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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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(Report, 2 figures, appendix)

D. F. Stott

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TYPE SECTIONS OF SOME FORMATIONS OF THE LOWER CRETACEOUS FORT ST. JOHN GROUP NEAR PINE RIVER, BRITISH COLUMBIA

INTRODUCTION

The purpose of this report is to describe in some detail the type sections and general lithology of formations within the Fort St. John group near Pine River. Several standard sections are described to supplement some of the stratigraphic details lacking in the type sections.

The term 'Fort St. John group' embraces a succession of Lower Cretaceous beds which, as pointed out by McLearn and Kindle (1950, p. 73)[1] varies from place to place; "it is not possible to use one, uniform classification of the strata for all of northeastern British Columbia." The formations of the Fort St. John group of the Pine River region were originally described by Wickenden and Shaw (1943):

> ....in this area at least, there are five distinct formations, chiefly of marine origin, between the Bullhead (group) and the Dunvegan (formation). Rather than attempt to correlate any or all of these with the St. John formation as previously defined, it seems advisable to redefine the term as a group name to include all these predominantly marine strata.

Wickenden and Shaw did not specifically designate type localities for any of these new formations, although some of their described sections have been assumed to be type sections (see McLearn and Kindle, 1950). Unfortunately, some of these are not well enough exposed to provide sufficient stratigraphic information, and therefore, more complete sections are here designated as typical.

The original and modified definitions of the Fort St. John group in other regions may be found in reports by Dawson (1881), McConnell (1893), McLearn (1918, 1923, 1932, 1945), Spieker (1921, 1922), Williams and Bocock (1932), Wickenden and Shaw (1943), Beach and Spivak (1944), Kindle (1944), Hage (1944), McLearn and Kindle (1950), Badgley (1952), Alberta Study Group (1954), and Stott (1960, 1961). As fossils collected during this study are still being examined, the interested reader is referred to Wickenden and Shaw (1943) for the original collections from the Pine River sections, and to McLearn and Kindle (1950) for regional correlations.

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[1] Dates or names and dates in parentheses refer to publications listed in the References.

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The location of sections is shown on the index map (Fig. 1). Those in the vicinity of Dokie Ridge are more accurately located in Figure 2. Descriptions of sections other than type sections are contained in the appendix. Tentative correlations and probable facies changes within the group have been suggested previously (Stott, 1960).

Access

The Foothills in the vicinity of Pine River valley are easily reached by the John Hart Highway from either Dawson Creek or Prince George, British Columbia.

Bullmoose Mountain, where several sections were examined, is accessible by way of a fairly good forestry road that extends southward from the John Hart Highway just east of Chetwynd. A car ferry is operated by the British Columbia Government across Pine River. A good pack-trail ascends Bullmoose Mountain about 28 miles south of the ferry-crossing. Abundant grazing for horses is available on the upper part of the mountain.

The type locality of the upper member of the Commotion formation on Commotion Creek is only a short distance upstream from the bridge on the Hart Highway. The higher part of this section is more easily reached by a logging road on the west side of the creek. The exposures of the Commotion formation on Hasler Creek may be reached by a logging road (not open to vehicles in 1960) that follows the creek.

The type section of the Goodrich formation on Boulder Creek is easily reached on foot from the Hart Highway.

The type section of the Cruiser formation—on the south side of Pine River—can be reached by using a boat or horse to cross the river.

The type section of the Hasler and sections of other formations on Dokie Ridge are most easily reached by helicopter. The writer, who used horses, travelled from Moberly Lake, forded Moberly River east of Fisher Creek, and ascended the long ridges that slope northward from Dokie Ridge. Horses must be pastured along the river in this region. So far as known, these sections are not readily accessible from the Hart highway.

Field Work and Acknowledgments

This report is based on data obtained during a study of Cretaceous rocks in the Foothills region between Smoky and Peace Rivers. The stratigraphic work, which began near Smoky River in 1958, was continued in 1959 and completed as far north as Moberly River in 1960.

Many of the correlation problems have been discussed with W. A. Bell, D. C. McGregor, J. A. Jeletzky, and F. H. McLearn—all of the Geological Survey—whose comments have been of great help. The flora and fauna of the Fort St. John group are not discussed here, as many of the collections have yet to be identified.

The writer is indebted to J. H. Wall and G. B. Mellon of the Research Council of Alberta for their discussions on some of the problems related to the Fort St. John group.

The type sections were measured and described in 1960 with the capable assistance of A. A. Wilkins and J. P. Hill. The writer is also grateful to R. Cameron, O. Gauthier, J. Aird, and A. Ringstrom.

STRATIGRAPHY

FORT ST. JOHN GROUP

Within the Fort St. John group of the Pine River region, Wickenden and Shaw (1943) recognized these five formations: in ascending order, the Moosebar, Commotion, Hasler, Goodrich, and Cruiser. Of these, only the Moosebar had been defined previously (McLearn, 1923, p. 5B). The others were described, and their distribution as known at that time was outlined, and several incomplete sections were summarized.

