area is difficult. These beds may be Palaeozoic and should perhaps be included in the Fantasque Formation as used in this report. Further detailed work is needed to show the exact relationships of the base of the Cretaceous to the underlying beds in the south half of the area. The regional unconformity becomes more obvious northwards and the base of the Cretaceous can be readily mapped. In the south, rocks of the Fantasque Formation and the overlying Cretaceous and possibly older Mesozoic rocks are in near angular conformity and for want of fossil evidence the junction can only be arbitrarily fixed.

*Age and correlation.* At several localities in the type area and also on the east side of Kotaneelee Range, Pennsylvanian fossils were found in beds underlying the Fantasque Formation. It is not possible to date these rather scant faunas precisely but they are of late rather than early Pennsylvanian age. No fossils were found in the chert but faunal evidence of age for the sandstones overlying the chert, though meagre, suggests a Permian age (Kindle, 1944, p. 6). A Permian age for the Fantasque Formation is assumed. According to Douglas and Norris (1959, p. 13), the regional relationships of their map-unit 9 (Fantasque Formation) indicate an unconformity with the underlying Mattson Formation.

Beds of Permian age have already been described from the Mattson Formation (*see* p. 21) at Tika Creek and Liard Range. Both localities lie beyond the northern outcrop limit of the Fantasque Formation. Similar beds were not found anywhere within the present area of outcrop of the Fantasque Formation. The Fantasque Formation could be a time equivalent of these beds, or they could be older and have been removed from the southern part of the area by pre-Fantasque erosion. Further detailed work is needed to solve this problem, which is further complicated by the rapid removal of all these younger Palaeozoic beds by sub-Cretaceous erosion.

Bedded cherts, overlain by Triassic strata, occur at a number of localities in northeast British Columbia (*see* Sutherland, 1958, pp. 19, 27, and 33). On the

Alaska Highway, near mile 381, Laudon and Chronic (1947, p. 1614) described a sequence of limestones, shales, and sandstones with overlying cherts which they named the Kindle Formation. Sutherland (1958, p. 28) excluded the chert unit (which is 120 to 255 feet thick) in his restricted usage of the term Kindle. He showed that his restricted Kindle was mainly Mississippian but included some Pennsylvanian beds near the top. Elsewhere Sutherland reported a thin chert unit at the top of his Mississippian Prophet Formation.

There seems little doubt that these late Palaeozoic chert occurrences in north-eastern British Columbia could well be referred to the Fantasque Formation. The name may also have some application in the subsurface. Various wells in the vicinity of the Alaska Highway have encountered cherty beds at the top of the Palaeozoic which have been loosely assigned to the "Permo-Pennsylvanian". In the Peace River area Macauley (1958, p. 304) reported "dense dolostones and white and buff lithographic chert" overlying the Stoddart Formation. The contact between these "Permo-Pennsylvanian" beds and the underlying Stoddart Formation was stated to be "clearly unconformable" by Rutgers (1958, p. 330).

If all these occurrences are part of one and the same phase of chert sedimentation, then it is a transgressive phase, as they rest on Mississippian (Prophet Formation), Pennsylvanian (Kindle Formation), and disconformably on the Stoddart Formation of the subsurface. An assumed correlation with the Fantasque Formation for these various chert occurrences would indicate a probable unconformity beneath the formation. A possibility suspected, but not proven in our area.

The Fantasque Formation occupies a similar stratigraphic position to the Permian Norquay Member of the Rocky Mountain Formation of Alberta, and a possible correlation of the underlying Tunnel Mountain Member with the Mattson Formation has already been suggested.



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# APPENDIX

## Stratigraphic Sections 1-10

## SECTION 1

West side of Yohin Ridge, about 12 miles south of South Nahanni River and about 22 miles west of South Nahanni. Map 95G, lat. 61°06′N, long. 123°55′W. Access by helicopter via South Nahanni and Jackfish River valleys and through the wind gap just south of the section. Helicopter landing and camp site on shore of small lake below the main cliffs.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | YOHIN FORMATION | | |
| | (Type Section) | | |
| | Section commences at a prominent sandstone dip-slope that forms the lip of the lower cliff on the west side of the small lake, and was measured down the cliffs in a steep gully. Overlying beds—Clausen Formation (type section). | | |
| 29 | Sandstone, dark grey, fine-grained; small flecks of pyrite; weathers reddish brown; forms a single massive bed. (Dip 34°E; strike 31°) | 2 | 600 |
| 28 | Shale, dark grey; irregularly fissile, iron stained; with some thin sandy layers | 2 | 598 |
| 27 | Sandstone, light grey, medium-grained; weathers light grey. Forms a prominent light coloured band at top of cliff | 7 | 596 |
| 26 | Sandstone, fine-grained, greenish grey; scattered flecks of pyrite; weathers brown, iron stained; forms a single massive bed | 2 | 589 |
| 25 | Shale, black, non-calcareous; finely disseminated pyrite; rusty weathering; a thin band of orange weathering ironstone nodules 22′ above base | 50 | 587 |
| 24 | Siltstone, dark grey to black, fine-grained; finely laminated and with some current bedding; minor shale bands | 41 | 537 |
| 23 | Siltstone, dark grey, fine-grained; laminated, some minute crossbedding; pyrite flecks; some thin shale bands | 32 | 496 |
| 22 | Shale, dark grey; thin layers of grey sandstone and some iron-stained nodular bands of black siltstone | 9 | 464 |
| 21 | Sandstone, grey, fine-grained; thin-bedded, regularly laminated; some minor shale bands | 15 | 455 |
| 20 | Sandstone, grey, fine-grained and interbedded black shale | 36 | 440 |
| 19 | Sandstone, dark grey, fine-grained; thin-bedded | 19 | 404 |
| 18 | Sandstone, dark grey and interbedded black shale | 7 | 385 |
| 17 | Sandstone, dark grey, fine-grained; thin-bedded and irregularly laminated | 48 | 378 |
| 16 | Shale, dark grey; thin layers of grey sandstone and some iron-stained nodular bands of black siltstone | 6 | 330 |
| 15 | Sandstone, grey, fine-grained; regularly laminated; some minor shale bands | 34 | 324 |
| 14 | Shale, dark grey; thin layers of dark grey sandstone and some nonstained nodular black siltstone | 34 | 290 |

Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 13 | Sandstone, grey, fine-grained; thin-bedded, interbedded with dark grey shale bands | 40 | 256 |
| 12 | Shale, black; with thin layers of grey sandstone | 5 | 216 |
| 11 | Sandstone, grey, medium- to fine-grained; thin-bedded but with some beds up to 0.2 ft of sandstone; minor shale; the whole unit is regularly laminated and shows very small-scale current bedding in places | 45 | 211 |
| 10 | Sandstone, grey, medium-grained; minor black shale bands | 4 | 166 |
| 9 | Sandstone, brownish grey, medium- to fine-grained; thin-bedded; weathers rusty grey | 5 | 162 |
| 8 | Shale, black; with minor thin sandstone layers; partly concealed, forms a dark recessive unit above the lower cliff | 25 | 157 |
| 7 | Sandstone, grey, medium-grained; thin-bedded with irregular black, carbonaceous? partings | 35 | 132 |
| 6 | Sandstone, grey, medium- to fine-grained, thin- to medium-bedded with black, carbonaceous? partings. (Dip 23°F; strike 26°) | 45 | 97 |
| 5 | Sandstone, dark grey, medium-grained; slightly pyritic, weathers reddish brown | ½ | 52 |
| 4 | Shale, non-calcareous, black; with many thin layers of grey sandstone; slightly pyritic; weathers dark reddish brown | 3 | 51 |
| 3 | Shale, non-calcareous, black; similar to overlying unit but with amount of sand decreasing downwards | 5 | 48 |
| 2 | Concealed interval | 40 | 43 |
| 1 | Sandstone, grey, fine- to medium-grained; thin-bedded with wavy black, shaly partings; possibly carbonaceous. This unit may not be in place. Base concealed. *Leptaena* sp., *Rhipidomella* sp., and *Chonetes* sp. in talus at foot of cliff | 3 | 3 |

CLAUSEN FORMATION

(Type Section)

Section commences at northwest side of a small lake and continues on the lower part of the main cliffs of Yohin Ridge.
Overlying beds—shale and limestone of Flett Formation (type section). Contact conformable.

| | | | |
|---|---|---|---|
| 7 | Shale, non-calcareous, black; paper thin, with nodular layers of dark brownish grey, orange weathering mudstone; dark grey, yellow weathering calcite, cone-in-cone layers near base | 105 | 551 |
| 6 | Mudstone, calcareous, black | 6 | 446 |
| 5 | Shale, calcareous, dark grey with highly weathered earthy zone at base | 5 | 440 |
| 4 | Shale, non-calcareous, dark grey or black; paper thin with nodules of mudstone with calcite and pyrite blebs | 145 | 435 |
| 3 | Shale, non-calcareous, black and mudstone; partly concealed | 95 | 290 |

**Section 1** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 2 | Shale, non-calcareous, black; with sub-botryoidal nodules of pyrite and mudstone | 155 | 195 |
| 1 | Concealed interval | 40 | 40 |
| | Base concealed. Underlying beds—Yohin Formation, unit 29. | | |
| | FLETT FORMATION | | |
| | (Type Section) | | |
| | Section continues up main cliffs of the west side of Yohin Ridge. Overlying beds—Mattson Formation (type section). Contact conformable. | | |
| 94 | Shale, dark grey; weathers olive-grey; with many thin, grey sandy layers, increasing in number towards the top; unit grades into the overlying sandstone of the Mattson Formation | 2 | 1,982 |
| 93 | Dolomite, grey, medium-grained; weathers dark yellowish orange; unit consists of two main beds separated by a layer of dark grey, non-calcareous shale | 4 | 1,980 |
| 92 | Shale, dark grey and sandy shale; weathers light yellowish orange, probably dolomitic | 16 | 1,976 |
| 91 | Shale, non-calcareous, black | 7 | 1,960 |
| 90 | Dolomite, grey, fine-grained; weathers dark yellowish orange; slightly silty; forms a series of blocky beds separated by black non-calcareous shales; minor current bedding in places | 12 | 1,953 |
| 89 | Shale, slightly calcareous, dark grey, paper thin; weathers brown with some thin sandy beds | 9 | 1,941 |
| 88 | Limestone, grey, medium-grained; weathers grey crinoidal; forms a series of blocky beds separated by calcareous shale | 12 | 1,932 |
| 87 | Limestone, grey, medium-grained; crinoidal; massive | 5 | 1,920 |
| 86 | Shale, calcareous, dark grey, paper thin | 3 | 1,915 |
| 85 | Limestone, grey, medium-grained; crinoidal; massive. *Rhipidomella* sp., *Spirifer* sp., *Spirifer* cf. *leidyi* Norwood and Pratten, *Composita* cf. *trinuclea* (Hall). GSC loc. 32678 | 24 | 1,912 |
| 84 | Shale, calcareous, dark grey, paper thin | 3 | 1,888 |
| 83 | Limestone, grey, medium- to coarse-grained; massive and forms a small cliff; several small shale beds near the base | 12 | 1,885 |
| 82 | Shale, calcareous, grey; paper thin with thin, fine-grained limestone layers. Abundant ostracods. GSC loc. 32695 | 14 | 1,873 |
| 81 | Limestone, light grey, coarse-grained; crinoidal; forms series of massive 2-3′ beds with ½′ shale interbeds; upper 10′ slightly darker grey with irregularly draped shale partings. *Amplexi-Zaphrentis* sp., *Rhipidomella* sp., *Dictyoclostus* cf. *inflatus* (McChesney), *D.* cf. *parvus* (Meek and Worthen), *Spirifer* cf. *pellaensis* Weller, *Brachythyris* cf. *subcardiformis* (Hall), *Dimegelasma* sp., *Torynifer* cf. *setigera* (Hall). GSC loc 32693 | 51 | 1,859 |

Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 80 | Shale, calcareous, grey with thin limestone beds | 37 | 1,808 |
| 79 | Limestone, grey, medium-grained; large irregular black chert masses up to 15% of the whole; some irregular thin-bedded layers towards the top | 32 | 1,771 |
| 78 | Concealed interval; probably calcareous shale, forms a recessive unit | 15 | 1,739 |
| 77 | Limestone, grey, medium-grained; crinoidal; forms a series of blocky 1′ beds with shaly partings; minor black chert | 6 | 1,724 |
| 76 | Shale, calcareous, black | 5 | 1,718 |
| 75 | Limestone, as unit 77, but no chert | 18 | 1,713 |
| 74 | Concealed interval; probably shale and thin limestone | 50 | 1,695 |
| 73 | Limestone, grey, medium- to fine-grained; crinoidal with several thin fissile beds near base; up to 10% black chert in upper half. *Diphyphyllum* sp., *Lyropora* sp., *Dictyoclostus* cf. *tenuicostatus* (Hall), *Camarotoechia* sp. GSC locs. 32699 and 32703 | 53 | 1,645 |
| 72 | Sandstone, grey, medium-grained; weathers brownish grey; forms a massive unit; minor current bedding. | 13 | 1,592 |
| 71 | Sandstone, greenish brown to dark olive-grey; ferruginous, weathers rusty; soft texture forms a single bed | 2 | 1,579 |
| 70 | Shale, non-calcareous, brown or black | 3 | 1,577 |
| 69 | Shale, non-calcareous, and sandy shale, dark brownish grey | 3 | 1,574 |
| 68 | Shale, non-calcareous, as unit 70 | 3 | 1,571 |
| 67 | Sandstone, light olive-grey, fine-grained; several red weathering bands of non-calcareous concretions | 28 | 1,568 |
| 66 | Shale, dark olive-grey, and thin-bedded sandstone; shale is calcareous at base but is gradually replaced by sand and the unit becomes lighter in colour; forms a resistant unit | 15 | 1,540 |
| 65 | Shale, calcareous, dark grey; rubbly weathering and with some thin, highly weathered limestone bands, becomes sandy near top; several bands of limonite encased septarian nodules; prominent band of concretions at top | 20 | 1,525 |
| 64 | Limestone, grey, coarse-grained; crinoidal; weathers brown; massive 2′ bed at base | 9 | 1,505 |
| 63 | Shale, calcareous, dark grey; with several beds of crinoidal limestone | 35 | 1,496 |
| 62 | Limestone, grey, coarse-grained; crinoidal | 2 | 1,461 |
| 61 | Shale, calcareous, grey, with some thin limestone beds | 7 | 1,459 |
| 60 | Shale, calcareous, dark grey or black | 4½ | 1,452 |
| 59 | Limestone, grey, medium-grained; crinoidal | ½ | 1,447 |
| 58 | Shale, calcareous, dark grey | 1 | 1,446 |
| 57 | Limestone, as unit 59 | 1 | 1,445 |
| 56 | Shale, calcareous, dark grey with two beds of crinoidal limestone, ½′ thick | 23 | 1,444 |
| 55 | Limestone, grey, medium-grained, crinoidal | 2 | 1,421 |
| 54 | Shale, calcareous, dark grey | 4 | 1,419 |
| 53 | Limestone, as unit 55 | 1½ | 1,415 |

**Section 1** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 52 | Limestone, grey, coarse-grained; crinoidal series of ½′ beds with shaly interbeds; weathers light brown | 3 | 1,413 |
| 51 | Limestone, grey, medium- to fine-grained; crinoidal; massive | 5 | 1,410 |
| 50 | Shale, calcareous, dark grey | 5 | 1,405 |
| 49 | Limestone, grey, medium-grained; crinoidal | 1½ | 1,400 |
| 48 | Shale, calcareous, dark grey | 13 | 1,398 |
| 47 | Limestone, grey, medium- to coarse-grained; crinoidal; massive | 4 | 1,385 |
| 46 | Shale, calcareous, dark grey; partly concealed | 20 | 1,381 |
| 45 | Limestone, dark grey, coarse-grained; crinoidal; weathers greenish grey | ¾ | 1,361 |
| 44 | Shale, calcareous, dark grey; some thin limestone bands, partly concealed | 5 | 1,360 |
| 43 | Limestone, dark grey, coarse-grained; crinoidal; weathers greenish grey | 1½ | 1,355 |
| 42 | Sandstone, greenish grey, fine-grained; thinly laminated with small-scale current bedding; grades into an argillaceous sandy shale towards base, a few thin layers of argillaceous sandy, crinoidal limestone near the top. Scattered siltstone nodules with an orange limonite covering occur within that unit | 45 | 1,353 |
| 41 | Mudstone, dark brownish grey, and crumbly shale; contains many fossil fragments and weathered nodules of crinoidal limestone, unit may be the remains of a highly weathered argillaceous, crinoidal limestone | 8 | 1,308 |
| 40 | Shale, calcareous, dark grey, alternating with limestone beds 1′ or less thick; overall proportion of two parts shale to one part limestone. *Kakwiphyllum* sp., *Spirifer* sp. A, *Pentremites* cf. *godoni* De france. GSC loc. 32688 | 103 | 1,300 |
| 39 | Shale, slightly calcareous, black, with thin limestone bands | 15 | 1,197 |
| 38 | Limestone, grey, medium- to fine-grained, massive, *Kakwiphyllum* sp. GSC loc. 32705 | 5 | 1,182 |
| 37 | Shale, calcareous, dark grey | 8 | 1,177 |
| 36 | Limestone, dark grey, fine-grained; thin-bedded, weathers to a platy talus | 10 | 1,169 |
| 35 | Shale, calcareous, black | 7 | 1,159 |
| 34 | Limestone, grey, fine-grained; thin-bedded with shale interbeds. *Buxtonia* sp., *Dictyoclostus* sp. indet., *Camarotoechia* sp., *Spirifer* sp. A, *Spirifer* cf. *bifurcatus* Hall, *Platyrachella*? *rutherfordi* (Warren), *Torynifer* cf. *pseudolineata* (Hall), *Composita* sp. GSC loc. 32687 | 22 | 1,152 |
| 33 | Shale, calcareous, black | ¾ | 1,130 |
| 32 | Limestone, argillaceous, dark grey, fine-grained; massive | 6 | 1,129 |
| 31 | Limestone, dark grey, medium-grained; several prominent chert beds and some thin fissile limestone bands; medium-bedded in lower part, becomes a series of blocky beds towards the top | 34 | 1,123 |
| 30 | Shale, calcareous, black; contains thin limestone bands | 11 | 1,089 |

Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 29 | Limestone, dark grey, medium-grained with bands of calcareous shale | 18 | 1,078 |
| 28 | Shale, calcareous and shaly limestone, *Ekvasophyllum* sp., *Buxtonia* sp., *Spirifer* sp. A. GSC loc. 32691 | 8 | 1,060 |
| 27 | Limestone, argillaceous, black, fine-grained; fissile, weathers to a platy talus | 15 | 1,052 |
| 26 | Shale, calcareous, grey and shaly limestone | 2 | 1,037 |
| 25 | Limestone, grey, medium-grained; partly crinoidal | 2½ | 1,035 |
| 24 | Shale, black, calcareous, and limestone, dark grey | 1 | 1,032 |
| 23 | Limestone, grey, medium-grained, and shale, black calcareous | 2 | 1,031 |
| 22 | Limestone, grey, medium-grained; slightly crinoidal | 24 | 1,029 |
| 21 | Limestone, dark grey, fine-grained; forms a single massive unit but weathers to a platy talus | 6 | 1,005 |
| 20 | Shale, calcareous, black | 5 | 999 |
| 19 | Limestone, dark grey, fine-grained; some slightly argillaceous fissile weathering bands; abundant black chert as irregular nodules in the lower part and as bands higher up | 31 | 994 |
| 18 | Shale, calcareous, black | 1 | 963 |
| 17 | Limestone, dark grey, fine-grained; some slightly argillaceous layers that weather to a fissile talus. *Spirifer* cf. *rowleyi* Weller. GSC loc. 32692 | 18 | 962 |
| 16 | Shale, black, calcareous, with thin-bedded limestone bands | 10 | 944 |
| 15 | Limestone, dark grey, medium-grained | 6 | 934 |
| 14 | Shale, slightly calcareous, black; resistant, more calcareous bed 28′ from base | 49 | 928 |
| 13 | Limestone, slightly argillaceous, dark grey or black, fine-grained; several shaly beds | 13 | 879 |
| 12 | Shale, slightly calcareous, black; paper thin, with a single highly weathered rusty band in the middle of the unit | 13 | 866 |
| 11 | Limestone, dark grey or black, fine-grained; consists of thin massive beds with shaly interbeds | 14 | 853 |
| 10 | Shale, calcareous, black; soft with microfossils, *Cribroconcha* aff. *C. costata* Cooper, *Graphiadactyllis* cf. *spinosus* Moery, ?*Amphissites* sp., ?*Seminolites* sp., *Glyptopleurina* n. sp. GSC loc. 32694 | 19 | 839 |
| 9 | Limestone, dark grey or black, fine-grained; forms a series of blocky beds with fissile limestone beds separating, weathers as a single massive unit | 12 | 820 |
| 8 | Shale, partly or wholly calcareous, black. *Dictyoclostus* cf. *burlingtonensis* (Hall), *Spirifer rowleyi* Weller, *Brachythyris* cf. *chouteauensis* Weller. GSC loc. 32697 | 72 | 808 |
| 7 | Limestone, argillaceous, black, fine-grained; weathers to a platy talus. *Chonetes* sp. B, *Phillipsia* sp. GSC loc. 32690 | 2 | 736 |
| 6 | Shale, non-calcareous, black; some calcareous layers | 56 | 734 |
| 5 | Limestone, argillaceous, black; weathers to a platy talus. *Echinoconchus alternatus* (Norwood and Pratten), *Chonetes illinoisensis* Worthen, *Chonetes* sp., *Camarotoechia allani* Warren, *Cleiothy-* | | |