The almost complete section of the Fort St. John group on Dokie Ridge (Fig. 2, sec. 1) appears unique as no continuous section of the group in the region of Pine and Peace Rivers has been described previously. In that section, the basal Moosebar shales are not exposed but a measurement can be obtained of the interval between the lower part of the Moosebar formation and the contact of the group with the overlying Dunvegan formation. On the main part of the ridge most of the shale intervals are talus- or grass-covered but the sandstone beds are well exposed. The Hasler shale is exposed in a small gully (Fig. 2) just north of the main ridge. The Moosebar shale and the lower two members of the Commotion formation are well exposed in the second gully (Fig. 2) north of the ridge. More than 4,800 feet of

TABLE OF FORMATIONS

Series	Group	Formation	Thickness (feet)	Lithology
Upper Cretaceous		Dunvegan	300-1,200	Marine and nonmarine sandstone and shale
	Fort St. John	Cruiser	350-800	Dark grey marine shale with sideritic concretions; some sandstone
Lower Cretaceous		Goodrich	100-1,350	Fine-grained, crossbedded sandstone; some shale
		Hasler	500?-900	Silty, dark grey marine shale with sideritic concretions; siltstone and sandstone in lower part; minor conglomerate
		Commotion	1,100-1,600	Fine-grained, brown calcareous sandstone interbedded with carbonaceous shale and coal; dark marine shale; coarse-grained sandstone and conglomerate
		Moosebar	100-1,000	Dark grey marine shale with sideritic concretions; glauconitic sandstone and pebbles at base
		Gething	300-700	Fine- to coarse-grained, brown, calcareous, carbonaceous sandstone; coal, carbonaceous shale, and conglomerate
		Cadomin	45-600	Massive conglomerate containing chert and quartzite pebbles

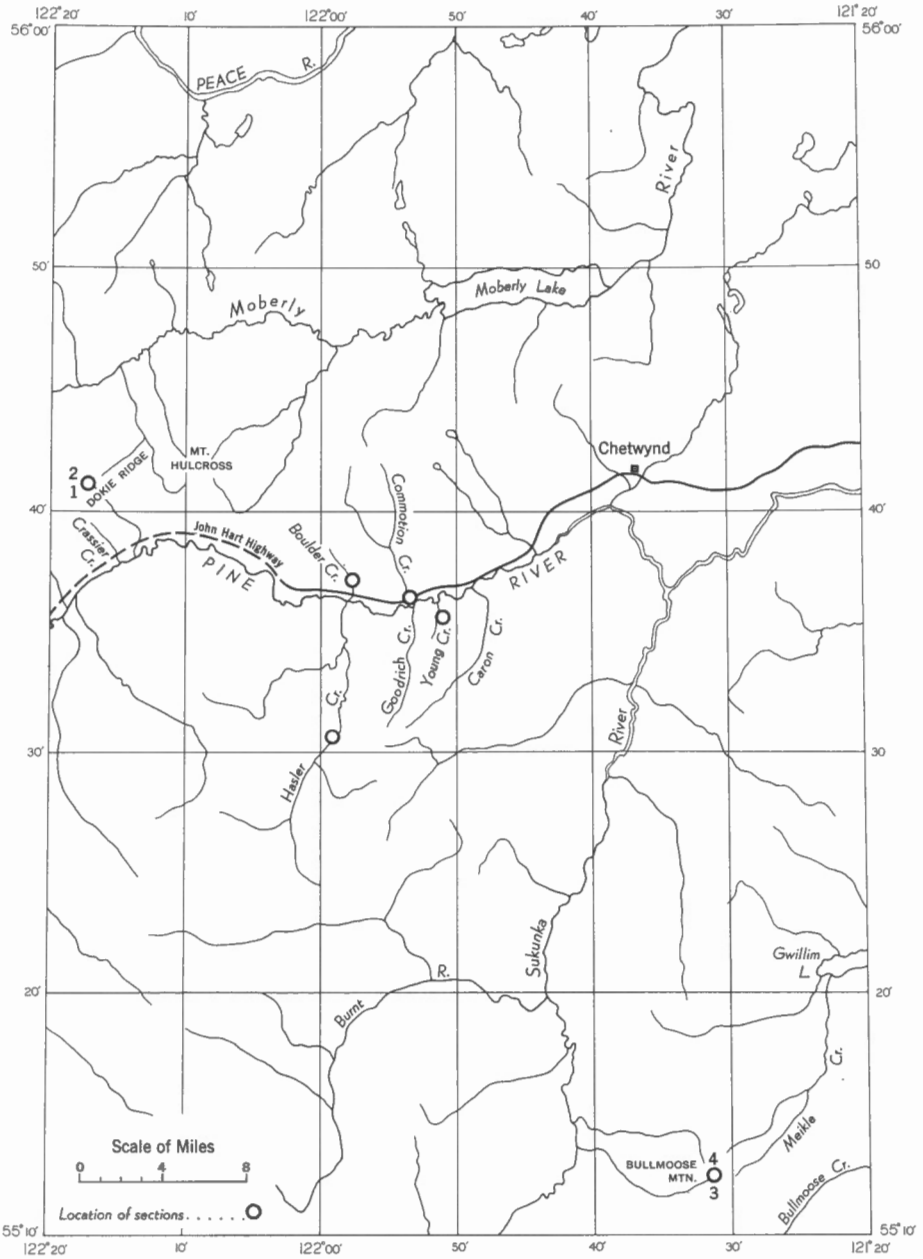

Figure 1. Index map showing location of sections of the Fort St. John Group near Pine River, B. C.