**Section 1** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | *ridina* cf. *obmaxima* McChesney, *Spirifer rowleyi* Weller, *Spirifer centronatus* (of authors). GSC loc. 32684 | 11 | 678 |
| 4 | Shale, slightly calcareous, black; paper thin with thin bands of hard, black, non-calcareous mudstone, weathering brown | 51 | 667 |
| 3 | Limestone, argillaceous, black, fine-grained; massive, but weathers to a platy talus | 20 | 616 |
| 2 | Shale, slightly calcareous, black; partly concealed | 26 | 596 |
| 1 | Shale, calcareous, black; with scattered nodules of black limestone that weather white or grey, grades upwards into a platy black mudstone. *Dictyoclostus* cf. *burlingtonensis* (Hall), *Chonetes*, sp. | 19 | 570 |
| | Underlying beds—Clausen Formation, unit 7. Contact conformable. | | |
| | Section continues up main cliffs of the west side of Yohin Ridge, over the ridge, and over into Jackfish Valley. | | |
| | Overlying beds—Lower Cretaceous Buckinghorse Formation. Contact not observed, disconformable. | | |
| | *Upper Member* | | |
| 143 | Sandstone, grey, fine-grained, irregular medium-(4-5") bedded becoming thick-bedded, dark grey weathering, lower 15' pale brown, fine-grained, quartzose sandstone with small brown spots, cliff-former | 46 | 3,160 |
| 142 | Concealed interval, except for 4 feet near base of white, medium-grained sandstone | 30 | 3,114 |
| 141 | Sandstone, pale brown, fine-grained with scattered rounded coarse quartz grains and green glauconite?, medium-bedded, broken silicified brachiopod fragments, yellow-brown weathering | 7 | 3,084 |
| 140 | Sandstone, yellow-brown, fine-grained, massive, towards base is coarse-grained with much white 'earthy' cement | 7 | 3,077 |
| 139 | Sandstone, light grey, medium- to coarse-grained, many white specks | 11 | 3,070 |
| 138 | Concealed interval | 7 | 3,059 |
| 137 | Sandstone, light brown-grey, medium-grained, medium-(3-4") bedded, pale brown weathering NOTE: mainly brown-grey weathering above. | 8 | 3,052 |
| 136 | Sandstone, light brown-grey, coarse-grained, massive, weathers dark grey, abundant white 'earthy' specks | 45 | 3,044 |
| 135 | Limestone, light grey, fine- to medium-grained, partly fragmental, a few brachiopods, medium to dark grey weathering. *Spirifer rockymontanus* Marcou. GSC loc. 31500 | 5 | 2,999 |
| 134 | Dolomite, argillaceous, greenish grey, fine-grained | 1 | 2,994 |
| 133 | Dolomite, arenaceous, light grey, fine-grained, more argillaceous towards the base | 6 | 2,993 |

Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 132 | Dolomite, pale brown to light grey, fine- to medium-grained, irregular layers of white chert with texture similar to that of dolomite, arenaceous content varies, abundant broken fragments of brachiopods and crinoid stems | 43 | 2,987 |
| 131 | Covered interval | 8 | 2,944 |
| 130 | Sandstone, light grey, medium-grained, brown-grey weathering, massive, scattered broken brachiopods with beekite on weathered surface | 7 | 2,936 |
| 129 | Covered interval | 3 | 2,929 |
| 128 | Dolomite, arenaceous to dolomitic sandstone, brown, fine-grained, brown weathering, broken brachiopods on surface, thick-bedded | 26 | 2,926 |
| 127 | Covered | 11 | 2,899 |
| 126 | Sandstone, dark grey, fine-grained, becomes pale brown towards base, brown weathering, petroliferous odour, broken brachiopods | 17 | 2,888 |
| 125 | Sandstone, pale brown, medium- to coarse-grained, massive, dark grey with some reddish weathering, white specks | 17 | 2,871 |
| 124 | Sandstone, pale brown, medium- to coarse-grained, one foot irregular layers of chert | 6 | 2,854 |
| 123 | Sandstone, feldspathic, reddish with white in centre part, medium- to coarse-grained, large-scale crossbedding | 18 | 2,848 |
| 122 | Sandstone, white with reddish feldspar, medium-grained, dark grey weathering, massive | 37 | 2,830 |
| 121 | Sandstone, light grey with some brown spots, fine- to medium-grained, a few reddish beds, thick-bedded | 60 | 2,793 |
| 120 | Sandstone, pale brown, medium-grained, slight dip-slope and overhang at top of ridge | 4 | 2,733 |
| 119 | Sandstone, reddish with white spots, medium-grained, medium- to thick-bedded, reddish brown weathering | 18 | 2,729 |
| 118 | Sandstone, pale brown to light grey, fine- to medium-grained, thick-bedded to massive, medium grey weathering | 15 | 2,711 |
| 117 | Sandstone, quartzose, white to light grey, medium-grained, thin-bedded | 9 | 2,696 |
| 116 | Sandstone, quartzose, white, medium-grained, light grey weathering | 7 | 2,687 |
| 115 | Sandstone, dolomitic?, light brown-grey, fine-grained, buff weathering | 3 | 2,680 |
| 114 | Shale, black, grading upward into very thin-bedded, white sandstone, and interbedded shale; at top 4-6" beds white, medium-grained quartzose sandstone | 17 | 2,677 |
| 113 | Sandstone, dolomitic, medium grey, fine-grained, medium-bedding, very irregular lower contact | 6 | 2,660 |
| 112 | Sandstone, grey, fine-grained, 'salt and pepper' type, partly covered, brown weathering, recessive | 19 | 2,654 |
| 111 | Sandstone, pale brown with white specks, coarse-grained, massive (3-4'), crossbedded. Cliff weathers dark grey | 16 | 2,635 |
| 110 | Covered | 9 | 2,619 |

## Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 109 | Sandstone, shaly, medium grey, fine-grained, thin-bedded | 5 | 2,610 |
| 108 | Sandstone, white, fine- to medium-grained; medium brown, medium- to coarse-grained in part near top, thin- to medium-bedded | 16 | 2,605 |
| 107 | Covered except for 5′ sandstone as above with a few black streaks | 15 | 2,589 |
| 106 | Sandstone, light grey to pale brown with spotted brown specks; medium-grained; medium-bedded (3-6″); weathers light grey; 'worm' grooving along bedding plane | 18 | 2,574 |
| 105 | Covered | 2 | 2,556 |
| 104 | Sandstone, dolomitic; medium grey, very fine-grained, medium-bedded, weathers buff | 10 | 2,554 |
| 103 | Covered | 7 | 2,544 |
| 102 | Sandstone, white; medium-grained, massive, weathers grey | 10 | 2,537 |
| 101 | Covered | 6 | 2,527 |
| 100 | Sandstone, soft, friable; light grey at base to medium grey at top, fine-grained, thin-bedded, a few dark grey carbonaceous streaks | 9 | 2,521 |
| 99 | Covered | 8 | 2,512 |
| 98 | Sandstone, white with pinkish tinge, medium-grained, thin- to medium-bedded | 29 | 2,504 |
| 97 | Covered | 3 | 2,475 |
| 96 | Sandstone, light grey, coarse-grained with rounded shale fragments, upper 8′ dark grey, very fine-grained, sandy dolomite, reddish brown weathering, irregular thin-bedded | 22 | 2,472 |
| 95 | Sandstone, light grey; medium-grained, soft, very thin-bedded, weathers back; partly covered | 5 | 2,450 |
| 94 | Sandstone, white to pale brown, thin- to medium-bedded with some massive units, carbonaceous streaks; grades up from underlying shale; dip-slope at top | 97 | 2,445 |
| 93 | Shale, fissile, black | 28 | 2,348 |
| 92 | Dolomite, sandy; dark grey; fine-grained; weathers yellow-brown | 4 | 2,320 |
| 91 | Shale, non-calcareous; black; partly covered | 21 | 2,316 |
| 90 | Sandstone, light grey with pale brown streaks; medium-grained, weathers grey to white | 21 | 2,295 |
| 89 | Sandstone, light grey with some black carbonaceous streaks; fine-grained; very irregular thin- to medium-bedded | 25 | 2,274 |
| 88 | Sandstone, white, medium-grained; irregular medium-bedded | 10 | 2,249 |
| 87 | Sandstone, light grey with brown specks to white at centre; medium- to coarse-grained; massive black shiny gouge at base probably due to movement along bedding plane | 45 | 2,239 |
| 86 | Sandstone, pale brown, medium-grained, crossbedded, weathers yellow-brown | 25 | 2,194 |
| 85 | Sandstone, white; fine- to medium-grained; cross-bedded; many ripple-marks on bedding surfaces; weathers white | 55 | 2,169 |



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Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 84 | Covered interval | 35 | 2,114 |
| 83 | Sandstone, white; medium-grained; massive, forms white dip-slope; weathers white | 25 | 2,079 |
| 82 | Covered | 10 | 2,054 |
| 81 | Sandstone, brown, grey with black streaks; 30% chert in dark grey layers | 3 | 2,044 |
| 80 | Sandstone, pale brown to grey-brown, medium-grained, soft rubbly, buff weathering; a few scattered brachiopods. *Spirifer rockymontanus* Marcou, *S. boonensis*? Swallow, *Composita* sp. GSC loc. 31502 | 45 | 2,041 |
| 79 | Limestone, argillaceous, medium grey, fine-grained; 2-3′ bedding; few brachiopods; weathers grey | 8 | 1,996 |
| 78 | Covered, except for 2′ coarse-grained brown-grey limestone near middle of unit, a few brachiopods. *Spirifer* cf. *boonensis*? Swallow, *Composita* sp. | 22 | 1,988 |
| 77 | Sandstone, medium grey, fine-grained | 2 | 1,966 |
| 76 | Dolomite, arenaceous, brown to brown-grey, fine-grained; irregular 2″-1′ parting, a few thick shelled brachiopods; 6″ of dark grey, non-calcareous shale at top, weathers buff | 10 | 1,964 |
| 75 | Limestone, dark grey, fine-grained, arenaceous; 1′ bedding; weathers dark grey | 4 | 1,954 |
| 74 | Sandstone, greenish grey, fine- to medium-grained; thin-bedded, recessive | 2 | 1,950 |
| 73 | Covered | 12 | 1,948 |
| 72 | Sandstone, silty, brown, fine-grained, yellowish brown weathering; partly covered | 7 | 1,936 |
| 71 | Dolomite, sandy, medium grey, fine-grained; some calcite coarsely crystalline filling 1″ vugs. Very irregular lower contact with limonite (pyrite) minor disconformity | 2 | 1,929 |
| | *Middle Member* | | |
| 70 | Sandstone, soft, brown, medium-grained; coarse-grained in middle; some mottled sandstone near top | 10 | 1,927 |
| 69 | Sandstone, light grey with brown spots, fine-grained, partly covered | 13 | 1,917 |
| 68 | Sandstone, white, fine-grained; thin-bedded ($\frac{1}{2}$″) to (4-6″) beds of buff sandstone near top | 16 | 1,904 |
| 67 | Sandstone, white to pale brown, fine- to medium-grained; massive (3′) beds; weathers brown | 38 | 1,888 |
| 66 | Sandstone, white to light grey, fine-grained, thin irregular bedded | 8 | 1,850 |
| 65 | Sandstone, light grey with brown spots, fine- to medium-grained; from 2′-3′ beds to 5′, thin-bedded in middle and massive at base | 34 | 1,842 |
| 64 | Sandstone, white with some reddish brown interbeds, a few dark grey irregular streaks, 1′-2′ beds with 3″-4″ beds at base; weathers light grey | 21 | 1,808 |
| 63 | Covered | 10 | 1,787 |

**Section 1** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 62 | Sandstone, white to light grey, fine- to medium-grained | 4 | 1,777 |
| 61 | Sandstone, light grey with brown spots, fine- to medium-grained; thin-bedded | 13 | 1,773 |
| 60 | Partly covered with 3-4″ beds of scattered outcrop of sandstone as above | 20 | 1,760 |
| 59 | Covered to big dark grey weathering dip-slope | 40 | 1,740 |
| 58 | Sandstone, reddish brown, medium- to coarse-grained, crossbedded, weathers brown | 25 | 1,700 |
| 57 | Sandstone, light grey, medium-grained, interbedded with sandy-dolomitic shale | 3 | 1,675 |
| 56 | Sandstone, yellow-brown, medium-grained, massive | 8 | 1,672 |
| 55 | Shale, fissile, non-calcareous, black | 1½ | 1,664 |
| 54 | Sandstone, light brown-grey, medium-grained, massive | 5 | 1,663 |
| 53 | Sandstone, white, fine-grained | 4 | 1,658 |
| 52 | Covered | 50 | 1,654 |
| 51 | Sandstone, pale brown with darker spots, fine- to medium-grained | 12 | 1,604 |
| 50 | Sandstone, light grey, fine-grained, interbedded with very thin-bedded shale, partly covered | 5 | 1,592 |
| 49 | Partly covered, black, fissile, non-calcareous shale at top and pale brown to light grey sandstone, fine-grained, weathering reddish brown at base | 32 | 1,587 |
| 48 | Sandstone, medium grey, fine-grained becoming very fine-grained, grading to silty shale at base | 14 | 1,555 |
| 47 | Sandstone, white, medium-grained, massive, dark grey weathering, forms large dip-slope | 70 | 1,541 |
| 46 | Sandstone, white, medium-grained, medium-bedded, covered at top | 57 | 1,471 |
| 45 | Sandstone, white to pale brown, fine- to coarse-grained; massive, many ripple-marks on overhangs; weathers dark grey | 240 | 1,414 |
| 44 | Sandstone, dark grey to black, fine-grained, with 20% black silty non-calcareous shale, carbonaceous, 'fucoid' markings | 7 | 1,174 |
| 43 | Sandstone, pale brown, fine-grained, massive with blocky parting | 12 | 1,167 |
| 42 | Sandstone, medium grey, fine-grained, some carbonized wood fragments, interbedded, shale, partly covered | 6 | 1,155 |
| 41 | Sandstone, white, medium-grained, massive, medium grey weathering | 10 | 1,149 |
| 40 | Shale, non-calcareous, black | 9 | 1,139 |
| | *Lower Member* | | |
| 39 | Sandstone, medium grey, fine- to medium-grained, thin- to medium-bedded (1-4″), irregular carbonaceous streaks, reddish brown weathering in part | 13 | 1,130 |
| 38 | Shale, non-calcareous, black, fissile, slightly micaceous, very thin interbeds near top | 10 | 1,117 |



64524-2—4½

Section 1 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 37 | Sandstone, light grey, fine-grained, medium- to thin-bedded, mainly rusty brown weathering with a greenish tint, ripple-marks and worm-trails | 22 | 1,107 |
| 36 | Shale, black, fissile, and some very thin sandstone beds, a few 'clay-ironstone' concretions | 5 | 1,085 |
| 35 | Sandstone, conglomeratic, dark grey-brown, medium-grained, reddish brown weathering, 6″ ironstone at base | 3 | 1,080 |
| 34 | Shale, partly covered with minor sand | 5 | 1,077 |
| 33 | Sandstone, medium brown, fine- to medium-grained, massive | 12 | 1,072 |
| 32 | Shale, non-calcareous, slightly micaceous, black, fissile | 2 | 1,060 |
| 31 | Sandstone, dark grey, fine-grained, carbonaceous, thin-bedded | 5 | 1,058 |
| 30 | Covered, probably as above with more shale | 7 | 1,053 |
| 29 | Sandstone, white, fine-grained, medium- to thick-bedded (1-4′), a few carbonaceous streaks | 10 | 1,046 |
| 28 | Sandstone, as above but medium-grained and greenish weathering | 10 | 1,036 |
| 27 | Covered | 23 | 1,026 |
| 26 | Sandstone, white, light grey to pale brown, fine-grained, thin- to thick-bedded, rusty brown weathering, wood fragments | 49 | 1,003 |
| 25 | Shale, non-calcareous, black, fissile, yellow sulphur weathering in part | 10 | 954 |
| 24 | Sandstone, dark grey, fine-grained, thin-bedded | 1 | 944 |
| 23 | *Coal,* black—shaly at top | 6 | 943 |
| 22 | Sandstone, dark grey, fine-grained, thin-bedded, containing 2-3″ wood fragments and *Lepidodendron* sp. | 1 | 937 |
| 21 | Sandstone, light grey, medium-grained, 4-5″ beds at top becoming 1′ beds at base | 30 | 936 |
| 20 | Sandstone, pale brown to pale pink, medium-grained, massive | 45 | 906 |
| 19 | Sandstone, grey, medium-grained, thick-bedded | 9 | 861 |
| 18 | Coal, argillaceous, black, grades to highly carbonaceous shale | 3 | 852 |
| 17 | Sandstone, dark grey, fine-grained, in upper 5′, thin alternating fine-grained, pale brown sandstone with alternating very thin-bedded sandstone and shale (20% shale), partly covered at base | 30 | 849 |
| 16 | Sandstone, light grey to pale brown, medium-grained, massive | 50 | 819 |
| 15 | Sandstone, pale brown to light grey, fine-grained, irregular thin- to medium-bedded (2-5″), a few more shaly partings, abundant carbonaceous layers, weathers greenish grey | 36 | 769 |
| 14 | Partly covered, black non-calcareous shale, and very thin sandstone | 18 | 733 |
| 13 | Sandstone, pinkish brown, fine- to medium-grained, thick-bedded, towards base, fine-grained, irregular thin- to medium-bedded sandstone with argillaceous partings, brown weathering | 29 | 715 |

**Section 1** — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 12 | Sandstone, light grey, fine- to medium-grained, massive, rusty brown weathering | 13 | 686 |
| 11 | Sandstone, white, fine-grained, very thin-bedded with black micaceous, carbonaceous layers on bedding plane | 6 | 673 |
| 10 | Sandstone, light grey, fine-grained, irregular medium-bedded, rusty brown weathering, abundant carbonaceous material | 14 | 667 |
| 9 | Shale, micaceous, silty black with alternating thin-bedded sandstone, partly covered | 28 | 653 |
| 8 | Covered interval | 60 | 625 |
| 7 | Sandstone, pale brown to white with reddish interbeds, fine- to medium-grained, thin- to medium- becoming thick-bedded towards base | 56 | 565 |
| 6 | Sandstone, light grey, fine-grained, thin- to medium-bedded with occasional more massive bed, a little interbedded silty shale, rusty brown weathering with green tinge | 33 | 509 |
| 5 | Sandstone, white to medium grey, fine-grained, medium- to thick-bedded, thin-bedded with carbonaceous streaks at base | 49 | 476 |
| 4 | Sandstone, white, fine-grained, with shale partings, black weathering band, cuts out 3′ of underlying sandstone | 6 | 427 |
| 3 | Sandstone, white to light grey, fine- to medium-grained, thin- to thick-bedded (mainly irregular 2-5″), rusty brown weathering with green tinge, black on bedding plane surface, slightly recessive at base | 325 | 421 |
| 2 | Sandstone, as above, forms massive cliff with 4-5″ partings | 92 | 96 |
| 1 | Sandstone, dark grey, very fine-grained, laminated, very thin-bedded | 4 | 4 |
| | Underlying beds—Flett Formation, unit 94. Contact conformable. | | |

## SECTION 2

South side of The Twisted Mountain, about 15 miles northwest of South Nahanni. Map 95G, lat. 61°13′N, long. 123°37′W. Access by boat; camp site on small terrace above the river near base of dip-slope forming west side of mountain. An old trail crosses swampy ground beneath scarp of Mattson Formation, access to the exposures after crossing the dense undergrowth of the lower ground is obvious. Fairly continuous exposures are found high on the mountain.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | FLETT FORMATION | | |
| | Base of section near axis of monocline, *see* Plate IA. | | |
| | Overlying beds—Mattson Formation. Contact conformable. | | |
| 80 | Dolomite, arenaceous, pale yellow-grey, fine-grained, orange-yellow weathering, small specks of green mineral (possibly glauconite), rare pyrite | 5 | 1,380 |
| 79 | Shale, non-calcareous, dark greenish grey, smooth, fissile | 18 | 1,375 |
| 78 | Dolomite, arenaceous, light grey, fine-grained, medium-bedded, pale yellow-brown weathering, 10-40% interbeds of black, non-calcareous shale decreasing upwards, lower 10′ consist of interbedded limestone and shale | 23 | 1,357 |
| 77 | Shale, non-calcareous, black, fissile, pale brown circular spores? up to ⅛″ in diameter | 5 | 1,334 |
| 76 | Limestone, dark grey, fine- to medium-grained, very thin-bedded (¼-½″) with interbeds of black shale | 3 | 1,329 |
| 75 | Limestone, fragmental, crinoidal, brown to brown-grey, medium-grained, thick-bedded | 4 | 1,326 |
| 74 | Shale, non-calcareous, black, very thin-bedded, some thin-shelled brachiopods, indeterminable | 5 | 1,322 |
| 73 | Limestone, bioclastic, argillaceous, medium grey, fine- to medium-grained, bryozoans, slickensides | 4 | 1,317 |
| 72 | Shale, non-calcareous, black, smooth | 5 | 1,313 |
| 71 | Limestone, crinoidal, medium- to coarse-grained, medium-bedded | 6 | 1,308 |
| 70 | Limestone, argillaceous?, medium grey, fine-grained, pyrite, medium-bedded (6-7″) evenly interbedded with dark brown-grey, thin irregular bedded shale | 4 | 1,302 |
| 69 | Shale, slightly argillaceous, grey, limestone nodules | 15 | 1,298 |
| 68 | Limestone, medium grey, fine- to medium-grained, fragmental in part, fossils abundant near base with colonial corals near top; interbeds of dark brown-grey shale decreasing upwards, minor chert near top. ?*Lithostrotion* sp., *Dictyoclostus* cf. *parvus* (Meek and Worthen), *Spirifer*[1] sp., *Spirifer* cf. *leidyi* Norwood and Pratten, *Composita* sp., *Camarotoechia* sp. A, *Torynifer* sp. GSC loc. 31487 | 13 | 1,283 |
| 67 | Shale, non-calcareous, dark grey, fissile | 38 | 1,270 |

**Section 2** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 66 | Limestone, dark grey, medium-grained; interbedded with 2′ bands of irregularly spaced black chert, scattered chert nodules; some earthy partings of thin-bedded, fissile, argillaceous limestone. Scattered fossil fragments including large *Schellwienella* sp. | 40 | 1,232 |
| | This unit forms the upper part of the first prominent limestone cliff below the yellow weathering sandstone cliffs. | | |
| 65 | Limestone, grey to dark grey, medium-grained; forms a series of 1′ beds interbedded with thin-bedded, fissile, argillaceous limestone and black calcareous shale. *Echinoconchus* sp., *Composita* sp., *Dielasma* sp. GSC loc. 31325 | 18 | 1,192 |
| 64 | Limestone, argillaceous, light olive-grey, medium- to coarse-grained; massive | 2 | 1,174 |
| 63 | Limestone, silty to quartzose, dark grey, medium-grained; forms series of blocky weathering beds separated by shaly partings | 4 | 1,172 |
| 62 | Shale, slightly calcareous, black; partly concealed | 4 | 1,168 |
| 61 | Sandstone, calcareous, light brown, medium-grained; weathers brown; interbedded with argillaceous silty limestone and shale | 9 | 1,164 |
| 60 | Shale, calcareous, black; scattered thin layers of argillaceous limestone. *Dictyoclostus* cf. *inflatus* (McChesney), *Dictyoclostus* cf. *tennicostatus* (Hall), *Camarotoechia* cf. *mutata* (Hall), *Spirifer* cf. *pellaensis* Weller, *Composita* sp., *Girtyella* aff. *turgida* (Hall). GSC loc. 31331 | 10 | 1,155 |
| | (Units 60-62 form a recessive interval at the base of the upper limestone cliff.) | | |
| 59 | Limestone, dark grey, medium-grained; forms a series of 1-2′ beds interbedded with 1′ beds of thin-bedded argillaceous limestone; lowest bed is a 3′ massive limestone with a 3′ black chert bed at base | 26 | 1,145 |
| 58 | Concealed; black shale at base with thin bed of grey, brown weathering, silty limestone 8′ above base | 20 | 1,119 |
| 57 | Sandstone, light olive-grey, medium- to fine-grained; weathers yellowish grey; medium-bedded and some irregularity in bedding | 11 | 1,099 |
| 56 | Shale, non-calcareous, black, with several bands, up to 4′ thick, of thin-bedded, olive-grey, iron-stained sandstone. Partly concealed | 60 | 1,088 |
| 55 | Limestone, slightly argillaceous, dark grey, medium grained; forms a series of rather irregular massive beds separated by shaly interbeds draped over the irregularities. Fragments of *Kakwiphyllum* sp. and *Caninia* sp. | 12 | 1,028 |
| 54 | Shale, non-calcareous, black; partly concealed | 35 | 1,016 |
| 53 | Concealed interval | 45 | 981 |
| | Forms gully with stream running along foot of prominent limestone dip-slope. | | |

Section 2 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 52 | Limestone, dark grey, medium-grained; crinoidal; forms a series of resistant limestone beds 1′ or more thick, separated by shaly partings. Top bed continuously exposed along much of the dip-slope. Abundant large corals including *Kakwiphyllum* sp. and *Caninia* sp. GSC loc. 31323. Unit forms prominent dip-slope, *see* Plate IB .... | 29 | 936 |
| 51 | Limestone, grey, medium- to coarse-grained; crinoidal, forms a series of thin, brown weathering limestone steps with thin-bedded argillaceous limestone partings. *Amplexi-Zaphrentis* sp., *Kakwiphyllum* sp., *Dictyoclostus* aff. *altonensis* (Norwood and Pratten), *Camarotoechia* sp., *Brachythyris* cf. *subcardiformis* (Hall), *Spirifer* sp. A, *Composita* sp., *Pentremites* cf. *godoni* De france, *Orbitremites* sp. GSC loc. 31326 ..... | 12 | 907 |
| 50 | Limestone, black, medium- to coarse-grained; crinoidal ..... | 6 | 895 |
| 49 | Sandstone, calcareous, dark grey, medium-grained; weathers brown ..... | 2 | 889 |
| 48 | Shale, calcareous, dark grey, and limestone, black, argillaceous ..... | 4 | 887 |
| 47 | Limestone, dark grey, medium-grained; massive, becomes platy at the top and grades into overlying unit ..... | 2 | 883 |
| 46 | Shale, calcareous, dark grey, with thin-bedded limestone layers; forms a recessive unit, partly concealed ..... | 18 | 881 |
| 45 | Limestone, black or dark grey, medium-grained; weathers yellowish grey ..... | 5 | 863 |
| 44 | Shale, calcareous, dark grey with thin-bedded argillaceous limestone layers. *Lithostrotion* cf. *pauciradiale* (McCoy), *Dictyoclostus* cf. *altonensis* (Norwood and Pratten), *Brachythyris* cf. *subcardiformis* (Hall), *Spirifer* sp. A, *Punctospirifer* sp., *Pentremites* sp., *Pentremites* cf. *godoni* De france. GSC loc. 31322 ..... | 1 | 858 |
| 43 | Limestone, grey, coarse-grained; crinoidal; includes some thin-bedded limestone layers, only visible when weathered, otherwise unit is massive ..... | 4 | 857 |
| 42 | Limestone, dark grey, medium- to coarse-grained; partly crinoidal interbedded in about equal 1′ beds with dark grey, fissile, argillaceous limestone ..... | 6 | 853 |
| 41 | Limestone, slightly argillaceous, dark grey, thin, medium-grained; includes a few thin resistant beds, but the unit weathers to a recessive, platy talus ..... | 51 | 847 |
| 40 | Limestone, dark grey, medium-grained; several thin bedded layers, but when not weathered forms a massive unit ..... | 11 | 796 |
| 39 | Limestone, dark grey, medium-grained; in massive 1-2′ beds alternating with platy thin-bedded, brownish grey argillaceous limestone in ½-1′ beds ..... | 15 | 785 |

**Section 2** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 38 | Limestone, grey, crinoidal, medium- to coarse-grained; with black chert bands and some layers of thin-bedded shaly limestone | 17 | 770 |
| 37 | Limestone, slightly argillaceous, dark grey, medium-grained; thin-bedded | 2 | 753 |
| 36 | Limestone, dark grey, medium-grained | 3 | 751 |
| 35 | Limestone, argillaceous, dark grey, medium- to fine-grained; thin-bedded and platy | 1 | 748 |
| 34 | Limestone, dark grey, medium-grained; massive, scattered crinoid stems and black chert | 16 | 747 |
| 33 | Limestone, black, medium-grained; thin-bedded, platy and with some sooty black shaly layers; partly crinoidal | 2 | 731 |
| 32 | Limestone, dark grey, medium-grained; massive | 2 | 729 |
| 31 | Limestone, dark grey or black, medium- to fine-grained; thin-bedded with argillaceous layers; weathers to a platy talus; partly concealed | 22 | 727 |
| 30 | Limestone, dark grey or black, fine- to medium-grained; with scattered chert bands, blocky weathering | 11 | 705 |
| 29 | Limestone, black, fine-grained, interbedded with black chert; unit forms a series of buff weathering, blocky beds | 12 | 694 |
| 28 | Limestone, dark grey, fine-grained; medium-bedded | 12 | 682 |
| 27 | Concealed interval; probably mainly thin-bedded, dark grey platy limestone and shale | 60 | 670 |
| | This concealed interval forms a sloping recessive unit at the top of the lowest cliff; lowest cliff has brownish appearance. | | |
| 26 | Limestone, dark grey or black, medium-grained; fissile with crinoid fragments. Contains *Chonetes* cf. *illinoisensis* Worthen | 2 | 610 |
| 25 | Limestone, dark grey, medium-grained; weathers brown | 2 | 608 |
| 24 | Limestone, dark grey, medium-grained; interbedded with layers of dark grey or black, fissile, platy limestone | 10 | 606 |
| 23 | Concealed interval | 20 | 596 |
| 22 | Limestone, argillaceous, fine-grained; weathers pale reddish brown; contains *Dictyoclostus* cf. *burlingtonensis* (Hall) | 2 | 576 |
| 21 | Shale, non-calcareous, black; with scattered oblate spheroidal, dark yellowish orange weathering ferruginous nodules | 160 | 574 |
| 20 | Limestone, argillaceous, grey, platy weathering; forms a resistant bed | 1 | 414 |
| 19 | Shale, calcareous, grey | 1 | 413 |
| 18 | Limestone, argillaceous, grey, weathers to a thin platy talus; with shaly, nodular band at base | 1 | 412 |
| 17 | Shale, calcareous, grey | 12 | 411 |
| 16 | Limestone, argillaceous, dark grey; shaly but forms a resistant brown weathering unit | 7 | 399 |

## Section 2 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 15 | Shale, grey or black; much of this unit concealed; upper part has some grey calcareous shale, lower part black, non-calcareous; some beds similar to the overlying argillaceous limestone probably occur and may account for the grey, calcareous shale in the talus | 95 | 392 |
| 14 | Mudstone and shale, dark greenish grey to black; iron stained | 4 | 297 |
| 13 | Siltstone, calcareous, dark greenish grey; thin-bedded | 9 | 293 |
| 12 | Concealed interval; probably mainly shale | 80 | 284 |
| 11 | Limestone, black or dark grey, medium-grained; crinoidal; forms a series of massive 1-2′ beds with brown weathering partings. (This unit forms the prominent brownish coloured dip-slope to the west of the core of the monocline.) | 6 | 204 |
| 10 | Limestone, dark grey, fine-grained; forms a series of blocky beds separated by thin-bedded limestones; several thin crinoidal layers. *Schellwienella* sp., *Spirifer* cf. *esplanadensis* Brown. GSC loc. 31327 | 8 | 198 |
| 9 | Limestone, dark grey; consists almost entirely of large grey crinoidal fragments; orange flecks. Abundant large *Spirifer* cf. *rowleyi* Weller and *Spirifer* cf. *stratiformis* Meek. GSC loc. 31327 | 7 | 190 |
| 8 | Concealed interval; probably mainly thin-bedded sandstone, weathers brown | 50 | 183 |
| 7 | Sandstone, grey, medium-grained; partly concealed, weathers brown | 23 | 133 |
| 6 | Sandstone, grey, medium-grained; mottled appearance; weathers brown; many 'fucoid' markings. *Chonetes* sp., *Spirifer* aff. *albertensis* Warren, *Pseudosyrinx*? sp., pelecypods. GSC loc. 31328 | 8 | 110 |
| 5 | Concealed interval; probably mainly thin-bedded sandstone with some thin, slightly calcareous crinoidal layers | 30 | 102 |
| 4 | Sandstone, grey, medium- to fine-grained; weathers brown, thin-bedded | 5 | 72 |
| 3 | Sandstone, light olive-grey, medium-grained; consists of two massive beds of quartzose sandstone separated by thinner bedded sandstone with carbonaceous layers. Top bed forms prominent dip-surface | 5 | 67 |
| 2 | Sandstone, greenish grey, medium-grained, weathers brown; thin-bedded with carbonaceous layers and many speckles of dark brownish colour. Base concealed | 12 | 62 |
| 1 | Concealed interval below, probably mainly thin-bedded recessive shale and sandstone to core of anticline | | 50 |
| | Underlying beds concealed, probably Clausen Formation. | | |

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | MATTSON FORMATION | | |
| | Overlying beds—Lower Cretaceous Buckinghorse Formation. | | |
| | Contact not observed, disconformable. | | |
| | *Upper Member* | | |
| 57 | Sandstone, quartzose, light grey to white with reddish brown in centre; massive to thick-bedded with a few thin-bedded micaceous and carbonaceous sandstone interbeds, petrified part of tree (2'x3") which cuts across bedding 35' from base | 105 | 1,066 |
| 56 | Siltstone, argillaceous, black; irregularly bedded containing white 'kaolin-like' masses (½-1"), lower 3.5' is sandstone, medium grey, fine-grained, thin-bedded with abundant carbonaceous streaks, rubbly weathering | 8 | 961 |
| 55 | Concealed interval | 68 | 953 |
| 54 | Sandstone, light grey, fine-grained; thin-bedded; abundant carbonaceous material | 3 | 885 |
| 53 | Sandstone, white, fine-grained, lower 6' irregularly medium-bedded (4-6"); upper part is thick bedded (3'); carbonaceous streaks, rare slickensides | 12 | 882 |
| 52 | Sandstone, white, fine-grained; thin-bedded; with ½" wood fragments | 2 | 870 |
| 51 | Concealed interval | 15 | 868 |
| 50 | Sandstone, white, fine-grained; thick-bedded to massive, friable | 33 | 853 |
| 49 | Concealed interval—grassy slope with evidence of black shale at base | 12 | 820 |
| 48 | Sandstone, white to light grey, fine-grained; massive to thick-bedded | 12 | 808 |
| 47 | Sandstone, light grey, fine-grained; medium-bedded (3-4"), carbonaceous streaks common | 12 | 796 |
| 46 | Sandstone, quartzose, white, fine-grained; massive, crossbedded, friable | 40 | 784 |
| 45 | Concealed interval | 35 | 744 |
| 44 | Sandstone, quartzose, white to light brown-grey; massive- to thick-bedded, friable in part, pinkish brown at base, small-scale crossbedding, slight break 85 feet from base | 125 | 709 |
| 43 | Sandstone, quartzose, light grey, fine-grained; thin-bedded, abundant carbonaceous micaceous shale interbeds | 10 | 584 |
| 42 | Sandstone, quartzose, light grey, fine-grained; massive, weathers light grey to pale brown | 12 | 574 |
| 41 | Sandstone, light grey, fine-grained; very thin-bedded, abundant carbonaceous partings | 4 | 562 |
| 40 | Sandstone, light grey, medium-grained; massive | 15 | 558 |
| 39 | Sandstone, light grey, fine-grained; thin-bedded, many carbonaceous partings | 8 | 543 |
| 38 | Sandstone, white, medium-grained; massive but some 4-5" partings | 14 | 535 |

Section 2 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 37 | Sandstone, light grey, fine-grained; thin-bedded (½-1″), abundant carbonaceous partings and streaks, from 3 to 7 feet from base unit consists of interbedded black slightly micaceous shale, and very thin sandstone, a few oblong ½″ vugs on surface .... | 19 | 521 |
| 36 | Shale, non-calcareous, black; fissile, interbeds of very thin ($\frac{1}{16}$″) sandstone, dense dark grey to black ironstone concretions that weather reddish ..... | 3½ | 502 |
| 35 | Sandstone, medium reddish brown, fine- to medium-grained; colour of this unit may be weathering feature ..... | 3 | 498 |
| 34 | Shale, non-calcareous, black, fissile, in lower 5 feet; then shale and interbedded light grey, fine- to medium-grained sandstone with abundant carbonaceous material, weathers reddish brown in part, small vugs on weathered surface may be due to partial noncementation, some bedding planes are irregular due to worm trails, branch casts?, and ripple-marks ..... | 18 | 495 |
| | Such features as ripple-marks are best observed in talus blocks. Such indications suggest that entire formation was deposited in shallow water. | | |
| 33 | Sandstone, as below except beds 1-3″ and less carbonaceous partings ..... | 4 | 477 |
| 32 | Sandstone, light grey, fine-grained; thin-bedded (½″), abundant carbonaceous partings and irregular streaks ..... | 3 | 473 |
| 31 | Sandstone, light grey, fine-grained; thin-bedded (2-5″) but can be followed along cliff as a more resistant unit varying in thickness from 2 to 10 feet ..... | 5 | 470 |
| 30 | Sandstone, light grey, fine-grained; very thin irregularly ($\frac{1}{16}$″) bedded, abundant carbonaceous shaly layers, top part contains layers 2″ thick of reddish brown weathering, reddish brown, fine-grained sandstone alternating with very thin-bedded, light grey sandstone ..... | 7 | 465 |
| 29 | Sandstone, medium grey, fine-grained; rubbly irregular bedded, abundant carbonaceous material, partly covered ..... | 5 | 458 |
| 28 | Sandstone, medium grey, fine-grained; thick-bedded, brown weathering, a few irregular carbonaceous streaks ..... | 8 | 453 |
| 27 | Sandstone, light grey, fine-grained; thin-bedded, irregular carbonaceous streaks ..... | 3 | 445 |
| 26 | Sandstone, white, fine- to medium-grained; massive .... | 71 | 442 |
| 25 | Sandstone, light grey, fine-grained, thin-bedded, rubbly weathering, recessive, abundant thin black carbonaceous layers ..... | 4 | 371 |
| 24 | Sandstone, pale brown-grey, fine- to medium-grained; thick-bedded, carbonaceous streaks rare ..... | 9 | 367 |

**Section 2** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 23 | Sandstone, white to light grey, fine-grained; thin- to medium-bedded, abundant thin carbonaceous partings, reddish brown in part, occasional ½" vugs on weathered surface, 12-foot unit in centre appears massive along cliff | 63 | 358 |
| 22 | Sandstone, light grey, fine-grained; thin-bedded abundant carbonaceous partings, upper 6 feet is thick-bedded, pale yellow-brown, arkosic sandstone, rounded 1" vugs, sharp upper contact | 9 | 295 |
| 21 | Shale, non-calcareous, micaceous blocks, numerous fragmentary plant impressions | 9 | 286 |
| 20 | Sandstone, light grey, fine-grained; thin-bedded (1-4"), common carbonaceous streaks and wood fragments | 12 | 277 |
| 19 | Shale, non-calcareous, black; fissile, many plant remains and impressions | 27 | 265 |
| | Units 33 and 35 appear to be local deposition as shale is not present when followed along cliff. | | |
| 18 | Sandstone, white, medium-grained; thin irregular bedded, abundant carbonaceous partings and wood fragments | 2 | 238 |
| 17 | Sandstone, white with pale brown streaks, fine- to medium-grained; massive- to thick-bedded, upper 10 feet reddish brown arkosic? sandstone, big overhang | 37 | 236 |
| 16 | Sandstone, light grey, fine-grained; thin- to medium-bedded, abundant carbonaceous partings, slightly recessive | 8 | 199 |
| 15 | Sandstone, as above, beds 1-4" thick, rounded grains, reddish brown weathering in part | 16 | 191 |
| 14 | Concealed interval | 22 | 175 |
| 13 | Sandstone, white, fine-grained; thin-bedded; sub-rounded to rounded grains, carbonaceous partings | 9 | 153 |
| 12 | Sandstone, yellow-brown, fine-grained; thin- (1-3") bedded, medium-bedded towards top | 12 | 144 |
| | Colour of this unit may be due to cement. | | |
| 11 | Sandstone, white, fine-grained; interbedded irregularly with carbonaceous shale | 5 | 132 |
| 10 | Sandstone, yellow-brown, fine-grained; yellow-brown weathering, thin- to medium-bedded | 7 | 127 |
| 9 | Sandstone, white to light grey, fine-grained; thin-bedded, abundant thin carbonaceous shale partings | 7 | 120 |
| 8 | Sandstone, pale yellow-brown, fine-grained; thick-bedded (3-5') with 2-4" irregular parting, weathers pale brown | 28 | 113 |
| 7 | Sandstone, light grey, fine-grained; thin irregular bedded with abundant carbonaceous partings | 10 | 85 |
| 6 | Sandstone, pale brown, fine-grained; thin-bedded, rusty weathering at base grading up into 6"-1' beds towards top with rare carbonaceous material | 10 | 75 |
| 5 | Sandstone, medium brown, fine-grained; thin- to medium-bedded, weathers light grey, black carbonaceous streaks | 17 | 65 |

Section 2 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 4 | Sandstone, light grey, fine-grained; thin-bedded, rusty weathering at base, appears to be 'dirty' sandstone on weathered surface but is clean orthoquartzite except for abundant irregular carbonaceous partings | 26 | 48 |
| 3 | Sandstone, light grey, fine-grained; medium (1-1½') irregular bedded, irregular carbonaceous shale partings | 5 | 22 |
| 2 | Shale, non-calcareous, micaceous, black, grading upward into interbedded light grey, fine-grained sandstone and shale, the shale contains 'ironstone' concretions some enclosing minor galena and sphalerite | 14 | 17 |
| 1 | Siltstone or arenaceous shale, dark grey, layer of 'ironstone' nodules at top—some septarian fractures in nodules lined with yellow dolomite rhombs, shale is iridescent along bedding plane with slickensides | 3 | 3 |
| | Underlying beds—Flett Formation, unit 80. Contact conformable. | | |