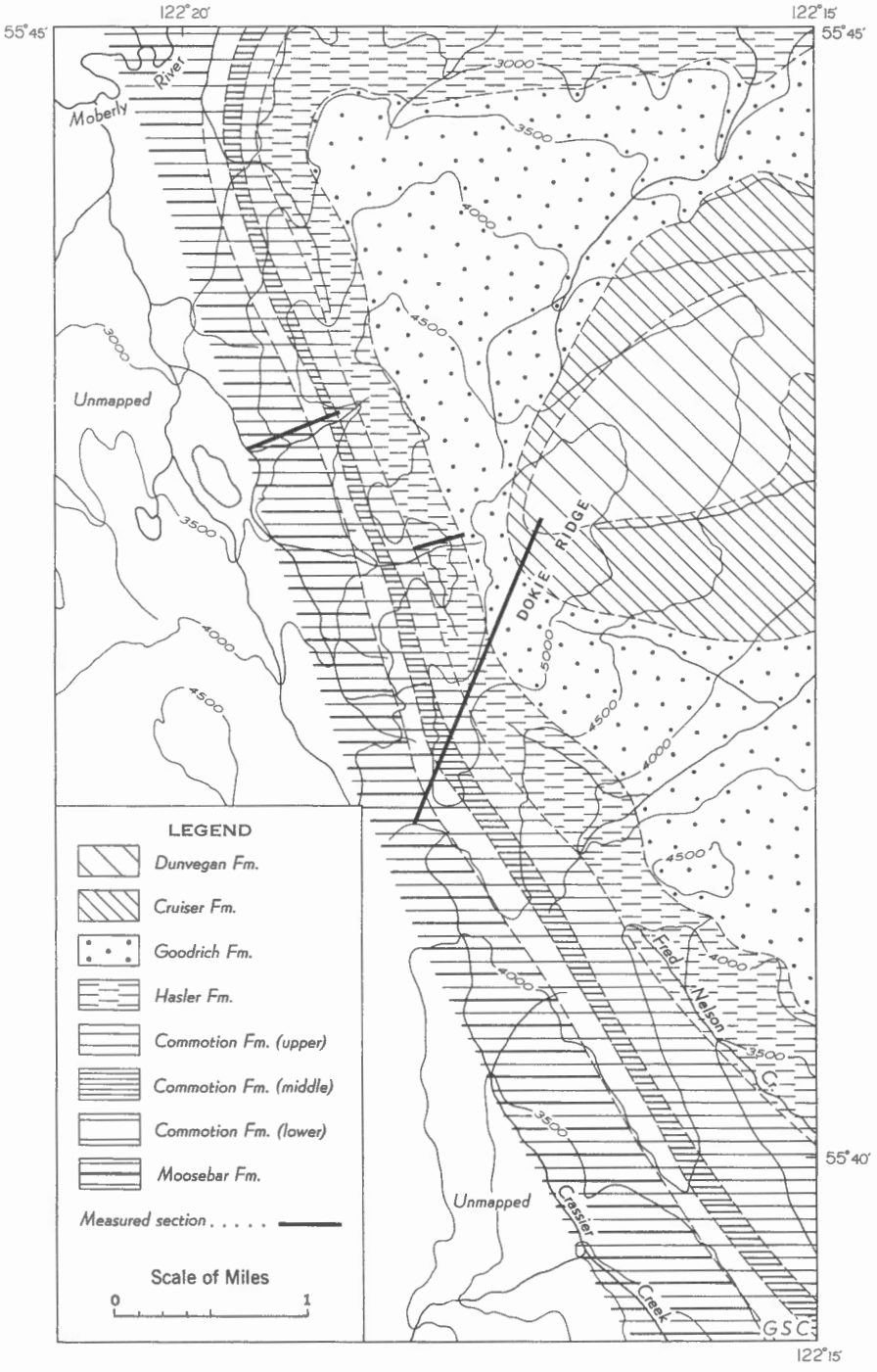

Figure 2. Index map showing location of measured sections on Dokie Ridge

strata were measured on Dokie Ridge, and probably the overall thickness of the group in this region does not exceed 5,000 feet.

The distribution and description of the Fort St. John group in the region south of Bullmoose Mountain are outlined by the writer (Stott, 1960). In 1960 the group was traced northwestward from there to beyond Moberly River. In the immediate vicinity of Pine River, the distribution of the group is shown by Wickenden and Shaw (1943).

Moosebar Formation

The Moosebar formation was originally defined by McLearn (1923). McLearn and Kindle (1950, p. 74) stated:

> The Moosebar is the lowest formation of the Fort St. John group in Pine and Peace River Valleys, and lies between the Gething formation of the Bullhead group and the Gates or Commotion formation of the Fort St. John group above. It consists of 1,000 to 1,200 feet of marine, dark shale, with, in places, thin layers of clay ironstone and, particularly in the upper part, some beds of sandstone. The type section is that exposed in the central part of Peace River Canyon, and in valleys of streams entering the canyon from the south and southwest.

In their description of the Moosebar formation near Pine River, Wickenden and Shaw indicated that a partial section of 540 feet is exposed on Crassier Creek. A more complete section—on Dokie Ridge north of the headwaters of Crassier Creek (Fig. 2)—was found to be 952 feet thick (Sec. 2). At that locality the basal beds do not outcrop but the Moosebar's upper contact with the Commotion formation is well exposed. Other sections of Moosebar shales were examined on Bullmoose Mountain where the thickness was 461 feet (Sec. 3). Variation in thickness is attributed mainly to facies changes in which Commotion sandstone grades laterally into Moosebar shales northwestward along the Foothills.