## SECTION 3

North scarp face of Tlogotsho Plateau about 2 miles east of the fork at headwaters of Ram Creek. Map 95F, lat. 61°10'N, long. 124°20'W. Camp site and helicopter landing at the side of tiny lake on spur below main scarp.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | FLETT FORMATION | | |
| | Overlying beds—Mattson Formation | | |
| 43 | Shale, non-calcareous, black, slightly micaceous, partly covered, upper contact has ½" irregular layer of pyrite | 34 | 658 |
| 42 | Dolomite, medium grey, medium-grained; yellow-orange weathering | 6 | 624 |
| 41 | Limestone, grey, coarse-grained; crinoidal, irregular patches of grey, medium-grained, yellow-orange weathering dolomite | 7 | 618 |
| 40 | Shale, non-calcareous, black, fissile, upper beds partly concealed | 44 | 611 |
| 39 | Limestone, grey, fine- to medium-grained; partly crinoidal, 10% dark grey chert | 20 | 567 |
| 38 | Shale, black, fissile | 1½ | 547 |
| 37 | Limestone, dark grey, fine- to medium-grained; medium-bedded with thin-bedded more argillaceous limestone interbeds, abundant black dense chert layers | 31 | 545 |
| 36 | Limestone, argillaceous, dark grey; thin-bedded, laminated, one-foot bed hard, sandy fine-grained limestone in centre, sharp upper contact | 13 | 514 |
| 35 | Limestone, arenaceous?, dark grey, fine-grained; yellow-brown weathering | 5 | 499 |
| 34 | Limestone, argillaceous, dark grey, fine-grained; irregular laminated, one-foot interbeds of harder limestone, 2" layers black chert towards top | 23 | 494 |
| 33 | Concealed interval | 49 | 471 |
| 32 | Limestone, argillaceous, dark grey to black, fine- to medium-grained; medium-bedded (6-8"), brown weathering, crinoidal in part, thinner more argillaceous layers | 7 | 422 |
| 31 | Concealed interval—probably shale | 27 | 415 |
| 30 | Shale, calcareous, dark grey, grading into argillaceous limestone | 8 | 388 |
| 29 | Limestone, grey, fine-grained; 10% dark grey chert nodules, forms top of small cliff | 10 | 380 |
| 28 | Limestone, grey, medium- to coarse-grained; crinoidal, one-foot beds with irregular very thin argillaceous interbeds | 12 | 370 |
| 27 | Limestone, grey, fine-grained matrix with patches of medium-grained, brown-grey weathering | 6 | 358 |
| 26 | Concealed interval | 4 | 352 |
| 25 | Limestone, argillaceous, dark grey, fine-grained—two beds with 8" thinner bedded in between, small colonial corals | 5 | 348 |
| 24 | Limestone, argillaceous, dark grey, thin-bedded, ½' crinoidal limestone at top | 5 | 343 |

Section 3 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 23 | Limestone, argillaceous, dark grey, fine-grained, thick-bedded | 3 | 338 |
| 22 | Shale, calcareous, dark grey, medium-grained, grey limestone at base | 3 | 335 |
| 21 | Concealed interval | 4 | 332 |
| 20 | Limestone, dark grey, fine-grained, medium-bedded (1-2′) with thinner more argillaceous interbeds | 5 | 328 |
| 19 | Limestone, argillaceous, dark grey, fine-grained, thin-bedded, occasional 10″ harder limestone beds, partly covered | 12 | 323 |
| 18 | Concealed interval | 26 | 310 |
| 17 | Limestone, dark grey, fine- to medium-grained, one-foot thin-bedded, very argillaceous limestone at top | 3 | 284 |
| 16 | Concealed interval | 4 | 281 |
| 15 | Limestone, argillaceous, dark grey, fine-grained, thin- to medium-bedded | 3½ | 277 |
| 14 | Limestone, medium grey, medium- to coarse-grained, medium-bedded | 8 | 273 |
| 13 | Limestone, dark grey, fine- to medium-grained, partly crinoidal in 8″ beds alternating with thin-bedded calcareous shale | 5 | 265 |
| 12 | Limestone, medium grey, coarse-grained, crinoidal | 3 | 260 |
| 11 | Limestone, medium to dark grey, fine-grained matrix, partly crinoidal, one-foot beds alternating with irregular 2-3″ thin-bedded argillaceous limestone | 18 | 257 |
| 10 | Concealed interval | 13 | 239 |
| 9 | Limestone, medium grey, medium-grained in one-foot beds with 1-2″ argillaceous limestone interbeds, brown weathering upper 1.0′ coarse-grained crinoidal limestone | 10 | 226 |
| 8 | Limestone, argillaceous, dark grey, fine-grained, blocky brown weathering, a few interbeds of more argillaceous limestone | 12 | 216 |
| 7 | Concealed interval | 20 | 204 |
| 6 | Limestone, medium-grained, very coarse-grained, crinoidal. Unit 6 forms tops of lower cliff, consisting of units 4-6 | 1 | 184 |
| 5 | Limestone, argillaceous, dark grey to black, fine-grained, medium- to thick-bedded (1-3′), brown-grey weathering, occasional one-foot layers of black dense chert | 63 | 183 |
| 4 | Limestone,—consists of alternating 2-3′ units of dark grey, hard, fine-grained, argillaceous limestone and 2′ units of medium-bedded (4-5″) similar limestone except the latter contains up to 50% black dense chert | 63 | 120 |
| 3 | Limestone, argillaceous, dark grey, fine-grained, thin-bedded, 4′ very thin-bedded calcareous shale at top | 16 | 52 |
| 2 | Limestone,—alternating one-foot beds coarse-grained fragmental limestone and thin-bedded argillaceous limestone | 5 | 36 |

## Section 3 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 1 | Limestone,—alternating 4-5′ units of medium-bedded, fine-grained, dark grey, argillaceous limestone and 2-3′ massive beds, fine- to medium-grained, dark grey, argillaceous limestone, buff to light brown-grey weathering, rare black chert layers near top. Units 1-3 darker weathering than units 4-6 | 31 | 31 |
| | Underlying beds—continuation of Flett Formation, lower part of section concealed. | | |
| | MATTSON FORMATION | | |
| | Overlying beds—concealed, probably Cretaceous. | | |
| | *Middle Member* | | |
| 52 | Sandstone, pale brown, medium-grained; thick-bedded | 7 | 1,534 |
| 51 | Concealed interval | 21 | 1,527 |
| 50 | Sandstone, light grey, fine-grained; thin-bedded, abundant carbonaceous streaks | 21 | 1,506 |
| 49 | Sandstone, light grey, medium-grained; massive; weathers rusty brown with green tinge | 6 | 1,485 |
| 48 | Sandstone, pale brown, fine- to medium-grained; irregularly fractured; weathers buff | 9 | 1,479 |
| 47 | Sandstone, dark grey, carbonaceous, fine-grained; thin-bedded; black interbedded shale | 14 | 1,470 |
| 46 | Sandstone, unit consists of three thick beds, rusty brown, medium-grained sandstone separated by two thin-bedded units, brown-grey, medium-grained limestone | 30 | 1,456 |
| 45 | Sandstone, black, very fine-grained and mudstone and shale, very thin-bedded, grading upward to flaggy (1″-2″) beds, grey, fine-grained sandstone | 27 | 1,426 |
| 44 | Sandstone, friable, light grey, coarse-grained, well-rounded; massive, weathers pale buff to whitish grey | 179 | 1,399 |
| | *Lower Member* | | |
| 43 | Concealed interval | 76 | 1,220 |
| 42 | Sandstone, very friable, coarse-grained; massive with 1′ crossbeds | 36 | 1,177 |
| 41 | Sandstone, as below, only thin- to medium-bedded, weathers grey | 9 | 1,141 |
| 40 | Sandstone, friable, light grey, medium- to coarse-grained, massive, weathers light grey to white | 18 | 1,131 |
| 39 | Concealed interval | 28 | 1,113 |
| 38 | Shale, black | 4 | 1,085 |
| 37 | Sandstone, light grey, medium-grained; thick-bedded; carbonaceous streaks, weathers dark grey | 40 | 1,081 |
| 36 | Sandstone, as above only medium-bedded | 5 | 1,041 |
| 35 | Coal at base about 5′, otherwise concealed | 16 | 1,036 |
| 34 | Sandstone, medium grey, medium-grained, massive, becomes medium-bedded, light grey towards base; weathers grey | 24 | 1,020 |



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## Section 3 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 33 | Concealed, probably a small coal bed at base | 30 | 996 |
| 32 | Sandstone, light grey, medium-grained; medium-bedded up to thick-bedded, sandstone, very thin-bedded black shale for 1.5′ at base | 76 | 966 |
| 31 | Sandstone, light grey to pale brown, medium-grained; weathers dark grey | 43 | 890 |
| 30 | Sandstone, as below, carbonaceous; very thin-bedded; recessive | 5 | 847 |
| 29 | Sandstone, light grey, medium-grained; 3-4″ beds; weathers rusty brown | 10 | 842 |
| 28 | Shale, arenaceous, black, covered at top | 7 | 832 |
| 27 | Sandstone, light grey, medium-grained; thin-bedded grading up to massive; carbonaceous partings and streaks | 35 | 825 |
| 26 | Shale, non-calcareous, black | 11 | 790 |
| 25 | Sandstone, grey, medium-grained; massive | 10 | 779 |
| 24 | Concealed interval | 32 | 768 |
| 23 | Sandstone, light grey to light pinkish grey, medium-grained; massive; weathers dark grey | 30 | 736 |
| 22 | Sandstone, light grey, fine- to medium-grained; thin-bedded (1-3″); abundant carbonaceous partings | 26 | 706 |
| 21 | Sandstone, pale brown, medium-grained; massive, weathers dark grey | 9 | 680 |
| 20 | Concealed interval | 32 | 671 |
| 19 | Sandstone, brown, fine-grained, weathers very rusty brown | 1 | 639 |
| 18 | Sandstone, white to light grey, medium-grained; 4-5″ beds; carbonaceous streaks | 15 | 638 |
| 17 | Sandstone, pale brown, medium- to coarse-grained; massive; loosely cemented; weathers dark grey | 38 | 622 |
| 16 | Sandstone, light grey, fine- to medium-grained; very thin-bedded; abundant carbonaceous streaks, partly covered | 32 | 584 |
| 15 | Sandstone, light grey, fine-grained, medium-bedded (1′); a few carbonaceous streaks | 17 | 552 |
| 14 | Sandstone, as unit 12 | 9 | 535 |
| 13 | Sandstone, light, grey to pinkish brown, medium-grained, medium-bedded (3″); weathers dark grey | 21 | 526 |
| 12 | Sandstone, light grey, medium-grained, very thin-bedded; abundant carbonaceous material gives a black bedding plane | 25 | 505 |
| 11 | Sandstone as below only irregular 4-5″ beds becoming 1-3″ higher up | 69 | 480 |
| 10 | Sandstone, medium brown, medium-grained, massive; weathers rusty brown to dark grey; a few carbonaceous streaks | 60 | 411 |
| 9 | Sandstone, light grey, medium-grained, thin-bedded (1-3″); grades up from black, silty shale; interbedded dark grey sandstone at base; carbonaceous streaks abundant | 51 | 351 |
| 8 | Sandstone, pale brown, medium-grained, medium- to thick-bedded (1-3′); weathers rusty brown | 24 | 300 |
| 7 | Sandstone, medium grey, fine- to medium-grained, thin-bedded (1-3″), weathers grey | 12 | 276 |

Section 3 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 6 | Shale, silty, black | 2 | 264 |
| 5 | Sandstone, light to medium grey, fine- to medium-grained; irregular 4-5′ blocky beds; weathers rusty brown on surface; fresh surface, pale brown | 19 | 262 |
| 4 | Sandstone, dark grey, fine-grained, abundant carbonaceous streaks; specks; rubbly brown weathering | 53 | 243 |
| 3 | Sandstone, pale brown, medium-grained; weathers brown | 2 | 190 |
| 2 | Sandstone, light grey, medium-grained, beds 4-6″ thick; abundant carbonaceous streaks; weathers yellow-brown | 32 | 188 |
| 1 | Sandstone, light grey, fine- to medium-grained, abundant carbonaceous partings; streaks, sandstone from base grades into a dark grey 'dirty' sandstone into a mudstone in centre part; back to light grey sandstone at top | 156 | 156 |
| | Underlying beds—Clausen Formation, unit 43. Contact conformable. | | |



64524-2—5½

## SECTION 4

North scarp face of Tlogotsho Plateau, in small creek forming part of headwaters system of east branch of Clausen Creek. About 12 miles south of Hot Spring on South Nahanni River and about 26 miles west of South Nahanni. Map 95F, lat. 61°08'N, long. 124°10'W. Helicopter landing on small spur provides access to creek where section was measured. Upper end of accessible section terminated by cliffs estimated to be 250′ below base of Mattson Formation. Lower end terminated by resistant, cliff-forming unit that forms minor escarpments in the low-lying land in front of the main scarp. This lower cliff, possibly equivalent to the Yohin Formation, is underlain by black shales, possibly of Devonian age. Descent of the lower cliff was not possible.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | FLETT FORMATION | | |
| | Overlying beds—Flett Formation | | |
| 22 | Limestone, grey argillaceous at base and thin-bedded; massive crinoidal beds higher up in unit | 120 | 1,360 |
| 21 | Shale, dark grey, calcareous and thin, argillaceous, fissile limestone | 90 | 1,240 |
| 20 | Sandstone, dark grey, weathering brown, thin-bedded; becomes an argillaceous siltstone in lower half of unit | 60 | 1,150 |
| 19 | Shale, black; weathers brown; with iron-stained, nodular mudstone layers; little or no limestone; becomes slightly silty at top and grades into base of unit 20 | 162 | 1,090 |
| 18 | Limestone, dark grey, fine-grained; thin-bedded (resistant) | 4 | 928 |
| 17 | Limestone, grey, crinoidal | 5 | 924 |
| 16 | Concealed interval, probably black shale and nobbly crinoidal limestone. *Amplexi-Zaphrentis* sp., *Spirifer* sp. A, *Brachythyris* cf. *subcardiformis* (Hall). GSC loc. 32707 | 64 | 919 |
| 15 | Limestone, dark grey, coarse-grained; crinoidal (resistant unit) | 4 | 855 |
| 14 | Shale, black; with scattered crinoidal limestone beds | 103 | 851 |
| 13 | Limestone, dark grey, crinoidal (resistant unit) | 3 | 748 |
| 12 | Shale, black; with beds of highly weathered dark grey, highly crinoidal limestone; weathers to a black rubble with numerous large crinoidal ossicles | 115 | 745 |
| 11 | Limestone, dark grey, fine-grained; blocky beds weathering to a platy talus. *Spirifer* cf. *rowleyi* Weller, *Reticularia* sp. GSC loc. 32701 | 18 | 630 |
| 10 | Mudstone, black and argillaceous limestone; some thin shales | 90 | 612 |
| 9 | Shale, non-calcareous, black, partly concealed | 68 | 522 |
| 8 | Limestone, grey, coarse-grained; crinoidal | 12 | 454 |
| 7 | Shale, slightly calcareous, black, with some thin iron-stained mudstone bands | 12 | 442 |
| 6 | Shale, calcareous, dark grey | 40 | 430 |

Section 4 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 5 | Limestone, thin-bedded, weathers to a platy talus, some shale interbeds. Talus contains *Echinoconchus alternatus* (Norwood and Pratten), *Cleiothyridina* cf. *obmaxima* McChesney, *Dielasma* sp. GSC loc. 32710 | 90 | 390 |
| 4 | Concealed interval; probably mainly thin-bedded limestone and shales, black or greenish black | 150 | 300 |
| 3 | Limestone, black or dark grey, fine-grained; thin-bedded, weathers to a platy talus; 2′ layer of black shale near base | 30 | 150 |
| 2 | Shale, black, and thin-bedded limestone | 60 | 120 |
| 1 | Limestone and black shale; upper part mainly limestone, lower part mainly shale | 60 | 60 |
| | Underlying beds—Clausen Formation, unit 10. | | |
| | CLAUSEN FORMATION | | |
| | Overlying beds—Flett Formation<br>Contact conformable | | |
| 10 | Mudstone, calcareous, black, thin-bedded (forms prominent dip-surface) | 50 | 615 |
| 9 | Concealed interval | 40 | 565 |
| 8 | Mudstone, as unit 10 | 25 | 525 |
| 7 | Shale, black and siltstone, thin-bedded, mainly concealed | 300 | 500 |
| 6 | Mudstone, calcareous, black; very soft. *Chonetes* sp. GSC loc. 32686 | 9 | 200 |
| 5 | Shale, calcareous, black | 30 | 191 |
| 4 | Mudstone, calcareous; forms resistant unit in shales | 8 | 161 |
| 3 | Shale, calcareous, black | 55 | 153 |
| 2 | Mudstone, calcareous, as unit 4 | 8 | 98 |
| 1 | Shale, calcareous, black | 90 | 90 |
| | YOHIN FORMATION? | | |
| | Limestone, argillaceous, dark grey, fine-grained; thin-bedded; top bed weathers light yellow; forms a prominent cliff with a middle recessive unit. Large nodular, calcareous 'reefoid' mass 5′ in diameter at upper contact. | | |

## SECTION 5

Bluefish Mountain, about 8 miles northwest of South Nahanni. Map 95G, lat. 61°06′N, long. 123°27′W. Access by helicopter from South Nahanni, camp site and helicopter landing in small open valley east of summit ridge. Bluefish Mountain consists of a series of east-facing scarps. The section can be most easily followed from the top, starting in the Flett Formation which forms the most westerly scarp, over the summit and down through the Clausen and Yohin Formations exposed on the southeast side. Exposure is eventually lost in dense scrub.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | YOHIN FORMATION? | | |
| | Overlying beds—Clausen Formation<br>Contact conformable | | |
| 4 | Limestone, grey, medium-grained; dense; with silty beds and beds of calcareous, silty, dark grey shale. *Productella* cf. *pyxidata* Hall, *Chonetes* sp., *Punctospirifer* sp., *Spirifer louisianensis*?, *Dielasma* sp. GSC loc. 32710 | 120 | |
| | This unit forms a prominent, yellowish weathering vertical cliff on the east side of the mountain and appears to be of variable thickness. | | |
| 3 | Shale, non-calcareous, black; paper thin; becomes very slightly calcareous towards the top with numerous thin sandstone beds in the upper 40 feet | 200 | |
| 2 | Limestone, argillaceous, fine-grained; thin-bedded and platy. Forms a single resistant unit in the shale cliff | 10 | |
| 1 | Shale, non-calcareous, dark grey; soft and with some nodular bands of dark grey, fine-grained, purplish brown mudstone; base concealed but similar beds probably continue downwards for about 200 feet to the edge of a tree covered ridge | 285 | |
| | Units 1-3 may be wholly or in part of Devonian age. | | |
| | CLAUSEN FORMATION | | |
| | Overlying beds—Flett Formation<br>Contact conformable | | |
| 7 | Shale, non-calcareous, black or dark grey | 175 | 506 |
| 6 | Siltstone, non-calcareous, grey or greenish grey; flaggy | 2 | 331 |
| | Units 5-7 inclusive form a resistant band in the cliff. | | |
| 5 | Sandstone, dark brown, medium-grained; with strong petroliferous odour | 2 | 329 |
| 4 | Shale, black, non-calcareous; with two thin sandstone beds | 5 | 327 |
| 3 | Siltstone, calcareous, grey | 1 | 322 |
| 2 | Limestone, slightly silty, grey; soft; fossil fragments | ½ | 321 |

Section 5 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 1 | Shale, non-calcareous or slightly calcareous; grey; scattered sandy layers, lower part concealed ..... | 320 | |
| | Forms a prominent dark coloured cliff. Underlying beds—Yohin Formation, unit 4. | | |
| | FLETT FORMATION | | |
| 40 | Limestone, grey, medium-grained; crinoidal, forms a series of 1' beds with coarser grained, fissile layers between them. Strike 47°; dip 28°W ..... | 12 | 761 |
| 39 | Limestone, grey, medium-grained; with irregular interbeds of thin-bedded, coarse-grained limestone; irregular biohermal bed at base, with abundant corals and some draping over biohermal masses. *Diphyphyllum* cf. *mutabile* Kelly, *Lithostrotion* (small cerioid species), *Kakwiphyllum* sp., *Syringopora* sp., *Spirifer* sp. A, *Spirifer* sp. B. GSC loc. 32709 ..... | 5 | 749 |
| 38 | Concealed interval ..... | 31 | 744 |
| 37 | Limestone, grey or brownish grey, fine-grained; thin-bedded; with much black chert in irregular beds; forms a small cliff ..... | 22 | 713 |
| 36 | Limestone, dark grey, medium-grained; medium-bedded; irregular and tends to have nodular appearance; thin-bedded, fissile layer near middle of unit ..... | 6 | 691 |
| 35 | Concealed interval; includes soft, medium-grained crinoidal limestone with swirl patterns ..... | 18 | 685 |
| 34 | Limestone, grey, medium-grained ..... | 11 | 667 |
| 33 | Concealed interval ..... | 16 | 656 |
| 32 | Limestone, grey, medium-grained; medium-bedded, some platy weathering interbeds ..... | 5 | 640 |
| 31 | Concealed interval ..... | 28 | 635 |
| 30 | Limestone, grey, medium-grained; slightly crinoidal; forms a small cliff. Talus from this unit and possibly from the concealed interval above yielded: *Kakwiphyllum* sp., *Amplexi-Zaphrentis* sp., *'Michelinia'* sp., *Dictyoclostus* sp., *Spirifer* sp. B. GSC loc. 32711 ..... | 22 | 607 |
| 29 | Concealed interval ..... | 28 | 585 |
| 28 | Limestone, slightly argillaceous, grey or brownish grey, medium-grained; massive but with some thin-bedded zones that are slightly silty. *Orthotetes* sp., productids, *Punctospirifer* sp., *Phillipsia* sp., small *Pentremites* sp. GSC loc. 32731 ..... | 22 | 557 |
| 27 | Concealed interval; includes some black shales and thin sandstones with black, non-calcareous, paper-thin shales at base; recessive. Talus from lower part yielded: *Platyrachella*? *rutherfordi* (Warren), *Spirifer* indet., *Camarotoechia* sp. GSC loc. 32681 | 300 | 535 |
| 26 | Limestone, grey, coarse-grained; crinoidal ..... | 1½ | 235 |
| 25 | Limestone, dark grey, argillaceous and calcareous shale. *Chonetes* sp., *Platyrachella*? cf. *rutherfordi* (Warren), *Mesoconularia* sp. GSC loc. 32704 ..... | 4 | 234 |

Section 5 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 24 | Limestone, light grey, very coarse-grained; crinoidal; massive bed at top and bottom of unit, separated by medium-bedded zone | 9 | 230 |
| 23 | Shale, calcareous, dark grey; many crinoid ossicles and shell fragments; some thin sandy layers | 4 | 221 |
| 22 | Sandstone, grey, medium-grained; irregularly bedded; weathers brown; some dirt layers and 'fucoids' | 2 | 217 |
| 21 | Shale, non-calcareous, black; paper thin but with some sandy layers | 5 | 215 |
| 20 | Sandstone, calcareous, greenish grey, medium-grained; irregularly bedded. *Leptaena* sp., *Streptorhynchus* sp., *Schellwienella* sp., *Platyrachella*? cf. *rutherfordi* (Warren). GSC loc. 32716 | 2 | 210 |
| 19 | Shale, non-calcareous, black; with thin layers of grey calcareous sandstone | 7 | 208 |
| 18 | Shale, non-calcareous, dark grey; some thin layers of grey calcareous sandstone; partly concealed | 50 | 201 |
| 17 | Sandstone, calcareous, dirty grey, medium-grained; massive | 5 | 151 |
| 16 | Sandstone, calcareous, grey, medium-grained. Strike 46°; dip 28°W. | 8 | 146 |
| 15 | Shale, non-calcareous, dark grey and thin-bedded sandstone | 17 | 138 |
| 14 | Sandstone, calcareous, greenish grey, thin-bedded; forms a rubbly cliff | 18 | 121 |
| 13 | Shale, non-calcareous, black; paper thin, some layers of orange weathering mudstone nodules; forms a dip-slope just below the summit of the mountain. *Spirifer* cf. *esplanadensis* Brown, *Spirifer* sp. and pelecypods from talus. GSC loc. 32722 | 20 | 103 |
| 12 | Sandstone, slightly calcareous, grey, medium-grained; with ferruginous band near top; forms top bed of main cliff east of summit | 2 | 83 |
| 11 | Shale, black, non-calcareous; paper thin | 13 | 81 |
| 10 | Sandstone, light buff-grey; medium-grained | 9 | 68 |
| 9 | Sandstone, calcareous, grey; medium-grained | 1 | 59 |
| 8 | Shale, non-calcareous, olive-grey; slightly silty | 1 | 58 |
| 7 | Limestone, grey, coarse-grained; crinoidal, slightly sandy; irregularly bedded | 2 | 57 |
| 6 | Concealed interval | 16 | 55 |
| 5 | Limestone, sandy, grey, medium-grained; massive but with thin laminations | 4 | 39 |
| 4 | Limestone, silty, grey, medium-grained; irregularly medium-bedded | 14 | 35 |
| 3 | Siltstone, calcareous, buff-grey; irregularly bedded with large round cobbles of calcareous siltstone, possibly an intra-formational conglomerate | 8 | 21 |
| 2 | Shale, slightly calcareous, grey | 9 | 13 |
| 1 | Limestone, grey, medium-grained; with layers of calcareous siltstone. *Syringopora* sp., *Schellwienella* sp., *Dictyoclostus* aff. *jasperensis* (Warren), *Punctospirifer* sp., '*Naticopsis*' sp. GSC loc. 32726 | 4 | 4 |
| | Underlying beds—Clausen Formation, unit 7. Contact conformable. | | |

## SECTION 6

Headwaters of Mattson Creek, west side of Liard Range. Map 95G, lat. 60°57′N, long. 123°55′W. The main section exposes most of the Mattson Formation and a part of the underlying Flett Formation. Some additional beds at the top of the Mattson Formation are exposed in a gully south of the main gap and are described as Section 6A.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | FLETT FORMATION | | |
| | Overlying beds—Mattson Formation | | |
| 10 | Partly concealed; includes orange weathering dolomite and thin-bedded dark shale | 80 | 416 |
| 9 | Limestone, grey, coarse-grained; crinoidal with interbedded black non-calcareous, fissile shale | 25 | 336 |
| 8 | Limestone, grey, coarse-grained; crinoidal, thick-bedded, grey to brown-grey weathering with irregular buff weathering layers of fine-grained, dolomitic limestone, cherty at top; fossil fragments | 36 | 311 |
| 7 | Limestone, grey to dark grey, medium- to coarse-grained; crinoidal, medium- to thick-bedded (2-3′), nodules and masses of grey; medium-grained chert—less chert in last 20′ | 75 | 275 |
| 6 | Limestone, dark grey, medium-grained; medium (2′) beds, minor dark grey chert nodules—small recrystallized colonial corals | 12 | 200 |
| 5 | Concealed interval | 113 | 188 |
| 4 | Limestone—one-foot beds as below with 6-8″ interbeds of very thin-bedded, argillaceous limestone | 7 | 75 |
| 3 | Limestone, dark grey, fine-grained; medium- to thick-bedded, light grey weathering, dark grey chert layers at top | 40 | 68 |
| 2 | Concealed interval | 11 | 27 |
| 1 | Limestone, dark grey, fine-grained; medium (1′) beds, a few brachiopod fragments and coiled gastropods | 16 | 16 |
| | Further exposures of Flett Formation concealed beneath talus. | | |
| | MATTSON FORMATION | | |
| | *Upper Member* | | |
| 135 | Sandstone, light grey; mainly concealed; approximate thickness | 50 | 3,141 |
| 134 | Sandstone, light grey with pale brown limonitic spots, medium-grained; thick-bedded | 7 | 3,091 |
| 133 | Concealed interval | 29 | 3,084 |
| 132 | Sandstone, calcareous, brown-grey, fine-grained | 2 | 3,055 |
| 131 | Concealed interval | 13 | 3,053 |
| 130 | Sandstone, dolomitic, light grey, fine-grained; thin-bedded | 13 | 3,040 |
| 129 | Limestone, arenaceous, white, medium-grained; thick-bedded | 11 | 3,027 |
| 128 | Concealed interval | 16 | 3,016 |

Section 6 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 127 | Limestone, grey, fine-grained at base becoming coarse-grained, crinoidal towards the top | 18 | 3,000 |
| 126 | Sandstone, dolomitic?, grey, fine-grained; grey weathering | 27 | 2,982 |
| 125 | Sandstone, white, medium-grained; brown weathering, a few crinoidal stems | 17 | 2,955 |
| 124 | Concealed interval | 85 | 2,938 |
| 123 | Sandstone, yellow-brown, medium-grained, brown weathering; massive | 20 | 2,853 |
| 122 | Sandstone, pale brown, medium- to coarse-grained; massive, contains some feldspar | 60 | 2,833 |
| 121 | Sandstone, pale brown, medium-grained; medium-bedded, brown weathering, white spots | 12 | 2,773 |
| 120 | Sandstone, light grey to pale brown, medium- to coarse-grained; massive | 29 | 2,761 |
| 119 | Sandstone, grey, fine-grained; brown weathering | 11 | 2,732 |
| 118 | Sandstone, light grey, medium-grained | 2 | 2,720 |
| 117 | Partly concealed—fine- to medium-grained, grey sandstone, buff weathering, a few small dark grey chert nodules | 16 | 2,718 |
| 116 | Concealed interval | 38 | 2,702 |
| 115 | Partly concealed; includes fine-grained, grey, dolomite, buff weathering | 16 | 2,664 |
| 114 | Sandstone, light grey, medium-grained; thick-bedded, brown-grey weathering, coarsely laminated | 28 | 2,658 |
| 113 | Concealed interval | 40 | 2,630 |
| 112 | Sandstone, light brown-grey, medium-grained; brown weathering | 5 | 2,590 |
| 111 | Concealed interval | 21 | 2,585 |
| 110 | Sandstone, light grey, medium-grained, medium-bedded | 7 | 2,563 |
| 109 | Concealed interval | 24 | 2,556 |
| 108 | Sandstone, dolomitic, grey, fine-grained; brown-grey weathering; partly concealed | 10 | 2,532 |
| 107 | Sandstone, pale brown, medium-grained; massive | 11 | 2,522 |
| 106 | Concealed interval | 65 | 2,511 |
| 105 | Sandstone, white, medium-grained; thick-bedded | 21 | 2,446 |
| 104 | Sandstone, grey, very fine-grained; thin irregular bedded | 15 | 2,424 |
| 103 | Dolomite, arenaceous, brown-grey, fine-grained; brown weathering | 7 | 2,409 |
| 102 | Concealed interval | 10 | 2,402 |
| 101 | Sandstone, pale brown, medium-grained; massive, grey weathering | 11 | 2,392 |
| 100 | Concealed interval | 26 | 2,381 |
| 99 | Sandstone, light grey with white specks, medium-grained; partly covered | 10 | 2,355 |
| 98 | Sandstone, pale brown to light grey, medium-grained; massive grey weathering | 25 | 2,345 |
| 97 | Sandstone, grey, fine- to medium-grained; thin-bedded becoming white, medium-bedded, in last 40′ | 63 | 2,320 |
| 96 | Shale, black, fissile, clay-ironstone concretions at top | 12 | 2,257 |
| 95 | Sandstone, white, medium-grained, thin- to medium-bedded | 26 | 2,245 |
| 94 | Sandstone, light grey, very thin, partly covered | 10 | 2,219 |

**Section 6** — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 93 | Sandstone, light grey to white, medium-grained; massive- to thick-bedded, medium-bedded towards top | 46 | 2,209 |
| 92 | Concealed interval | 6½ | 2,163 |
| 91 | Sandstone, light grey to white, medium-grained; thin to medium slightly irregular bedded | 13 | 2,157 |
| 90 | Concealed interval | 60 | 2,144 |
| 89 | Sandstone, calcareous, light brown to grey, medium-grained; medium-bedded | 3 | 2,084 |
| 88 | Concealed interval | 8 | 2,081 |
| 87 | Sandstone, light grey to white, fine-grained; medium-bedded | 11 | 2,073 |
| 86 | Concealed interval | 19 | 2,062 |
| 85 | Dolomite, arenaceous, grey, fine-grained; brown weathering; contains thick-shelled silicified brachiopod fragments. Shows current bedding | 24 | 2,043 |
| 84 | Limestone, grey, coarse-grained, fragmental; light grey weathering; fossil shell fragments and crinoid ossicles | 3 | 2,019 |
| 83 | Dolomite, dark grey, fine-grained; dark brown weathering, abundant bryozoans | 6½ | 2,016 |
| 82 | Limestone, grey, medium- to coarse-grained; rounded grains | 19 | 2,009 |
| 81 | Limestone, grey, fine-grained, medium-bedded. Shell fragments and *Spirifer* cf. *rockymontanus* Marcou | 5 | 1,990 |
| 80 | Sandstone, calcareous, grey, fine-grained; thick-bedded, grey weathering | 23 | 1,985 |
| 79 | Limestone, cryptograined; grey weathering at base then grey, medium-grained, fragmental at top. Rare fossil fragments | 2 | 1,962 |
| | *Middle Member* | | |
| 78 | Sandstone, yellow-grey, medium-grained; grey-buff weathering, a few broken thick-shelled brachiopods | 11 | 1,960 |
| 77 | Concealed interval | 3 | 1,949 |
| 76 | Sandstone, brown-grey, medium-grained; massive; brown-weathering, coarsely laminated | 15 | 1,946 |
| 75 | Sandstone, pale yellow-brown, medium-grained; soft, friable, small rounded balls | 18 | 1,931 |
| 74 | Sandstone, slightly micaceous, light grey, very fine-grained; thin-bedded | 8 | 1,913 |
| 73 | Sandstone and shale | 2 | 1,904 |
| 72 | Concealed interval | 22 | 1,902 |
| 71 | Shale, black, with interbedded sandstone near top | 18 | 1,880 |
| 70 | Sandstone, grey, fine-grained, thin-bedded; irregular curved carbonaceous streaks. Some dark grey, medium-grained carbonaceous sandstone at top | 24 | 1,862 |
| 69 | Concealed interval | 10 | 1,838 |
| 68 | Sandstone, grey, medium-grained; rusty brown weathering | 6 | 1,828 |
| 67 | Concealed interval | 14 | 1,822 |

Section 6 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 66 | Sandstone, grey to brown, medium-grained; medium-bedded, brown weathering, partly concealed | 27 | 1,808 |
| 65 | Sandstone, massive, quite similar underlying unit. Crossbedded in part with some carbonaceous material | 60 | 1,781 |
| 64 | Sandstone, white, fine- to medium-grained; medium-bedded, much harder than massive underlying unit below | 35 | 1,721 |
| 63 | Sandstone, pale brown, medium- to coarse-grained; massive, grey weathering, coarsely laminated | 37 | 1,686 |
| 62 | Concealed interval | 7 | 1,649 |
| 61 | Sandstone, dark grey, thin irregular bedded, dirty; becoming light grey; mainly fine-grained with many irregular carbonaceous laminations towards top | 20 | 1,642 |
| 60 | Partly concealed—thin-bedded sandstone and shale | 26 | 1,621 |
| 59 | Sandstone, grey, medium-grained; irregular medium-bedded, forms resistant unit | 14 | 1,595 |
| 58 | Sandstone, dark grey, medium-grained; medium-(4-5″) bedded, abundant mud-filled worm? holes | 4 | 1,581 |
| 57 | Concealed interval—traces black shale and thin-bedded sandstone | 33 | 1,577 |
| 56 | Sandstone, light grey, fine- to medium-grained; thin- to medium-bedded. Forms prominent small cliff | 21 | 1,544 |
| 55 | Shale, arenaceous, black, with very thin sandstone beds at top—recessive unit | 28 | 1,523 |
| 54 | Sandstone, brown-grey, medium-grained; thin-bedded, buff weathering | 2 | 1,495 |
| 53 | Concealed interval | 4½ | 1,493 |
| 52 | Shale at base grading to very fine-grained, grey sandstone and shale, upper 20′ medium-bedded, medium-grained, grey sandstone, dip-slope at top | 35 | 1,489 |
| 51 | Sandstone, light grey to pale brown, fine- to medium-grained; thin-bedded at base becoming medium- to thick-bedded | 45 | 1,454 |
| 50 | Sandstone, similar to overlying unit | 33 | 1,409 |
| 49 | Shale, black with very thin-bedded sandstone | 4 | 1,376 |
| 48 | Sandstone, light grey to white, medium- to coarse-grained; massive, friable in part, some secondary euhedral overgrowths | 208 | 1,372 |
| | *Lower Member* | | |
| 47 | Sandstone, light grey, fine- to medium-grained; thin-bedded, carbonaceous streaks | 39 | 1,164 |
| 46 | Sandstone, dark grey, fine-grained; irregular thin-bedded with carbonaceous streaks, interbedded shale at base | 18 | 1,125 |
| 45 | Shale, black, fissile | 4 | 1,107 |
| 44 | Sandstone, yellowish brown, medium-grained, thick-bedded | 15 | 1,103 |
| 43 | Shale at base grading upwards to very fine-grained, grey sandstone and shale with grey, fine-grained sandstone at top, carbonaceous streaks | 35 | 1,088 |

Section 6 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 42 | Sandstone, grey with some limonitic stain, medium-grained, rusty brown weathering, pyrite | 2 | 1,053 |
| 41 | Shale, black | 13 | 1,051 |
| 40 | Sandstone, dark grey, medium-grained; rusty brown weathering, thin irregular bedded, abundant carbonaceous streaks and partings | 10 | 1,038 |
| 39 | Sandstone, light grey, medium-grained; thin-bedded at base becoming thick-bedded with limonite spots, top of dip-slope | 23 | 1,028 |
| 38 | Partly concealed with traces of black shale and very thin-bedded sandstone | 44 | 1,005 |
| 37 | Sandstone, light grey, fine-grained, medium- to thin-bedded, white weathering; very fine carbonaceous material | 18 | 961 |
| 36 | Sandstone, grey-brown, medium-grained; thick-bedded, brown weathering; crossbedding in part, not as resistant as underlying units | 18 | 943 |
| 35 | Sandstone, light grey, fine-grained; thin- to medium-bedded, dark grey weathering | 11 | 925 |
| 34 | Sandstone, as above but thin- to very thin-bedded, abundant carbonaceous layers | 10 | 914 |
| 33 | Shale, black, fissile | 4 | 904 |
| 32 | Sandstone, dark grey (due to fine carbonaceous material), medium-grained; irregular thin-bedded; grooving, and flow casts, abundant carbonaceous partings | 8 | 900 |
| 31 | Sandstone, light brown-grey, fine-grained; medium irregular bedded, carbonaceous streaks | 10 | 892 |
| 30 | Shale, black with 50% light grey, very thin-bedded sandstone towards top, recessive | 13 | 882 |
| 29 | Sandstone, yellow-brown, medium-grained; medium- to thick-bedded; rusty brown weathering, small wood fragments | 9 | 868 |
| 28 | Shale, black at base becoming thin, very irregular bedded, fine-grained, light grey sandstone with 20% interbedded shale, very thin ($\frac{1}{8}$-$\frac{1}{16}$") *coal* layers | 49 | 859 |
| 27 | Sandstone, light grey to white, fine-grained; thin irregular bedding, abundant carbonaceous streaks | 33 | 810 |
| 26 | Sandstone, medium grey, fine-grained; medium-bedded; rusty brown weathering, greenish tinge in weathering | 25 | 777 |
| 25 | Sandstone, medium grey, fine-grained; thin- to very thin-bedded; carbonaceous streaks. Recessive unit | 23 | 752 |
| 24 | Sandstone, light grey, fine-grained; medium-bedded | 9 | 729 |
| 23 | Concealed interval | 2 | 720 |
| 22 | Sandstone, grey, fine- to medium-grained; medium-bedded, ferruginous cement in part | 16 | 718 |
| 21 | Sandstone, light grey to light brown-grey, fine- to medium-grained; mainly thin-bedded; with carbonaceous streaks and partings | 40 | 702 |
| 20 | Sandstone, fine-grained, mainly alternating very thin-bedded, with abundant carbonaceous layers and fine- to medium-grained, medium-bedded sandstone. Worm (?) burrows | 48 | 662 |

Section 6 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 19 | Sandstone, light to medium grey, fine-grained, medium-bedded; carbonaceous streaks | 24 | 614 |
| 18 | Concealed interval. Some trace of black shale | 12 | 590 |
| 17 | Sandstone, medium grey, medium-grained; some limonite staining, cement, partly concealed | 7 | 578 |
| 16 | Concealed interval | 7 | 571 |
| 15 | Sandstone, light to medium grey, thin- to medium-bedded, rusty brown weathering | 24 | 564 |
| 14 | Sandstone, light grey, medium-grained; thin-bedded, upper 2′ has abundant carbonaceous, micaceous partings | 16 | 540 |
| 13 | Sandstone, light grey, fine-grained, thin- to medium-bedded | 44 | 524 |
| 12 | Sandstone, grey, fine-grained; very thin-bedded; abundant carbonaceous material on bedding plane | 24 | 480 |
| 11 | Sandstone, grey, medium-grained; medium-bedded; some fine carbonaceous material | 10 | 456 |
| 10 | Sandstone, light grey, medium-grained; medium-bedded; rusty brown weathering | 5 | 446 |
| 9 | Shale, black with 50% interbedded sandstone grading upwards into thin-bedded, fine-grained, light grey sandstone, carbonaceous | 11 | 441 |
| 8 | Sandstone, very pale brown, fine-grained; thin-bedded | 13 | 430 |
| 7 | Sandstone, as below, only massive | 17 | 417 |
| 6 | Sandstone, light brown-grey with pinkish tinge in part, medium-grained; medium- to thin-bedded, dark grey weathering, a few carbonaceous streaks | 132 | 400 |
| 5 | Sandstone—units consist of 10-20′ cliffs of medium-bedded, fine- to medium-grained, light grey sandstone separated by 5′ recessive units of thin-bedded, highly carbonaceous sandstone, at top of each cliff there is 1-2′ ferruginous, rusty brown sandstone | 67 | 268 |
| 4 | Sandstone, light grey, medium-grained; thin-bedded; carbonaceous streaks | 9 | 201 |
| 3 | Sandstone, white to light grey, medium-grained; medium-bedded | 73 | 192 |
| 2 | Sandstone, as above, but more thinly bedded | 72 | 119 |
| 1 | Concealed by sandstone talus | 47 | 47 |
| | Underlying beds—Flett Formation, unit 10. Contact conformable. | | |