The contact of the Moosebar formation with the underlying Gething formation is distinct and is generally marked by a layer of well-rounded chert pebbles. This contact was not seen on Bullmoose Mountain nor near Dokie Ridge. The basal succession on Coalbed Creek near Peace River canyon is as follows:

Moosebar Formation

Shale, dark grey, silty, blocky ..... 40 feet

Conglomerate; mudstone matrix; pebbles, well-rounded, more spherical than discoidal, chert and quartzite, averaging 1/2-1 inch but rare cobbles as much as 4 inches in diameter ..... 1.5 feet

Shale, dark grey, silty ..... 1 foot

Gething Formation

Sandstone, silty, carbonaceous, brown; thinly bedded

A similar basal Moosebar conglomerate has been observed in sections south of Bullmoose Mountain (see Stott, 1960, Sec. 3).

The upper boundary of the Moosebar formation is gradational and is drawn at the base of the first thick succession of sandstone. The contact does not maintain a constant stratigraphic position but occupies an increasingly higher stratigraphic position as the formation is traced northeastward and northwestward in the Foothills.

In the section on Bullmoose Mountain, two highly glauconitic argillaceous sandstones occur in the basal 30 feet of the formation. Small chert pebbles are present within the lower sandstone. These beds may be partly or wholly equivalent to the Bluesky formation (Badgley, 1952; Alberta Study Group, 1954; Workman, 1959) of the Peace River Plains. This sandstone unit was not recognized south of Bullmoose Mountain (see Stott, 1960, Sec. 3).

The lower half of the Moosebar formation consists of rubbly to flaky dark grey shale containing abundant sideritic concretions. The upper part shows an increase in silt content in the form of argillaceous siltstone and silty sandstone.

Commotion Formation

A succession of sandstone, shale, and conglomerate, which overlies the Moosebar formation, was defined as the Commotion formation by Wickenden and Shaw (1943, p. 5). Although the formation is mappable near Pine River, exposures are so poor and incomplete that Wickenden and Shaw were unable to describe in detail a complete succession at any one locality. Their estimate of thickness on Hasler Creek, obtained from discontinuous exposures, can be considered only as an approximation, as the section there is not as complete as one might infer from the remarks of McLearn and Kindle (1950, p. 78).

Although the outcrops on Hasler and Commotion Creeks can serve as typical exposures of the formation, two more complete sections are designated as standards; one on Bullmoose Mountain (Sec. 4), and one on Dokie Ridge (Secs. 1 and 2). In the former, the basal member is partly nonmarine, but at the latter locality it is predominantly, if not entirely marine.

The variation in thickness of the Commotion formation is due mainly to facies changes. A general thinning of the formation occurs northeastward. Some thickening occurs in the upper two members as they are traced northwestward to Peace River. Two sections on Bullmoose Mountain were 1,598 and 1,145 feet thick. On Dokie Ridge the thickness is 1,311 feet.

The lower contact with the Moosebar formation is gradational and does not occupy the same stratigraphic position throughout the Foothills. The upper boundary of the Commotion formation is very distinct, with an abrupt change from carbonaceous and/or coarse-grained sediments to marine shale. It appears to form a persistent horizon which lies at approximately the same stratigraphic position throughout the region.

Three mappable members are recognized in the Commotion formation between Wapiti and Pine Rivers. Wickenden and Shaw, who first recognized these units, did not, however, stress the marine nature of the middle shale member, although mention was made of marine fossils from the basal beds of the overlying sandstone member. Formal names are not proposed for these members at the present time, pending completion of this study and more precise correlation between the Pine and Peace River sections.

Description of Type Localities

Only a generalized description can be given of the succession at the type localities. The outcrops on Commotion Creek give a fair approximation of the lithology of the upper member. The contact of the Hasler and Commotion formations is exposed about 3/4 mile upstream from the falls and is easily reached from the logging road that follows the creek. The succession there is as follows:

Hasler Formation

Siltstone, argillaceous and sandy, dark grey; blocky to massive; rusty-weathering..... 8 feet

Sandstone, very coarse grained; disseminated chert pebbles, 1/8 - 1/2 inch ..... 10 feet

Commotion Formation

Sandstone, very argillaceous, carbonaceous, silty; flaggy to thickly bedded ..... 5 feet

Wickenden and Shaw (1943, p. 6) apparently considered that the contact lay somewhat lower stratigraphically, but it is more properly drawn between the basal Hasler conglomerate and the carbonaceous sediments of the Commotion formation.

Isolated exposures of the plant-bearing beds of the upper member occur farther downstream. A description of the largest, which is more or less typical, follows:

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
17	Sandstone, fine-grained, laminated	6	66
16	Mudstone, dark grey; rubbly to blocky	5.5	60
15	Siltstone, sandy, argillaceous ...	3	54.5
14	Mudstone, dark grey	9	51.5
13	Coal, partly talus-covered	1	42.5
12	Mudstone, dark grey	3	41.5
11	Sandstone, laminated, brown, thick-bedded	10	38.5
10	Shale, olive-grey, rubbly	0.5	28.5
9	Coal	0.5	28
8	Mudstone, very coaly and carbonaceous	6	27.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Sandstone, fine- to medium-grained, laminated, brownish grey; crosslaminated, carbonaceous; massive; brown-weathering	5.5	21.5
6	Mudstone, black, rubbly	2.5	16
5	Coal	1	13.5
4	Sandstone, fine-grained, laminated, crosslaminated, brown, very argillaceous; massive; brown-weathering	5	12.5
3	Mudstone, sandy, dark grey, platy	0.5	7.5
2	Sandstone, fine-grained, laminated, crosslaminated, brown; thickly bedded; very argillaceous at base	5	7
1	Mudstone, dark grey, blocky	2	2
	End of exposure		