## SECTION 6A

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | MATTSON FORMATION | | |
| 54 | Sandstone, grey, medium- to coarse-grained; thick-bedded; jointed, forms large, dark grey weathering dip-slope | 10 | 776 |
| 53 | Sandstone, light grey, medium-grained; many irregular worm? trails; thick-bedded but irregular jointing gives impression of being thin-bedded | 22 | 766 |
| 52 | Mudstone, dark grey, small pyrite nodules, some very fine-grained, dark grey sandstone at top, recessive | 21 | 744 |
| 51 | Sandstone, grey, medium-grained; conglomeratic with chert pebbles up to 1-2" in upper foot | 2 | 723 |
| 50 | Sandstone, grey, medium-grained; medium-bedded | 2 | 721 |
| 49 | Sandstone, brown, medium-grained; medium-bedded; jointed on bed face, becomes white, medium- to coarse-grained towards base, small-scale cross-bedding | 65 | 719 |
| 48 | Shale, very dark brownish grey to black, fissile, not as hard and brittle as shale in lower part of the Mattson Formation | 32 | 654 |
| 47 | Sandstone, white, medium-grained; medium-bedded | 4 | 622 |
| 46 | Shale, dolomitic, greenish grey, some very fine-grained, dolomitic sandstone | 2 | 618 |
| 45 | Sandstone, very pale brown, medium-grained, 3 inches of granular conglomerate | 2 | 616 |
| 44 | Interbedded green shale and thin-bedded greenish grey, medium-grained sandstone | 58 | 671 |
| 43 | Shale, grey, very thin-bedded with 10% grey, very fine-grained, sandstone | 24 | 603 |
| 42 | Sandstone, light grey, fine-grained; brown weathering and laminated at base, a few fossil fragments | 18 | 579 |
| 41 | Sandstone, argillaceous, dark grey, medium-grained; very thin-bedded | 3 | 561 |
| 40 | Sandstone, white, medium-grained; medium-bedded, a few uncollectable brachiopods | 22 | 559 |
| 39 | Sandstone, white, fine-grained and grey shale | 4 | 537 |
| 38 | Sandstone, light grey, medium-grained | 1 | 533 |
| 37 | Shale, brownish grey | 1 | 532 |
| 36 | Sandstone, light grey to white, medium-grained, crossbedded | 38 | 531 |
| 35 | Sandstone, greyish brown, fine- to medium-grained | 5 | 493 |
| 34 | Sandstone, white to light grey, medium- to coarse-grained; a foot of shale 5 feet from top, medium- to thick-bedded | 38 | 488 |
| 33 | Shale, silty, black, very thin-bedded | 1½ | 450 |
| 32 | Sandstone, light grey and pale brown, medium- to coarse-grained, massive to thick-bedded, large overhang at base | 35 | 448 |
| 31 | Shale, non-calcareous, dark grey | 7 | 413 |
| 30 | Sandstone, dark grey, fine-grained; brown weathering | 13 | 406 |
| 29 | Shale, very dark grey, very thin-bedded, poorly exposed, a few small rounded brachiopods—not collectable | 5 | 393 |
| 28 | Shale, thin-bedded, partly concealed | 7 | 388 |

Section 6A — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 27 | Concealed interval | 10 | 381 |
| 26 | Dolomite, arenaceous, grey, fine-grained; buff weathering | 3 | 371 |
| 25 | Sandstone, light grey, medium-grained | 2½ | 368 |
| 24 | Concealed interval | 9 | 365 |
| 23 | Sandstone, pale brown, medium-grained | 10 | 356 |
| 22 | Concealed interval | 15 | 346 |
| 21 | Sandstone, white, medium- to coarse-grained; medium-bedded | 12 | 331 |
| 20 | Concealed interval | 30 | 319 |
| 19 | Sandstone, grey, medium-grained; dark brown weathering | 5 | 289 |
| 18 | Concealed interval | 29 | 284 |
| 17 | Sandstone, slightly calcareous, pale brown, medium-grained; medium-bedded | 42 | 255 |
| 16 | Shale, dark grey, thin-bedded | 4 | 213 |
| 15 | Sandstone, grey, fine-grained; grey weathering | 2 | 209 |
| 14 | Concealed interval | 7 | 207 |
| 13 | Sandstone, brown, medium-grained; medium-bedded, brown weathering, calcareous at top | 10 | 200 |
| 12 | Concealed interval | 17 | 190 |
| 11 | Sandstone, calcareous, light grey, medium-grained | 7 | 173 |
| 10 | Concealed interval | 26 | 166 |
| 9 | Sandstone, pale brown, medium-grained; medium-bedded | 16 | 140 |
| 8 | Concealed interval | 8 | 124 |
| 7 | Sandstone, calcareous, light grey, coarse-grained | 8 | 116 |
| 6 | Limestone, grey, medium-grained | 8 | 108 |
| 5 | Limestone, light grey, medium-grained, some fragmentary silicified brachiopods and crinoidal stems | 12 | 100 |
| 4 | Limestone, light grey, coarse-grained, crinoidal, thick- to medium-bedded | 29 | 88 |
| 3 | Limestone, grey, fine-grained, very cherty | 10 | 59 |
| 2 | Concealed interval | 30 | 49 |
| 1 | Sandstone, calcareous, brown to grey, fine-grained | 19 | 19 |

Units 3-6 of Section 6A may be equivalent to units 127-129 of Section 6.

## SECTION 7

East side of Liard Range, about 8 miles west of Flett Rapids on Liard River. Map 95B, lat. 60°42′N, long. 123°47′W. Access by helicopter via Flett Creek. Helicopter landing and camp site on spur in front of main cliffs. Section measured directly on the scarp face (*see* Pl. IIA), which consists of carbonate rocks of the Flett Formation, up to the summit ridge consisting of sandstones of the Mattson Formation. Some minor lateral changes occur in the Flett Formation where individual limestone beds may pinch in and out along strike. A series of normal faults parallel with the scarp face repeat several of the lowest exposed beds and a continuous section of the lower part of the Mississippian sequence is not exposed.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | MATTSON FORMATION | | |
| 27 | Sandstone, grey, medium-grained; massive, thinner bedded near base; top of unit forms a prominent dip-slope running down to a col on the west side of summit ridge | 50 | 646 |
| 26 | Shale, non-calcareous, black; paper thin with some thin sandy layers | 2 | 596 |
| 25 | Sandstone, light grey, medium-grained; medium-bedded | 14 | 594 |
| 24 | Shale, sandy, grey or dark grey | 6 | 580 |
| 23 | Sandstone, light grey, medium-grained; with many black inclusions | 11 | 574 |
| 22 | Sandstone, brown, medium-grained; thin-bedded | 4 | 563 |
| 21 | Sandstone, light brown, medium-grained; many dark speckles; medium-bedded | 22 | 559 |
| 20 | Sandstone, reddish brown, fine-grained; thin-bedded; ferruginous | 4 | 537 |
| 19 | Sandstone, light grey, medium-grained; with many thin shaly partings | 7 | 533 |
| 18 | Sandstone, buff, coarse-grained; weathers to a rubbly talus with 'plant' fragments | 1 | 526 |
| 17 | Sandstone, brown, medium-grained; loosely cemented; contains pelecypod fragments | 2 | 525 |
| 16 | Concealed interval | 10 | 523 |
| 15 | Sandstone, brown, medium-grained; medium-bedded; weathers dark brown; 'plant' fragments | 3 | 513 |
| 14 | Sandstones, light grey, coarse-grained; almost pure orthoquartzite, forms a series of jagged pinnacles along summit of ridge | 45 | 510 |
| 13 | Sandstone, grey, medium-grained; forms a series of medium-bedded to massive beds | 60 | 465 |
| 12 | Sandstone, pale brown, fine-grained; irregularly medium- to thin-bedded with brown, slightly micaceous layers | 5 | 405 |
| 11 | Sandstone, grey, medium-grained | 3 | 400 |
| 10 | Shale, non-calcareous, black; paper thin; with red weathering mudstone concretions, partly concealed | 25 | 397 |



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## Section 7 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 9 | Sandstone, brownish grey, medium-grained; medium-bedded, contains brown twig-like inclusions; forms a series of terraces leading to summit of Liard Range | 85 | 372 |
| 8 | Shale, non-calcareous, black; paper thin; with red weathering silty mudstone nodules | 10 | 287 |
| 7 | Siltstone, calcareous, grey, medium-grained; weathers brown; contains crinoid fragments | 7 | 277 |
| 6 | Concealed interval; includes scattered outcrops of medium-bedded sandstone and some orange weathering beds | 79 | 270 |
| 5 | Sandstone, light brown, medium-grained; massive | 18 | 191 |
| 4 | Concealed interval; probably mainly grey, coarse-grained sandstone | 90 | 173 |
| 3 | Sandstone, light grey, medium-grained | 33 | 83 |
| 2 | Concealed interval | 18 | 50 |
| 1 | Sandstone, pinkish buff, medium-grained; medium-bedded; forms the lowest sandstone cliff. Base of unit not exposed | 7 | 32 |
| | Concealed interval, mainly sandstone | 25 | 25 |
| | Underlying beds—Flett Formation, unit 35. | | |
| | FLETT FORMATION | | |
| 35 | Partly concealed; includes thin bands of thin-bedded, yellow weathering silty dolomite; thin bands of grey silty shale and some loosely cemented crinoidal limestone near base. *Dictyoclostus* cf. *parvus* (Meek and Worthen), *Diaphragmus*? sp., *Spirifer* sp., *Pentremites* sp. GSC loc. 32719 | 80 | 909 |
| 34 | Limestone, grey, medium-grained; with some thin-bedded argillaceous layers and some thin beds of grey crinoidal limestone | 45 | 829 |
| 33 | Limestone, light grey, medium-grained; with some irregular bands of black chert; contains *Syringopora* sp. | 20 | 784 |
| 32 | Limestone, argillaceous, dark grey, medium-grained; thin-bedded | 4 | 764 |
| 31 | Limestone, grey, medium- to coarse-grained; irregularly medium-bedded with scattered black chert masses and thin argillaceous partings. *Streptorhynchus* sp., *Spirifer* cf. *pellaensis* Weller, *Cleiothyridina*—large species, fragmentary. GSC loc. 32714 | 21 | 760 |
| 30 | Concealed interval | 9 | 739 |
| 29 | Limestone, grey, medium-grained; with thin weathering interbeds of slightly silty limestone and scattered black chert | 5 | 730 |
| 28 | Concealed interval; probably mainly thin-bedded limestone | 60 | 725 |
| 27 | Limestone, dark grey, fine-grained; interbedded with chert bands and thin-bedded platy limestone; forms a series of 1′ terraces | 26 | 665 |
| 26 | Concealed interval | 22 | 639 |
| 25 | Limestone, grey, medium- to fine-grained; with several bands of black chert | 4 | 617 |

Section 7 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 24 | Limestone, greyish buff, coarse-grained; crinoidal .... | 8 | 613 |
| 23 | Limestone, grey, medium-grained; weathers buff, with thin rubbly layers alternating with dense 1-2′ beds | 34 | 605 |
| 22 | Concealed interval. Talus from this interval yielded *Amplexi-Zaphrentis* cf. *enniskellini* (Lewis), *Diphyphyllum* sp., *Syringopora* sp., *Orthotetes* aff. *keokuk* (Hall), *Dictyoclostus* aff. *altonensis* (Norwood and Pratten), *Dictyoclostus* sp., *Spirifer* sp. A, *Spirifer* sp. B, *Brachythyris* cf. *subcardiformis*? Hall, *Dimegelasma* sp. A, *Athyris*? sp., *Torynifer* cf. *salemensis* (Weller), *Eumetria* sp., *Composita* sp., *Dielasma* sp., *Camarotoechia* aff. *purduei* Girty, *Naticopsis* sp., *Allorisma*? sp. GSC loc. 32675 ..... | 45 | 571 |
| 21 | Limestone, dark grey, medium-grained; with some thin platy bands ..... | 18 | 526 |
| 20 | Concealed interval ..... | 90 | 508 |
| 19 | Limestone, dark grey, medium-grained ..... | 11 | 418 |
| 18 | Concealed interval ..... | 17 | 407 |
| 17 | Limestone, grey, fine-grained; slightly silty, very dense with sub-conchoidal fracture; interbedded with layers of thin-bedded, argillaceous limestone, giving whole unit a banded appearance ..... | 31 | 390 |
| 16 | Limestone, grey, medium-grained; forms a series of 1′ terraces ..... | 13 | 359 |
| 15 | Limestone, dark grey, coarse-grained; crinoidal ..... | 4½ | 346 |
| 14 | Limestone, dark grey, fine-grained; with thin-bedded argillaceous partings separating 1-2′ beds ..... | 34 | 341 |
| 13 | Limestone, dark grey, medium-grained, crinoidal .... | 2 | 307 |
| 12 | Limestone, dark grey, fine-grained; with thin-bedded argillaceous limestone layers separating 1′ beds | 34 | 305 |
| 11 | Concealed interval ..... | 13 | 271 |
| 10 | Limestone, argillaceous, slightly silty, black; thin-bedded; weathers brown ..... | 19 | 258 |
| 9 | Concealed interval ..... | 80 | 239 |
| 8 | Limestone, grey or brownish grey, coarse-grained; crinoidal, soft and rubbly weathering; partly concealed. *Strophalosia*? sp., *Rhipidomella* cf. *missouriensis* (Swallow), *Spirifer* aff. *rowleyi* Weller, *Punctospirifer* sp. GSC loc. 32718 ..... | 18 | 159 |
| 7 | Limestone, light grey, medium-grained; medium-bedded; scattered black chert masses. *Chonetes* cf. *burlingtonensis* Weller, *Echinoconchus* aff. *alternatus* (Norwood and Pratten), *Schellwienella* sp., *Spirifer* aff. *vernonensis* Swallow, *Spirifer logani* Weller, *Spirifer* sp. GSC loc. 32676 ..... | 8 | 141 |
| 6 | Limestone, dark grey, fine-grained; platy; weathers buff. *Leptaena* sp. A, *Chonetes* sp., *Rhipidomella diminutiva* Rowley, *Dictyoclostus burlingtonensis* (Hall), *'Leiorhynchus'* sp., *Phillipsia* sp. ..... | 20 | 133 |
| 5 | Concealed interval ..... | 20 | 113 |



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Section 7 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 4 | Limestone, argillaceous, grey, fine-grained; thin-bedded, irregularly platy. *Leptaena* sp. A, *Chonetes* cf. *burlingtonensis* Weller, *Rhipidomella* cf. *diminutiva* Rowley, *Dictyoclostus* cf. *burlingtonensis* (Hall), *Spirifer* sp., *Spirifer* cf. *rowleyi* Weller, *Dielasma* sp., *Phillipsia* sp. GSC loc. 32729 | 2 | 93 |
| 3 | Limestone, slightly silty, dark grey, fine-grained; medium-bedded; weathers to a blocky yellow-coloured talus | 19 | 91 |
| 2 | Limestone, argillaceous, dark grey, medium-grained; some thin silty layers; finely laminated; forms a group of massive blocky beds, some thin shaly partings; weathers yellowish brown | 12 | 72 |
| 1 | Limestone, argillaceous, medium-grained; thin-bedded, soft; with thin bands of hard, calcareous siltstone; weathers to a thin, almost shaly talus. Strike 128°; dip 38°W | 35 | 60 |
| | Base concealed, probably continues for 25′ and is then cut off by a normal fault which repeats unit 7 | 25 | 25 |

## SECTION 8

West side of Kotaneelee Range, south of Tlogotsho Plateau near Etanda Lakes at the divide between headwaters of Jackfish and Kotaneelee Rivers. Map 95C, lat. 60°50'N, long. 124°20'W. Access by helicopter from South Nahanni via Jackfish River valley. Camp site and helicopter landing on wide grassy terrace immediately opposite a prominent cirque on west side of valley. Base of section in deep creek at south end of terrace, section continues up on to the open hillside with good continuous exposure in a series of deeply incised gullies (*see* Pl. IIB). Sandstones of Mattson Formation form the cliffs at the summit of the ridge and sweep down in a series of dip-slopes into the Kotaneelee Valley on the east side of the range.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | ETANDA FORMATION | | |
| | (Type Section) | | |
| | Overlying beds—Mattson Formation | | |
| 43 | Shale, non-calcareous and siltstone, black, thin-bedded, quartzose; weathers to a black almost shaly talus | 345 | 2,302 |
| 42 | Sandstone, dark grey, medium-grained | 2 | 1,957 |
| 41 | Siltstone, non-calcareous, black, thin-bedded; weathers to a shaly talus | 60 | 1,955 |
| 40 | Sandstone, dark grey, medium-grained and siltstone, thin-bedded; forms a resistant group of beds approximately half sandstone and half siltstone in ½-1' beds. Dip 20°E; strike 17° | 14 | 1,895 |
| 39 | Shale, non-calcareous, black with two thin, brown weathering sandstone bands | 40 | 1,883 |
| 38 | Sandstone, quartzose, greyish orange, medium-grained; well-rounded grains with some interstitial limonite | 6 | 1,841 |
| 37 | Shale, non-calcareous, black and siltstone with scattered nodular bands of yellow weathering, non-calcareous black mudstone; weathers to a thin shaly talus but bed could be massive given the right altitude or as recovered from a drill-core. Black chert bands rare | 470 | 1,835 |
| 36 | Siltstone, calcareous, dark grey; grades upwards into a blocky, dense, silty limestone | 25 | 1,365 |
| 35 | Siltstone, non-calcareous, black, thin-bedded; and shale, non-calcareous, black | 28 | 1,340 |
| 34 | Siltstone, slightly calcareous, dark grey, thin-bedded; laminated and with some thin bands of fine-grained sandstone | 30 | 1,312 |
| 33 | Siltstone and shale, similar to unit 35 | 14 | 1,282 |
| 32 | Siltstone, similar to unit 35 | 30 | 1,268 |
| 31 | Shale, non-calcareous, black; with some thin bands of dark grey siltstone | 120 | 1,238 |
| 30 | Siltstone, slightly calcareous, dark grey; regularly laminated; medium-bedded | 12 | 1,118 |
| 29 | Sandstone, grey, medium- to fine-grained | 4 | 1,106 |
| 28 | Shale, non-calcareous, black; paper thin; some layers of non-calcareous, black mudstone nodules | 95 | 1,102 |

Section 8 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 27 | Siltstone, non-calcareous, dark grey; irregularly medium-bedded, forms resistant unit | 2 | 1,007 |
| 26 | Shale, non-calcareous, black; as unit 28 | 255 | 1,005 |
| 25 | Mudstone, non-calcareous; weathers to a blocky talus | 4 | 750 |
| 24 | Shale, non-calcareous, black; as unit 28 | 37 | 746 |
| 23 | Shale, non-calcareous, black with bands of dark grey, slightly calcareous siltstone; siltstone weathers dark yellowish orange and is thinly interbedded with the shale giving the unit a pronounced striped appearance. *Camarotoechia* sp., *Spirifer* cf. *pellaensis* Weller, *Leiorhynchus* cf. *carboniferum* Girty. GSC loc. 32670 | 23 | 709 |
| 22 | Shale, non-calcareous, black; as unit 28 | 87 | 686 |
| 21 | Siltstone, calcareous, black, fine-grained; laminated but forms a single massive bed; weathers yellowish brown and may be slightly dolomitic | 2 | 599 |
| 20 | Shale, non-calcareous, black; paper thin; as unit 28 | 211 | 597 |
| 19 | Shale, non-calcareous, black; with thinly laminated layers of calcareous siltstone | 22 | 386 |
| 18 | Siltstone, slightly calcareous, dark grey; finely laminated | 1½ | 364 |
| 17 | Shale, non-calcareous, black; with some thin layers of grey, slightly calcareous siltstone | 23 | 362 |
| 16 | Sandstone, slightly calcareous, grey, medium-grained; weathers yellow | 12 | 339 |
| 15 | Mudstone, calcareous, dark grey; thin-bedded, soft; with some bands of calcareous siltstone | 10 | 327 |
| 14 | Siltstone, calcareous, grey, laminated | 4 | 317 |
| 13 | Concealed interval; mainly calcareous, dark grey siltstone with some black non-calcareous shale at base | 63 | 313 |
| 12 | Siltstone, calcareous, grey, fine-grained; weathers orange-yellow, massive. Units 9-12 form a prominent small cliff | 4 | 250 |
| 11 | Siltstone, calcareous, dark grey; thin-bedded. Dip 31°E; strike 15° | 14 | 246 |
| 10 | Siltstone, calcareous, dark grey; thin-bedded; with some shaly intervals, only slightly calcareous. *Dictyoclostus* cf. *burlingtonensis* (Hall), *Brachythyris* sp., *Spirifer* cf. *keokuk* (Hall), *Camarotoechia* sp. GSC loc. 32688 | 42 | 232 |
| 9 | Siltstone, slightly dolomitic, dark grey, fine-grained; weathers yellowish orange; massive with subconchoidal fracture | 5 | 190 |
| 8 | Siltstone, non-calcareous, dark grey or black; thin-bedded; siliceous | 1 | 185 |
| 7 | Shale, non-calcareous, black; paper thin | ¾ | 184 |
| 6 | Siltstone, non-calcareous, dark grey; irregularly thin-bedded | 3 | 183 |
| 5 | Partly concealed; some shale as unit 7 at base | 32 | 180 |
| 4 | Limestone, silty, dark grey, fine-grained; weathers brownish grey; rare casts of pelecypods | 19 | 148 |
| 3 | Dolomite, silty, dark grey, medium-grained; weathers orange; dense, with subconchoidal fracture | 2 | 129 |

**Section 8 — *concluded***

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 2 | Concealed interval; probably includes thin-bedded, grey, calcareous siltstones | 107 | 127 |
| 1 | Siltstone, calcareous, grey; thin-bedded. Exposure intermittent for 50 feet below this point and then ceases | 20 | 20 |
| | MATTSON FORMATION | | |
| 15 | Sandstone, grey, medium- to coarse-grained; weathers grey, massive | 50 | 1,116 |
| 14 | Concealed interval; mainly thin-bedded sandstone. Dip 20°E; strike 14° | 75 | 1,066 |
| 13 | Sandstone, grey, medium-grained; quartzose; weathers light brown; with black 'rootlet'-like marks and black filled cavities; thin-bedded; forms a prominent small cliff | 130 | 991 |
| 12 | Concealed interval | 90 | 861 |
| 11 | Sandstone, pale yellowish orange, medium-grained; siliceous cement; very dense and massive; forms a prominent cliff | 175 | 771 |
| 10 | Concealed interval; includes some black, non-calcareous, paper-thin shale | 280 | 596 |
| 9 | Sandstone, grey, medium-grained; thin-bedded, weathers pinkish grey; much 'carbonaceous' speckling; some worm tracks | 65 | 316 |
| 8 | Sandstone, light brownish grey; medium-grained; with carbonaceous mottlings: medium-bedded | 106 | 251 |
| 7 | Concealed interval | 6 | 145 |
| 6 | Sandstone, grey, medium-grained; medium-bedded; very dense | 15 | 139 |
| 5 | Concealed interval | 6 | 124 |
| 4 | Sandstone, black, coarse-grained; loosely cemented, weathers to a rough yellowish surface; massive; minor amounts of feldspar | 18 | 118 |
| 3 | Sandstone and sandy shale, black or dark grey; becomes sandier upwards and changes gradually from a recessive to a resistant unit | 40 | 100 |
| 2 | Sandstone, grey, medium-grained; weathers brown; forms a small cliff, the lowest of the main cliff-forming units of the upper part of the mountain | 20 | 60 |
| 1 | Sandstone, dark grey, medium- to fine-grained; thin-bedded; becomes less thin-bedded towards the top | 40 | 40 |
| | Underlying beds—Etanda Formation, type section. | | |

## SECTION 9

North side of gap in Kotaneelee Range where the range is crossed by Kotaneelee River, about 36 miles northwest of Fort Liard. Map 95C, lat. 60°36′N, long. 124°13′W. Access by helicopter from Fort Liard via Fisherman Lake and Kotaneelee Valley. Base of section in a small creek where black shales of Etanda Formation are prominently exposed; base of formation not exposed and probably truncated by faulting. Good exposures continue up into Mattson Formation which is exposed in a series of gently east-dipping scarps on both sides of the valley; much of the formation, however, is not readily accessible. Chert cliffs of the Fantasque Formation form a deep canyon at the east end of the valley (see Pl. IVB).

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | ETANDA FORMATION | | |
| | Overlying beds—Mattson Formation | | |
| 41 | Concealed interval | 95 | 1,959 |
| 40 | Shale, non-calcareous, black; paper thin; with several bands of highly weathered brown sandstone near base; main mass of shale has nodular bands of dark grey, fine-grained ferruginous mudstone at about 7′ intervals, each approximately ½-1′ thick, thinner bands occur irregularly between them, all these nodular bands weather light yellowish orange | 115 | 1,864 |
| 39 | Sandstone, grey, medium-grained; almost pure orthoquartzite; consists of three main 2′ units with rubbly black shale interbeds | 11 | 1,749 |
| 38 | Sandstone, as unit 39; massive | 10 | 1,738 |
| 37 | Sandstone, argillaceous, dark grey; thin-bedded | 4 | 1,728 |
| 36 | Sandstone, dark grey, medium-grained; loosely cemented, with black layers; intimately interbedded with black non-calcareous shale and black shaly, micaceous siltstone | 16 | 1,724 |
| 35 | Concealed interval | 95 | 1,708 |
| 34 | Sandstone, argillaceous, dark grey, medium-grained; loosely cemented; many black speckles, weathers brown | 5 | 1,613 |
| 33 | Concealed interval | 230 | 1,608 |
| 32 | Shale, slightly calcareous, black, with irregular beds of fine-grained argillaceous limestone. *Spirifer* sp. aff. *pellaensis* Weller, *Camarotoechia* sp. GSC loc. 32720 | 48 | 1,378 |
| 31 | Shale, calcareous, light grey; soft | 34 | 1,330 |
| 30 | Limestone, argillaceous, grey, fine-grained; weathers dark yellowish orange | 1 | 1,296 |
| 29 | Mudstone, calcareous, light grey; soft and crumbly, thin-bedded | 36 | 1,295 |
| 28 | Limestone, argillaceous, grey; slightly dolomitic, weathers orange. Moderately fossiliferous with *Leiorhynchus carboniferum*? Girty, *Spirifer* sp. aff. *pellaensis* Weller, small clams. GSC loc. 32732 | 5 | 1,259 |
| 27 | Shale, calcareous, grey | 16 | 1,254 |

Section 9 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 26 | Limestone, argillaceous, grey, fine-grained | 6 | 1,238 |
| 25 | Shale, slightly calcareous, grey; paper thin | 31 | 1,232 |
| 24 | Siltstone, calcareous, grey; thin-bedded; some shaly interbeds form prominent small cliff | 16 | 1,201 |
| 23 | Shale, slightly calcareous, grey | 42 | 1,185 |
| 22 | Mudstone, calcareous, grey; weathers light brown; forms resistant band | ½ | 1,143 |
| 21 | Shale, calcareous, grey | 304 | 1,142 |
| 20 | Shale, slightly calcareous, grey | 46 | 838 |
| 19 | Siltstone, dolomitic, brown; thin-bedded | ½ | 792 |
| 18 | Shale, slightly calcareous, grey; with thin mudstone bands. *Spirifer* sp. aff. *keokuk* Hall in talus | 8 | 791 |
| 17 | Dolomite, silty, moderate brown, medium-grained; weathers buff; medium-bedded | 1 | 783 |
| 16 | Shale and thin-bedded mudstone, very slightly calcareous | 44 | 782 |
| 15 | Shale and thin-bedded mudstone, grey; with some thin nodular bands of grey, rusty weathering mudstone | 120 | 738 |
| 14 | Siltstone, slightly dolomitic, grey; weathers brown | 2 | 618 |
| 13 | Shale, non-calcareous, dark grey | 10 | 616 |
| 12 | Siltstone, slightly dolomitic, grey; weathers brown | 2 | 606 |
| 11 | Shale, non-calcareous, dark grey or black | 24 | 604 |
| 10 | Siltstone, non-calcareous, grey; thinly laminated | 11 | 580 |
| 9 | Shale, slightly calcareous, black; paper thin<br>Base of main cliff exposure on east side of creek. | 120 | 569 |
| 8 | Siltstone, calcareous, dark grey, fine-grained; weathers buff-grey; thin-bedded; dense with subconchoidal fracture. *Chonetes* sp., *Dictyoclostus*? sp., *Syringothyris* sp. GSC loc. 32713 | 65 | 449 |
| 7 | Limestone, silty, dark grey; weathers light brown; massive | 2 | 384 |
| 6 | Limestone, argillaceous, dark grey, fine-grained; thin-bedded | 2 | 382 |
| 5 | Concealed interval, probably mainly shale, calcareous, black and thin-bedded argillaceous limestone. Beds near vertical; strike 0° | 270 | 380 |
| 4 | Limestone, silty, dark grey, fine-grained; weathers dark grey | 25 | 110 |
| 3 | Shale, black and calcareous siltstone; small *Chonetes* in talus | 45 | 85 |
| 2 | Siltstone, calcareous and sandstone, grey, fine-grained. Dip 73°E; strike 358° | 25 | 40 |
| 1 | Shale, non-calcareous, black and calcareous siltstones, grades into overlying beds<br>Dip 55°E, strike 11°. No further exposures, base of formation not exposed. | 15 | 15 |

Section 9 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | MATTSON FORMATION | | |
| | *Lower Member* | | |
| 2 | Sandstone, quartzose, grey, medium-grained; weathers dark yellowish orange; medium-bedded to massive, consists mainly of ½-1′ beds, forms prominent and inaccessible cliff. Dip 35°E; strike 5° | 80 | 95 |
| 1 | Sandstone, grey, coarse-grained; weathers grey; thin-bedded with many shaly interbeds | 15 | 15 |
| | Underlying beds—Etanda Formation, unit 41. Contact conformable. | | |

## SECTION 10

Section exposed on both sides of Tika Creek, west of La Biche River (Yukon Territory). Map 95C, lat. 60°45'N, long. 124°53'W. Access by fixed wing, float-equipped aircraft to Dendale Lake and short helicopter flight to the section. Well-exposed thick section of Mattson Formation with Permian fossils in upper part. Mattson Formation underlain by unfossiliferous shale and sandstone provisionally assigned to Etanda Formation.

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | ETANDA? FORMATION | | |
| | Overlying beds—Mattson Formation<br>Contact conformable | | |
| 26 | Shale, black; minor thin-bedded sandstone at base .... | 65 | 776 |
| 25 | Sandstone, grey and brown, fine-grained; thin-bedded; forms small ledge, upper 2' dark grey sandstone .... | 10 | 711 |
| 24 | Shale, black; fissile—upper 10' has very thin-bedded, fine-grained, dark grey sandstone ..... | 29 | 701 |
| 23 | Sandstone, grey, fine- to very fine-grained; thin-bedded; rusty weathering ..... | 4 | 672 |
| 22 | Shale, black, fissile ..... | 7 | 668 |
| 21 | Sandstone, as unit 25—forms small ledge ..... | 17 | 661 |
| 20 | Shale, black, fissile ..... | 2 | 644 |
| 19 | Sandstone, quartzose, grey, fine-grained; thin-bedded | 2½ | 642 |
| 18 | Shale, non-calcareous, black—10% ½" beds of grey, fine-grained sandstone ..... | 18 | 639 |
| 17 | Shale, at base grading to interbedded shale and sandstone with dark grey, finely laminated sandstone at top ..... | 14 | 621 |
| 16 | Shale grading to sandstone as in unit 17 ..... | 12 | 607 |
| 15 | Shale, black, fissile, irregular layers and lenses of dark grey, fine-grained sandstone, rusty weathering, sandstone increases upwards ..... | 37 | 595 |
| 14 | Shale and mudstone, black with 10% lens and layers of light grey, fine-grained sandstone, which increases to 50% in last 45 feet ..... | 95 | 558 |
| 13 | Sandstone, light grey, medium-grained; laminated with interbedded shale at base ..... | 3 | 463 |
| 12 | Concealed interval ..... | 7 | 460 |
| 11 | Shale, non-calcareous, black; a few fine-grained, grey sandstone interbeds near top ..... | 27 | 453 |
| 10 | Concealed interval ..... | 125 | 426 |
| 9 | Shale, black, a few thin carbonaceous interbeds ..... | 21 | 301 |
| 8 | Concealed interval ..... | 12 | 280 |
| 7 | Shale with minor sandstone ..... | 28 | 268 |
| 6 | Concealed interval ..... | 80 | 240 |
| 5 | Sandstone, grey, fine-grained; thin-bedded; carbonaceous ..... | 30 | 160 |
| 4 | Concealed interval ..... | 15 | 130 |
| 3 | Shale, black, fissile. Partly covered, minor folding resulting in only proximate thickness ..... | 40 | 115 |
| 2 | Concealed interval ..... | 20 | 75 |
| 1 | Mainly covered, some interbedded medium-grained, light grey sandstone ..... | 55 | 55 |
| | Base concealed. | | |

## Section 10 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| | MATTSON FORMATION | | |
| | *Upper Member* | | |
| 160 | Shale, bituminous, black with minor dark grey, fine-grained sandstone, thin coal seams, unit is poorly exposed | 10 | 4,672 |
| 159 | Shale, non-calcareous, black, fissile | 8 | 4,662 |
| 158 | Sandstone, dolomitic?, light grey, fine-grained; thin-bedded | 4 | 4,654 |
| 157 | Concealed interval | 30 | 4,650 |
| 156 | Sandstone, grey, very fine-grained; thin-bedded with irregular lens of grey shale | 29 | 4,620 |
| 155 | Concealed interval | 30 | 4,591 |
| 154 | Shale, dark grey, thin-bedded, minor layers of sandstone | 9 | 4,561 |
| 153 | Limestone, arenaceous, and fine-grained; grey, calcareous sandstone, alternating harder and softer units | 38 | 4,552 |
| 152 | Sandstone, calcareous, grey, fine-grained, medium-bedded (6-7″), buff weathering | 10 | 4,514 |
| 151 | Concealed interval | 45 | 4,504 |
| 150 | Limestone, argillaceous, dark grey, fine-grained, thin irregular bedded, becomes more argillaceous towards base. *Kochiproductus* sp., *Cancrinella* sp., *Pterospirifer* sp. GSC loc. 32595 | 164 | 4,459 |
| 149 | Shale, slightly calcareous, black to dark grey | 30 | 4,295 |
| 148 | Shale, calcareous, brown-grey with interbedded fine-grained, brown-grey highly argillaceous limestone | 16 | 4,265 |
| 147 | Limestone—alternating grey, fine-grained limestone, and thin-bedded, brown-grey, very argillaceous limestone, abundant brachiopods near top. *Dictyoclostus* cf. *neoinflatus* Licharew, *Kochiproductus* sp., *Linoproductus* sp., *Spiriferella* sp., *Pterospirifer* cf. *alatus* Schlotheim. GSC loc. 32596 | 18 | 4,249 |
| 146 | Shale, very calcareous, brown-grey, fine-grained; very thin-bedded with one-foot limestone interbeds | 30 | 4,231 |
| 145 | Shale, as above with minor limestone | 12 | 4,201 |
| 144 | Limestone, argillaceous, brown-grey, fine-grained; thick (2′) bedded; 5 feet calcareous shale at top | 32 | 4,189 |
| 143 | Sandstone, calcareous, light grey, fine-grained; medium- to thick-(1-2′) bedded, forms small ledge | 31 | 4,157 |
| 142 | Concealed interval | 45 | 4,126 |
| 141 | Sandstone, calcareous, medium grey, fine-grained; many 'worm' trails | 5 | 4,081 |
| 140 | Concealed interval | 24 | 4,076 |
| 139 | Limestone, black, fine- to medium-grained; many ostracods and a few brachiopods. *Orbiculoidea* sp., *'Productus'* sp., *Dielasma* cf. *elongatum* Schlotheim. GSC loc. 32594 | 4 | 4,052 |
| 138 | Sandstone, calcareous, light grey, medium- to coarse-grained; many irregular dark laminations in lower part, small cliff | 47 | 4,048 |

Section 10 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 137 | Shale, calcareous, grey alternating with grey, fine-grained limestone; a few fossils, beekite on surface. *Kochiproductus* sp., *Marginifera* sp. GSC loc. 32593 | 16 | 4,001 |
| 136 | Concealed interval | 4 | 3,985 |
| 135 | Sandstone, light grey, medium-grained | 3 | 3,981 |
| 134 | Concealed interval | 4 | 3,978 |
| 133 | Sandstone, light grey, medium- to coarse-grained; thick- (4′) bedded, small ledge | 55 | 3,974 |
| 132 | Concealed interval | 15 | 3,919 |
| 131 | Sandstone, light brown, medium-grained; massive | 14 | 3,904 |
| 130 | Concealed interval | 4 | 3,890 |
| 129 | Sandstone, light grey, medium-grained, medium-bedded | 26 | 3,886 |
| 128 | Concealed interval | 5 | 3,860 |
| 127 | Sandstone, calcareous, pale brown, fine-grained; medium-bedded | 4 | 3,855 |
| 126 | Concealed interval to next cliff | 7 | 3,851 |
| 125 | Sandstone, pale brown, medium-grained | 20 | 3,844 |
| 124 | Mainly concealed; scattered exposures of shale at top, and medium-grained, pale brown sandstone near the base | 160 | 3,824 |
| 123 | Limestone, grey, fine-grained, thick-bedded (2-3′) | 15 | 3,664 |
| 122 | Limestone, grey, coarse-grained; crinoidal, small (¼″), dense, light grey chert | 8 | 3,649 |
| 121 | Limestone, argillaceous, dark brown-grey, fine-grained; thin-bedded; partly crinoidal | 6 | 3,641 |
| 120 | Sandstone, calcareous, light grey, medium-grained | 14 | 3,635 |
| 119 | Limestone, grey, fine-grained, hard, arenaceous grading to calcareous sandstone towards base | 44 | 3,621 |
| 118 | Concealed interval | 18 | 3,577 |
| 117 | Limestone, argillaceous, dark grey, fine-grained, brachiopods. *Juresania nebrascensis* (Owen), *Dictyoclostus gallatinensis* Girty, *Marginifera* sp., *Spirifer opimus* Hall, *Composita* cf. *subtilita* (Hall), *Eumetria* sp. GSC loc. 32597 | 14 | 3,569 |
| 116 | Sandstone, calcareous, medium grey, medium-grained; brown weathering, thin-bedded (2-3″) | 6 | 3,555 |
| 115 | Limestone, argillaceous, dark grey, fine-grained; thin-bedded | 12 | 3,549 |
| 114 | Limestone, argillaceous, dark brown-grey, fine-grained; partly crinoidal (6-10″) beds with thinner more argillaceous layers | 25 | 3,537 |
| 113 | Concealed interval | 5 | 3,512 |
| 112 | Sandstone, medium- to coarse-grained; thick-bedded to massive | 50 | 3,507 |
| 111 | Mainly concealed; thin-bedded, grey sandstone at top | 20 | 3,457 |
| 110 | Sandstone, grey, medium- to coarse-grained; massive | 21 | 3,437 |
| 109 | Sandstone, grey, medium-grained; medium-bedded at bottom and dark grey sandy dolomite at top | 30 | 3,415 |
| 108 | Sandstone, light grey, medium-grained; massive; contains black specks | 14 | 3,385 |

## Section 10 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 107 | Sandstone, grey, medium-grained, lower 3′ fine-grained, grey, dolomitic, cherty, sandstone; medium-bedded | 17 | 3,371 |
| 106 | Sandstone, grey, medium-grained; thin- to medium-bedded | 24 | 3,354 |
| 105 | Sandstone, grey, fine- to medium-grained; thin- to medium-bedded; carbonaceous streaks | 86 | 3,330 |
| 104 | Concealed interval | 11 | 3,244 |
| 103 | Sandstone, grey, dolomitic, medium-grained | 20 | 3,233 |
| 102 | Dolomite, silty, dark grey, fine-grained | 10 | 3,213 |
| 101 | Sandstone, friable, pale brown, medium-grained; massive | 8 | 3,203 |
| 100 | Sandstone, light grey, medium-grained; thin- to medium-bedded with occasional massive bed, rare carbonaceous material | 64 | 3,195 |
| 99 | Sandstone, light grey, very thin-bedded, fine-grained; abundant carbonaceous partings | 5 | 3,131 |
| 98 | Sandstone, dark grey, fine- to medium-grained; medium-bedded; rare chert towards top | 66 | 3,126 |
| 97 | Sandstone, light grey, medium-grained; massive | 16 | 3,060 |
| 96 | Shale, black, with 50% sandstone, as below, with fine irregular carbonaceous laminations | 20 | 3,044 |
| 95 | Sandstone, grey, fine-grained; medium irregular bedding, irregular carbonaceous streaks | 16 | 2,844 |
| 94 | Sandstone, cherty, brown, fine-grained | 1½ | 2,828 |
| 93 | Chert, black, dense | 2 | 2,826 |
| | *Middle Member?* | | |
| 92 | Sandstone, dolomitic, grey, fine-grained; thick-bedded; rare silicified crinoid stems | 10 | 2,824 |
| 91 | Sandstone, brown-grey, medium-grained; medium-bedded; some fine black spots | 39 | 2,814 |
| 90 | Sandstone, light grey, fine-grained; very thin-bedded; abundant carbonaceous partings | 34 | 2,775 |
| 89 | Sandstone, friable, soft, yellow, medium-grained; weathers yellow | 75 | 2,741 |
| 88 | Sandstone, grey to dark grey, fine-grained; interbedded with shale, one bed ⅛″ circular silicified worm burrows | 13 | 2,666 |
| 87 | Shale, black, very thin-bedded 3′ units, hard, dark grey, brown weathering mudstone, chertified; a few flattened phosphatic brachiopod fragments in shale | 42 | 2,653 |
| 86 | Sandstone, pale brown, medium-grained; massive | 16 | 2,611 |
| 85 | Shale, fissile, black, 1-2″ soft, light grey 'mud' at top | 12 | 2,595 |
| 84 | Sandstone, light grey to light brown-grey, medium-grained; greenish weathering tinge | 60 | 2,583 |
| 83 | Shale, black, minor sand | 18 | 2,523 |
| 82 | Sandstone, light grey, fine- to medium-grained; medium-bedded; 20% interbedded shale; recessive | 30 | 2,505 |
| 81 | Sandstone, as below only medium-bedded; top 3′ coarse-grained conglomeratic sandstone, ½″ chert pebbles and rose quartz | 78 | 2,475 |