Farther downstream, the lower beds of the upper member are well exposed and contain the massive conglomeratic beds that are so characteristic of this member in the region from Belcourt Lake to north of Moberly River. The succession is as follows:

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Overlying beds not exposed		
6	Conglomerate; massive; pebbles about 1/8 inch; mostly inaccessible	25	110.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Conglomerate; massive; coarse-grained matrix; pebbles average 1/2 - 1 inch, some are 2 inches; chert and quartzite pebbles, grey, green, black, bluish grey, and white	28	85.5
4	Conglomerate; massive; pebbles 1/8 inch; coarse-grained matrix; pebbles increase in size towards top	7.5	57.5
3	Contact with underlying beds is distinct and abrupt. Conglomerate appears to lie unconformably on sandstone		
2	Sandstone, fine-grained, laminated; lenses and streaks of coarse-grained sandstone and pebbles 1/8 - 1/4 inch; some crossbedding	6	50
1	Sandstone, fine-grained, laminated, grey, clean; very massive; bedding not apparent; streaks of coarse-grained sandstone and some pebbles	44	44

Slightly below these beds is another cliff on which the following succession is exposed:

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10	Sandstone and shale interbedded	16	51

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Sandstone, fine-grained, laminated, grey; grey- to brown-weathering	1.5	35
8	Sandstone and shale inter-bedded	1	33.5
7	Sandstone, fine-grained, laminated, massive; grey- to brown-weathering	7	32.5
6	Shale and sandstone interbedded; grades into massive sandstone along slope	7	25.5
5	Sandstone, fine-grained, laminated, grey; medium-bedded	2	18.5
4	Shale and sandstone interbedded..	2.5	16.5
3	Sandstone, fine-grained, laminated, grey; thickly bedded; brown-weathering; shaly interval in middle	6	14
2	Sandstone, fine-grained, laminated, grey; some inter-bedded shale; beds 2 - 3 inches	5	8
1	Sandstone, fine-grained, lamin-ated, grey; thickly bedded; brown-weathering	3	3

The more massive beds, particularly the conglomerates, are partly exposed along Hasler Creek and are better exposed on a ridge trending northwestward to Pine River.

The middle member is not completely exposed in the vicinity of Pine River but may be recognized as a recessive interval between the more prominent sandstones of the adjacent members. The contact between the upper and middle members is exposed on the south side of Hasler Creek about 7 miles upstream from Pine River. The succession there follows:

Upper Member

Sandstone, fine-grained, laminated, grey; massive; few thin lenses of shale ..... 47 feet

Contact with middle member is distinct, abrupt, and shows cut-and-fill structures. Relief on the shale is in the order of 3-4 feet

Middle Member

Mudstone, very silty, dark grey, to siltstone, argillaceous, rusty-weathering, blocky ..... 21 feet

Although in this section the contact relationship appears to be that of an erosional unconformity, the more common one is a gradation from the mudstone into the overlying sandstone.

The lower member of the Commotion formation is very poorly exposed along Hasler Creek where only a few units of fine-grained laminated brown sandstone outcrop, and none of the shale intervals are visible. As outlined by Wickenden and Shaw, only an approximate thickness and generalized description can be obtained at this locality.

The basal sandstone member, originally estimated by Wickenden and Shaw to be 500 to 600 feet thick, varies from 781 feet on Bullmoose Mountain (Sec. 3) to 355 feet on Dokie Ridge (Sec. 2). The basal part of the member consists predominantly of fine-grained, brown sandstone which is probably marine. South of Bullmoose Mountain, these marine sandstones are overlain by a succession of interbedded sandstones, siltstones, and mudstones containing an abundant flora; according to Bell and McGregor, the plant fossils are typical of the Luscar flora. On Bullmoose Mountain, conglomerate appears in three massive beds of the lower member. Although the conglomerate resembles the Cadomin conglomerate the pebbles are much smaller, averaging about 1/2 inch in diameter. On Dokie Ridge where no plant-bearing beds were recognized in the basal member, the entire member consists of fine-grained, well-sorted sandstone and dark grey shale, and is considered to be marine.

The middle marine shale member increases in thickness from south of Wapiti River toward Peace River. Its maximum thickness on Bullmoose Mountain is 315 feet and on Dokie Ridge, 447 feet. It consists of a succession of dark grey to black silty shales which are rubbly to platy, weather rusty, and contain some reddish brown sideritic concretions. A layer of chert pebbles commonly is found at the base of the middle member, immediately above carbonaceous sediments of the lower member. The upper beds are transitional into the sandstones of the upper member.

The upper member is the Boulder Creek conglomerate of Spieker (1921). Its maximum thickness on Bullmoose Mountain is 501 feet, and on Dokie Ridge, 556 feet. It contains fine-grained clean marine sandstone, conglomerate, carbonaceous sandstone, and mudstone. The shales of the middle member grade upwards into a massive unit of fine-grained sandstone, which in turn is overlain by massive conglomerate. The conglomerate forms a very prominent cliff near the mouth of Commotion Creek. Several conglomerate beds are present in some localities. The conglomerate is composed mainly of chert and quartzite pebbles averaging between 1/2 and 1 inch in diameter. The upper beds of this member are nonmarine, consisting of carbonaceous sandstones and mudstones. These beds apparently yielded the angiosperm flora collected by Wickenden and Shaw and reported by Bell (1956, p. 37). The present study has shown, by collections from several widely separated sections, that angiosperm plants first become abundant in the upper member. This assemblage differs from that of the lower member.