Section 10 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 80 | Sandstone, white to light grey, medium-grained; thick-bedded | 35 | 2,397 |
| 79 | Shale, black | 2 | 2,362 |
| 78 | Sandstone, light grey, medium-grained, well-rounded; thin- to medium-bedded | 8 | 2,360 |
| 77 | Shale, black, minor sandstone | 25 | 2,352 |
| 76 | Sandstone, light grey, medium-grained; medium-bedded | 14 | 2,327 |
| 75 | Partly covered, mainly shale interbedded sandstone | 35 | 2,313 |
| 74 | Sandstone, grey, fine-grained; medium-bedded | 6 | 2,278 |
| 73 | Concealed interval | 10 | 2,272 |
| 72 | Sandstone, grey, fine-grained; carbonaceous, interbedded 1′ black shale beds | 12 | 2,262 |
| 71 | Sandstone, light grey, medium-grained; medium- to thick-bedded, weathers buff | 18 | 2,250 |
| 70 | Sandstone, light grey, fine-grained; thin-bedded | 12 | 2,232 |
| 69 | Shale, black with 50% sandstone, dark grey, carbonaceous, fine-grained | 18 | 2,220 |
| 68 | Sandstone, grey, fine- to medium-grained; thin- to medium-bedded, weathers buff | 8 | 2,202 |
| 67 | Shale, black; minor grey, fine-grained sandstone | 21 | 2,194 |
| 66 | Sandstone, white to grey, medium-grained; medium irregular bedded; has a brown-green weathering tinge | 38 | 2,173 |
| 65 | Sandstone, grey, thin-bedded shale, recessive | 5 | 2,135 |
| 64 | Sandstone, white to pale brown, medium-grained; massive bedded; large-scale crossbedding, friable | 47 | 2,130 |
| 63 | Sandstone, medium grey at base becoming lighter upwards, fine- to medium-grained; medium-bedded | 55 | 2,083 |
| 62 | Sandstone, light grey, fine-grained; thin- to medium-bedded | 36 | 2,028 |
| 61 | Sandstone, light grey, medium-grained; thin-bedded (1-3″) | 30 | 1,992 |
| 60 | Sandstone, grey, medium-grained; medium- to thick-bedded; weathers vuggy | 20 | 1,962 |
| 59 | Sandstone, grey, medium-grained; thin-bedded | 6 | 1,942 |
| 58 | Shale, as below with 50% ½″ beds of dark grey, fine-grained sandstone | 9 | 1,936 |
| 57 | Shale, fissile, black | 13 | 1,927 |
| 56 | Sandstone, light grey, fine-grained; medium-bedded, weathers buff | 10 | 1,914 |
| 55 | Concealed interval | 11 | 1,904 |
| 54 | Sandstone, light grey, fine- to medium-grained; thin-bedded becomes medium-bedded at top | 14 | 1,893 |
| 53 | Concealed interval | 45 | 1,879 |
| 52 | Sandstone, white to pale brown, fine- to medium-grained | 85 | 1,834 |
| | *Lower Member?* | | |
| 51 | Shale, fissile, black; partly covered, minor sandstone | 44 | 1,749 |
| 50 | Shale, interbedded in lower part with 1′ beds of white to light grey, medium-grained sandstone | 66 | 1,705 |
| 49 | Sandstone, light grey, medium-grained; medium- to thick-bedded (1-3′); weathers rusty brown | 10 | 1,639 |

Section 10 — *continued*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 48 | Shale, fissile, black, partly covered | 67 | 1,629 |
| 47 | Sandstone, dark grey, fine-grained, weathers brown, some carbonaceous material scattered throughout; 1′ shale, fissile, black, in centre | 14 | 1,562 |
| 46 | Concealed interval | 80 | 1,548 |
| 45 | Shale, black, very thin-bedded; a few clay ironstone nodules, a few very thin sandstone layers | 85 | 1,468 |
| 44 | Sandstone, medium to dark grey, fine-grained; medium- to thick-bedded but forms a massive cliff | 20 | 1,383 |
| 43 | Sandstone, grey, medium-grained; thin irregular bedded | 12 | 1,363 |
| 42 | Sandstone, dark grey, fine-grained; 'dirty', with 30% interbedded siltstone and shale; thin-bedded | 96 | 1,351 |
| 41 | Sandstone, grey, medium-grained; thin-bedded; fine laminations | 30 | 1,255 |
| 40 | Sandstone, grey, medium-grained; massive; orange-brown weathering | 9 | 1,225 |
| 39 | Sandstone, grey, fine-grained with interbedded shale and siltstone; fine laminations, iridescent green weathering in part | 20 | 1,216 |
| 38 | Sandstone, grey, fine-grained; fine carbonaceous laminations | 40 | 1,196 |
| 37 | Sandstone, brown-grey to dark grey, fine-grained; 50% interbedded dark grey siltstone and shale; thin-bedded; prominent gully from north | 60 | 1,156 |
| 36 | Sandstone, grey, medium-grained; rusty brown weathering | 15 | 1,096 |
| 35 | Shale, black with 50% dark grey, fine-grained sandstone, slightly recessive | 9 | 1,081 |
| 34 | Sandstone, grey, fine- to medium-grained; minor shale, brown weathering | 52 | 1,072 |
| 33 | Shale, black | 2 | 1,020 |
| 32 | Sandstone, grey, fine-grained; very thin-bedded with a few medium beds, small-scale crossbedding | 44 | 1,018 |
| 31 | Shale, with interbedded pale brown, very thin-bedded, sandstone, recessive unit | 6 | 974 |
| 30 | Concealed interval | 20 | 968 |
| 29 | Sandstone, grey, fine-grained; very thin-bedded (½-2″); carbonaceous streaks 5% shale; top 20′ evenly laminated sandstone with no shale | 71 | 948 |
| 28 | Sandstone, thin-bedded; as unit 26 | 13 | 877 |
| 27 | Shale, fissile, black, minor sandstone | 12 | 864 |
| 26 | Sandstone, grey, fine-grained to medium-grained at base; thin (2-4″) beds, laminations of carbonaceous material, minor shale | 40 | 852 |
| 25 | Sandstone, grey, fine-grained; very thin-bedded; recessive; 50% interbedded shale; partly covered at base | 45 | 807 |
| 24 | Shale, black in lower 10′ with 25% sandstone, grades up to mainly sandstone. Thin-bedded (⅛″-1″), grey, fine-grained shale interbeds | 23 | 767 |

Section 10 — *concluded*

| Unit No. | | Thickness (feet) | Height above base (feet) |
|---|---|---|---|
| 23 | Sandstone, light grey, fine- to medium-grained; mainly thin-bedded; a few 1′ beds of grey, medium-grained sandstone with abundant small-scale cross-bedding. Bedding surfaces black due to carbonaceous material | 22 | 744 |
| 22 | Shale, black, minor sandstone | 18 | 722 |
| 21 | Sandstone, medium grey, fine- to medium-grained; thin-bedded; small-scale crossbedding | 174 | 704 |
| 20 | Sandstone, light to medium grey, medium-grained; laminated; 10% shale increases to 50% in last 10′ | 25 | 530 |
| 19 | Concealed | 38 | 505 |
| 18 | Sandstone, medium grey, fine-grained; thin-bedded, 10% interbeds, black shale | 25 | 467 |
| 17 | Concealed interval | 52 | 422 |
| 16 | Sandstone, medium grey, fine- to medium-grained; thick-bedded, grey weathering, forms small cliff | 17 | 370 |
| 15 | Concealed except for 3′ thin-bedded sandstone in middle | 10 | 353 |
| 14 | Sandstone, medium grey, medium-grained; laminated, with minor interbedded shale | 12 | 343 |
| 13 | Concealed interval | 32 | 331 |
| 12 | Sandstone, light grey, medium-grained; medium-bedded (6″), becoming thin-bedded (½″-2″) towards top, carbonaceous | 28 | 301 |
| 11 | Concealed, except for minor sandstone in middle similar to unit 10 | 30 | 273 |
| 10 | Sandstone, grey, fine-grained; thin-bedded (¼″-½″), irregularly laminated with small worm borings | 27 | 243 |
| 9 | Concealed interval | 11 | 216 |
| 8 | Sandstone, as unit 10, worm trails, minor erosional surfaces | 4 | 195 |
| 7 | Concealed interval | 15 | 191 |
| 6 | Sandstone, as unit 10 | 4 | 176 |
| 5 | Concealed interval | 7 | 172 |
| 4 | Sandstone, light to medium grey, medium-grained; fine even laminations and some darker grey with irregular laminations, thin-bedded (¼-½″) | 53 | 165 |
| 3 | Sandstone, pale brown, medium-grained; carbonaceous fragments | 2 | 112 |
| 2 | Sandstone, light grey, medium-grained; laminated; partly covered at base; thin-bedded | 31 | 110 |
| 1 | Sandstone, as unit 2, cliff former | 79 | 79 |
| | Underlying beds—Etanda? Formation, unit 26. Contact conformable. | | |



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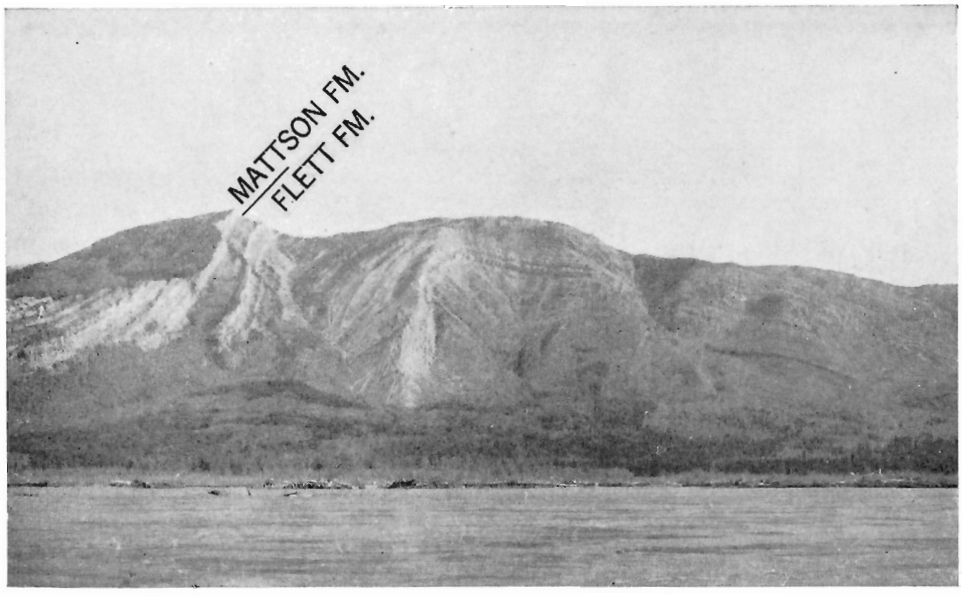
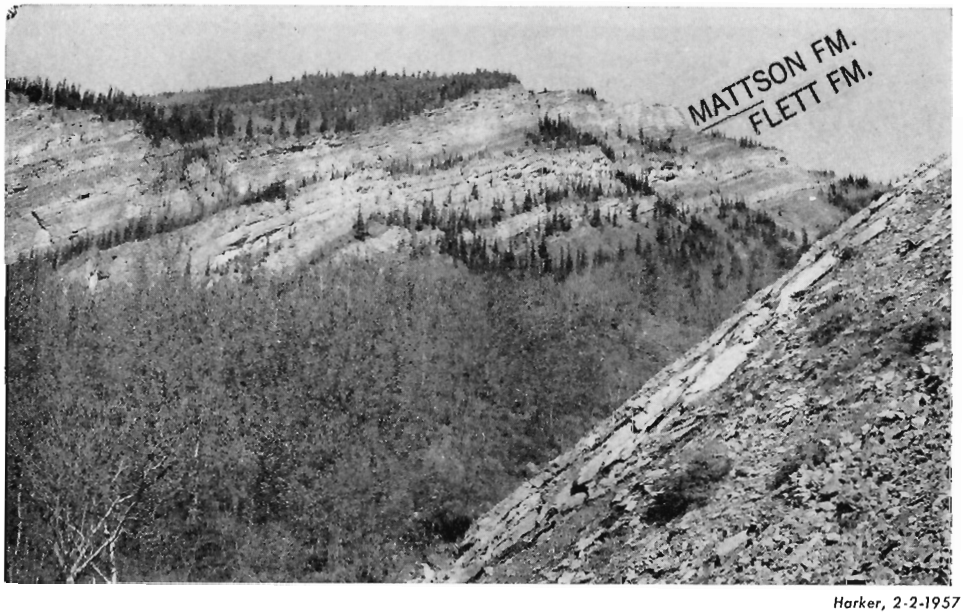


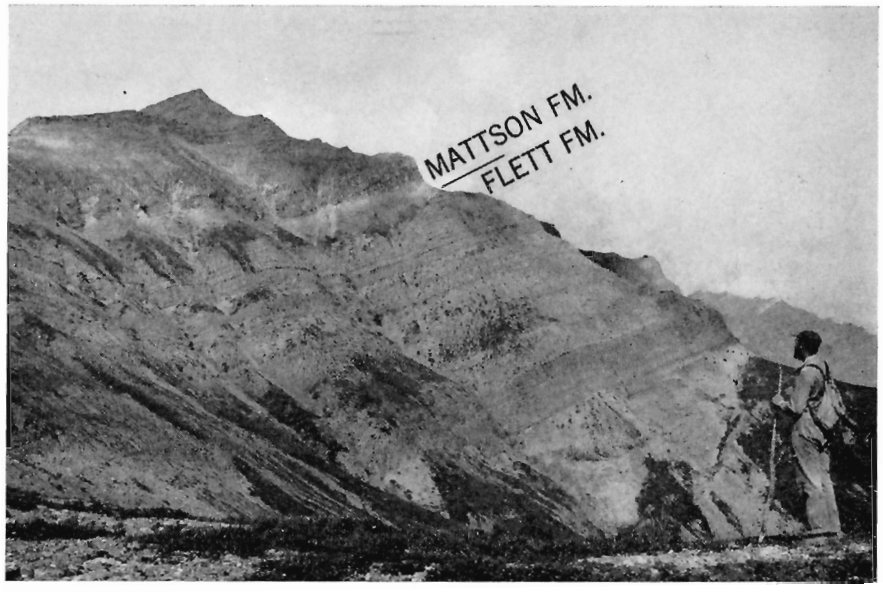

*Harker, 2-7-1957*

PLATE I. A. The Twisted Mountain. Monocline of Flett Formation overlain by lower member of Mattson Formation.




*Harker, 2-2-1957*

PLATE I. B. The Twisted Mountain. View from limestone dip-slope of Flett Formation (unit 29) showing upper beds of Flett Formation overlain by sandstones of olwer member of Mattson Formation.




*Harker, 5-7-1957*

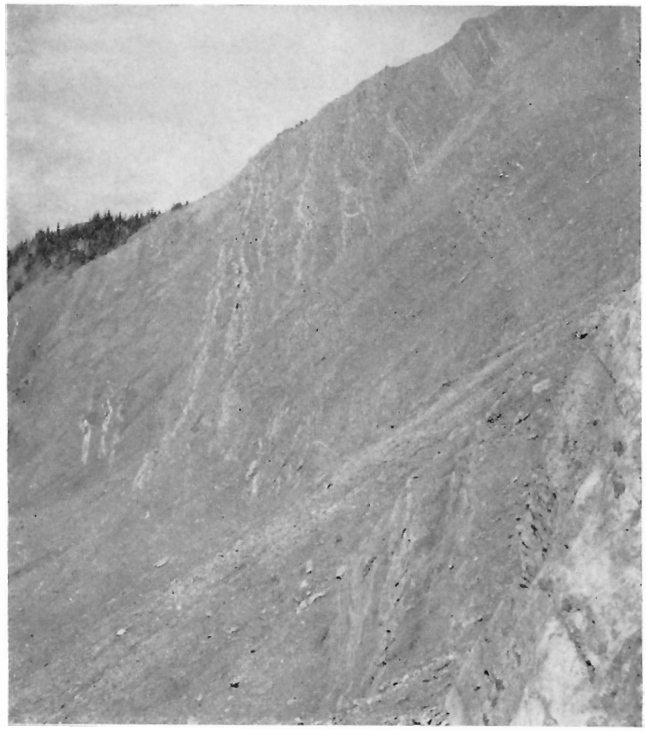
PLATE II A. East face of Liard Range showing Flett Formation and lower part of Mattson Formation.

*Harker, 4-3-1957*

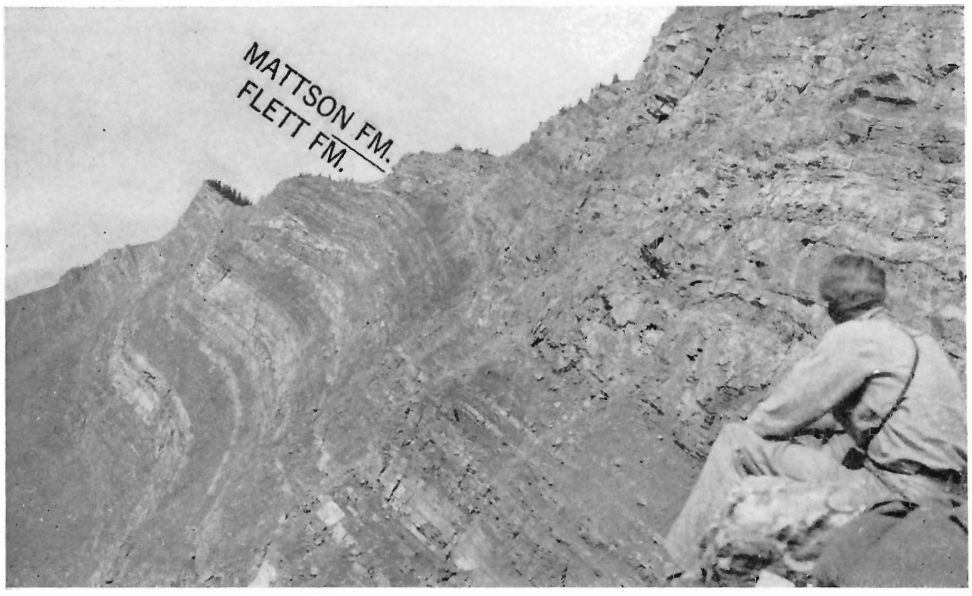
PLATE II. B. Looking south to Etanda Lakes. The lowest small cliff consists of the basal beds of Mattson Formation. Type section of underlying Etanda Formation in gully sloping down to main valley floor.

PLATE III

A. Lower part of Flett Formation showing alternation of limestone and shale, black shales of underlying Clausen Formation at extreme left, Jackfish section.

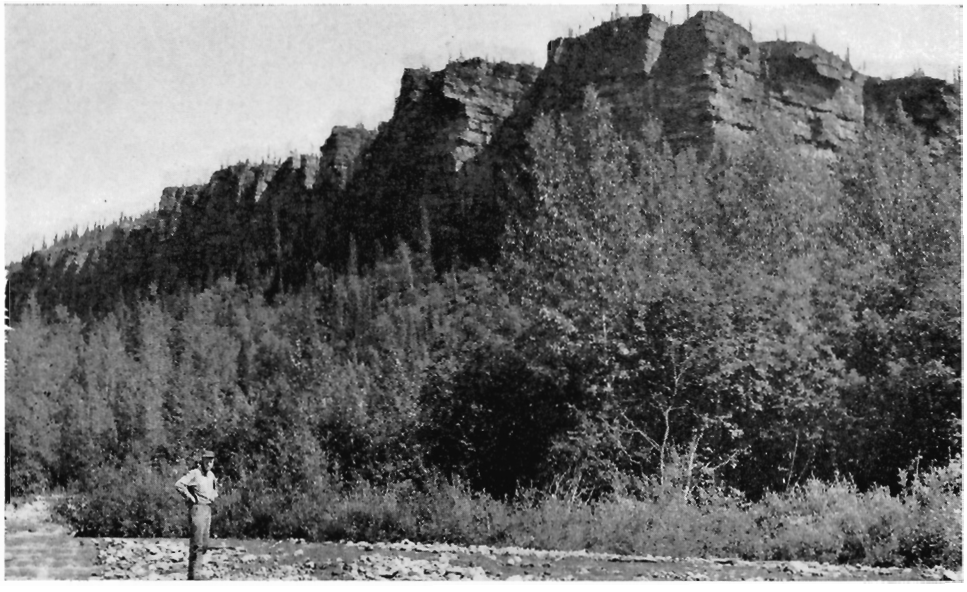


*Harker, 7-2-1957*



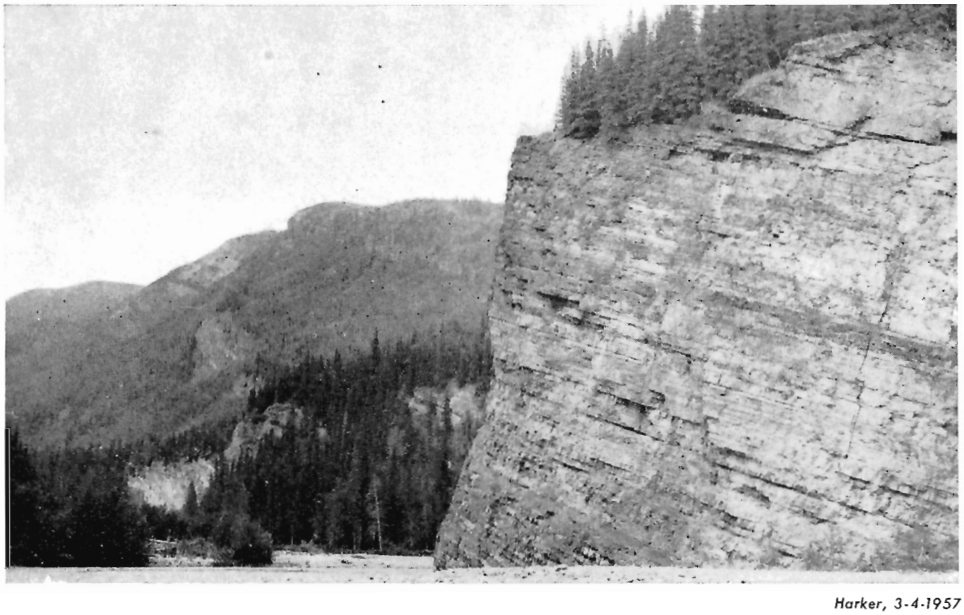

*Harker, 7-3-1957*

B. Upper beds of Flett Formation, overlain by sandstones of Mattson Formation, Jackfish section.



*Harker, 5-1-1957*

PLATE IV. A. Massive chert of Fantasque Formation at the type section, Beaver River.



*Harker, 3-4-1957*

PLATE IV. B. Fantasque Formation, Kotaneelee River.