Hasler Formation

The Hasler formation was defined by Wickenden and Shaw (1943, p. 6) as those shales overlying the Commotion formation. They found no complete section of the formation near Pine River and did not specify a type section, although they noted outcrops along Hasler Creek. The type section is therefore designated as that occurring in a small stream flowing westward from Dokie Ridge into a tributary of Moberly River (see Fig. 2). This section is only a few miles from the area where the formation was established.

At the type locality the Hasler formation is almost completely exposed except for about 25 feet of beds at the base. The formation can be divided into two members there but exposures elsewhere were too poor to make such a division useful. The type section is 868 feet thick. No other completely exposed section of the Hasler is known, and therefore, variation in thickness cannot be determined.

Type Section—Hasler Formation: Stream flowing westward off north slope of Dokie Ridge, Dawson Creek map-area, B. C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Goodrich Formation		
3	Conglomerate; pebbles average 1/2 inch, some are 1 1/2 inches in diameter	1.5	32.5
2	Siltstone, sandy, argillaceous, brown; very sandy at top	6	31
1	Sandstone, fine-grained, brown, laminated; massive to thickly bedded; 6 inches of conglomerate at top	25	25
	Hasler Formation		
	Upper Member		
37	Siltstone, argillaceous, sandy, brown, laminated; massive	10	868
36	Mostly covered at creek level. Mudstone grading upwards into siltstone; exposed on high cliff	86	858
35	Sandstone, fine-grained, laminated, brown; thinly bedded to flaggy; and interbedded shale, silty; shale content decreases upwards	33	772
34	Mudstone, rubbly; numerous thin layers of sideritic concretions; siltier at top with few thin beds of sandstone	38	739
33	Partly covered. Mudstone, rubbly, with some beds of siltstone	31	701

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
32	Sandstone, very coarse grained, grey, pebbly	1	670
31	Siltstone, argillaceous, laminated; blocky to flaggy; few sideritic concretions	9	669
30	Mostly covered. Shale, rubbly	27	660
29	Shale, rubbly	8	633
28	Conglomerate, massive; coarse-grained matrix; pebbles average about 1/2 inch in diameter	2	625
27	Shale, very rubbly, dark grey; grading upwards into mudstone, silty, blocky	110	623
26	Conglomerate, thinly bedded, lensy; rounded pebbles up to 1 inch but most average about 1/2 inch; coarse-grained matrix; interbedded shale	3	513
25	Shale, rubbly; rusty-weathering; few ironstone concretions	9	510
24	Shale, rubbly to platy; rusty-weathering; siltier towards top	19	501
23	Shale, rubbly; rusty-weathering; siltier at top	35	482
	Lower Member		
22	Siltstone, argillaceous; massive to blocky	12	447

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
21	Mudstone, silty, dark grey; blocky; siltier towards top; partly covered	33	435
20	Siltstone, argillaceous, laminated, flaggy; rusty-weathering; sandy at top; some interbedded shale	24	402
19	Shale, silty, platy, dark grey; interbedded platy siltstone	30	378
18	Siltstone and shale interbedded	18	348
17	Shale, silty, platy, dark grey	31	330
16	Siltstone, argillaceous, laminated; platy to flaggy; rusty-weathering; few concretions; some fine-grained sandstone	15	299
15	Shale, silty, platy; some interbedded siltstone, laminated, grey; siltier at top; sideritic concretions	27	284
14	Sandstone, fine-grained, brown to grey, laminated; thinly bedded; interbedded shale	4	257
13	Shale, silty, dark grey; rubbly to platy; some sideritic concretions	18	253
12	Sandstone, laminated; thinly bedded; interbedded shale in 3- to 4-inch beds; more sandstone at top	10	235
11	Not well exposed. Shale to mudstone, silty	12	225

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10	Sandstone, very fine grained, silty and argillaceous, brown; flaggy; interbedded shale and siltstone	8	213
9	Siltstone, argillaceous, sandy, dark grey; blocky to thinly bedded	15	205
8	Covered	30	190
7	Siltstone, very argillaceous, dark grey; blocky; grey- to rusty-weathering	16	160
6	Mudstone, blocky, dark grey	15	144
5	Mudstone, very silty, dark grey; blocky; grades into argillaceous siltstone	18	129
4	Mudstone, silty, dark grey; blocky; rusty-weathering	26	111
3	Siltstone, argillaceous, sandy, laminated, grey; flaggy	34	85
2	Mudstone, very silty, dark grey; blocky; grading upwards into siltstone, argillaceous, rusty-weathering	26	51
1	Covered. Approximate	25	25
	Contact with Commotion formation was not seen.		

The lower boundary of the Hasler formation is marked by a layer of pebbles in a shaly matrix or by pebbly sandstone. The precise stratigraphic relationship of the base of the formation throughout the region is not known, but more beds may occur at the base in the Pine River region than farther southeastward in the Foothills. The

upper boundary is drawn at the base of massive sandstone and probably does not maintain a constant stratigraphic position.

The Hasler formation consists of dark grey marine shale with sideritic concretions. On Dokie Ridge the lower part of the formation is very silty and contains several units of fine-grained, thinly bedded sandstone. The shales in the upper part of the formation are rubbly and are less silty, except near the top where they grade upwards into the sandstones of the Goodrich formation. Thin conglomerates in the upper part may correlate with the conglomerate noted by Wickenden and Shaw on Hasler Creek.

A recessive unit lying above the Commotion formation has been mapped as the Hasler formation as far south as Murray River. Some of the lower beds are exposed on the eastern flank of Bullmoose Mountain.

Goodrich Formation

The Goodrich formation includes, according to Wickenden and Shaw (1943, p. 7), sandstone beds lying between the Hasler and Cruiser shales. A described section on the first eastern tributary of Boulder Creek was found by these geologists to be 262 feet thick. As this section is fairly well exposed, it is hereby designated as the type section. Moreover, as 463 feet was measured in 1960, much more of the formation is exposed at this locality than was indicated previously. Inasmuch as all the formation does not outcrop at this locality, a standard section is also outlined on Dokie Ridge (Sec. 1). There the formation, which apparently contains a much larger stratigraphic interval, is 1,320 feet thick.

Type Section—Goodrich Formation: Goodrich Creek, first eastern tributary of Boulder Creek, Dawson Creek map-area, B. C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Top of ridge—end of exposure		
	Goodrich Formation		
20	Sandstone, fine-grained, laminated; massive but platy-weathering	23	463.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
19	Covered. Approximately	35	440.5
18	Sandstone, fine-grained, laminated, grey; platy to flaggy; some interbedded argillaceous siltstone; sandier and massive towards top	37	405.5
17	Siltstone, sandy, argillaceous, laminated; flaggy to platy; interbeds of fine-grained argillaceous sandstone	27	368.5
16	Covered	33	341.5
15	Sandstone, fine-grained, laminated, cross-laminated; crossbedded; massive to thick-bedded; light-yellowish-brown- to grey-weathering; few thin shaly intervals; platy-weathering, especially at top	43	308.5
14	Mudstone, very silty; blocky; some interbedded siltstone; grading into sandy flaggy siltstone at top	24	265.5
13	Sandstone, fine-grained, grey; platy	10	241.5
12	Mudstone, silty, dark grey; some argillaceous siltstone; grading upwards into siltstone	23	231.5
11	Sandstone, medium-grey; flaggy	8	208.5
10	Siltstone, sandy, argillaceous; grading upwards into sandstone, fine-grained, laminated, flaggy	4	200.5
9	Covered	19	196.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Sandstone, fine-grained, laminated, grey; thickly bedded; platy-weathering, especially at top; lenses of coarse-grained sandstone	38.5	177.5
7	Mudstone, silty; dark grey; platy; grading upwards into argillaceous siltstone and thin sandstone	22	139
6	Sandstone, fine-grained, grey, homogeneous; thickly bedded to massive; yellow-weathering	32	117
5	Mudstone, very silty, to siltstone, argillaceous, blocky, dark grey; thin beds of laminated, fine-grained sandstone	17	85
4	Sandstone, fine-grained, laminated, grey; thickly bedded to massive	13	68
3	Sandstone, argillaceous, silty, fine-grained, dark grey, laminated; thinly bedded to platy	12	55
2	Mudstone to siltstone; dark grey; blocky; siltier at top	8	43
1	Sandstone, fine-grained, laminated, argillaceous, thin- to medium-bedded; 2- to 6-inch beds; few thin shale beds and reddish-brown-weathering concretions	35	35

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Hasler Formation		
2	Mudstone, silty; grading into siltstone, argillaceous, laminated, blocky	93	213
1	Mudstone and siltstone interbedded (70 - 30): mudstone, very silty, dark grey; blocky to platy; rusty-weathering; sulphur stain; few reddish-brown-weathering concretions; not well exposed in upper part	120	120

The contact of the Goodrich formation with the underlying Hasler formation is gradational and is drawn at the base of massive sandstone. Interbedded sandstone and shale are placed within the upper part of the Hasler formation. In contrast, the upper boundary is distinct and abrupt where Cruiser shales lie on massive Goodrich sandstone. Nevertheless, the upper boundary probably is drawn at the top of successively lower sandstones as the formation is traced eastward and southeastward.

Although the Goodrich sandstones are predominantly fine grained, some coarse-grained sandstone and conglomerate are known to be present within the formation. On a hill on the west side of Hasler Creek about 4 miles from Pine River, coarse-grained massive sandstone, 30 feet thick, lies about 60 feet below a massive conglomerate. The conglomerate, 25 feet thick, consists mainly of chert and quartzite pebbles averaging 1/4 to 1/2 inch in diameter. Some sandstone lenses occur within the conglomerate; in some places along the cliff, sandstone replaces most of the conglomerate.

A very pronounced lithologic change is found within the formation as it is traced southeastward along the Foothills towards Murray River. Most of the sandstone grades laterally into siltstone and mudstone, until near Wolverine River the formation consists of only one thin unit of sandstone (see Stott, 1960). Farther south, this sandstone disappears and the Goodrich formation is no longer recognizable.

Cruiser Formation

According to Wickenden and Shaw (1943, p. 8):

> Overlying the Goodrich is a formation consisting of dark grey shale and sandstone beds. The name 'Cruiser' is suggested for this formation, which is well exposed on Cruiser Mountain.

McLearn and Kindle (1950, p. 83) stated that the type locality of the formation was on Cruiser Mountain. Inasmuch as the shales are no longer exposed there, that locality is unsatisfactory as the type section. No complete section of the formation is known within this region but the largest exposure is on a small tributary on the south side of Pine River, 3/4 to 1 mile east of Young Creek. That section is therefore designated as the type section. Wickenden and Shaw (p. 9) gave a summary description of this section; a more detailed one follows:

Type Section—Cruiser Formation: Gully east of Young Creek, south side of Pine River, Dawson Creek map-area, B. C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Dunvegan Formation		
	Sandstone, fine-grained, cross-laminated, grey; massive to thick-bedded	10	
	Cruiser Formation		
10	Partly covered. Mudstone, silty; interbedded argillaceous sandstone	40	742
9	Mudstone, very silty; grading upwards into argillaceous siltstone	28	702

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Siltstone, argillaceous, dark grey; blocky to bedded	36	674
7	Mudstone, very silty; blocky; grading into argillaceous siltstone; few concretions, reddish-brown-weathering	85	638
6	Mudstone, rubbly to blocky; rusty-weathering; siltier at top	60	553
5	Mudstone, silty, dark grey, rusty-weathering; interbedded platy siltstone (30%) increasing towards top; becoming very sandy and flaggy, beds 2 - 3 inches	197	493
4	Mudstone, very silty, dark grey; rusty-weathering; some interbedded siltstone; siltier at top	99	296
3	Mudstone, silty, dark grey; rusty-weathering; some platy siltstone; sulphur stain	94	197
2	Mudstone, silty; platy to blocky; rusty-weathering; partly covered	24	103
1	Mudstone and siltstone interbedded (70 - 30); dark grey, rusty-weathering; flaggy; becoming much siltier and sandy in upper third with 2- to 3-inch beds	79	79
	Underlying beds covered by glacial drift		

Although the Cruiser formation is more than 750 feet thick at the type locality, it is considered to be only 361 feet thick on Dokie Ridge (Sec. 1). Without more closely spaced sections, it cannot be stated at this time whether the decreased thickness is due only to a

facies change from shale to sandstone in the upper beds, or also to a similar change in the lower beds. It may be that changes take place at both the top and the base. Probably several sandstones included in the Dunvegan and Goodrich formations change eastward into shale, thereby increasing the stratigraphic interval of the Cruiser formation.

On Dokie Ridge the almost continuous succession of sandstone between the base of the Goodrich formation and Dunvegan formation indicate the pronounced facies change in beds equivalent to the Cruiser formation. The occurrence of dark grey shale nevertheless indicates that some of the Cruiser formation can be mapped as a distinct unit. Even at that, some massive sandstone has been included in the formation. A lower recessive interval (Units 70-72, Sec. 1) perhaps should also have been included in the Cruiser formation, but as this interval did not appear to consist of marine shale it was included in the underlying formation.

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APPENDIX

Section 1. Dunvegan formation and Fort St. John group; Dokie Ridge, Dawson Creek map-area, B.C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Dunvegan Formation		
16	Sandstone, coarse-grained, brownish grey; massive; grey-weathering; some conglomeratic lenses	14	230
15	Covered	26	216
14	Sandstone, fine-grained, brown, laminated; massive; cross-bedded; platy-weathering	27	190
13	Conglomerate; pebbles up to 1 inch in diameter	3	163
12	Sandstone, fine-grained, brown, laminated; massive; grey-weathering; lenses of conglomerate	8	160
11	Sandstone, fine-grained, brown, homogeneous, to laminated, grey; massive; platy-weathering	30	152
10	Covered	8	122
9	Sandstone, fine-grained, brown, homogeneous, to laminated; massive; platy-weathering, grey-weathering	30	114
8	Covered	10	84

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Sandstone, fine-grained, brown, laminated; crossbedded; massive; platy-weathering, grey-weathering	13	74
6	Siltstone, argillaceous, brown	1	61
5	Sandstone, fine-grained, brown, laminated; crossbedded; massive but weathers platy; grey-weathering	9	60
4	Covered; appears to be mainly sandstone	20	51
3	Sandstone, fine-grained, laminated, brownish grey; crossbedded; platy-weathering, grey weathering	14	31
2	Covered	12	17
1	Sandstone, fine-grained, laminated, brownish grey; platy; crossbedded; grey-weathering	5	5
	Cruiser Formation		
8	Covered. Shale, silty, rusty-weathering, in talus	115	361
7	Sandstone, fine-grained, brown, laminated; crossbedded; platy	14	246
6	Covered	14	232
5	Sandstone, fine-grained, grey, homogeneous; massive; grey-weathering	16	218

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Sandstone, fine-grained, brown, laminated to homogeneous; massive; some crossbedding; grey-weathering	38	202
3	Covered	40	164
2	Siltstone, argillaceous, dark grey, platy; rusty-weathering; few dolomitic lenses; very sandy towards top; some interbedded silty shale	34	124
1	Partly covered. Rusty-weathering, platy, dark grey shale in talus	90	90
	Goodrich Formation		
72	Sandstone, fine-grained, brownish grey, laminated to homogeneous; irregularly bedded; slightly mottled; grey-weathering; flaggy to medium-bedded, some crossbedding	55	1,320
71	Sandstone, fine-grained, brown, laminated; grey- to brown-weathering; flaggy	8	1,265
70	Covered. A few small exposures of platy sandstone and silty shale	102	1,257
69	Sandstone, fine-grained, brown, laminated, calcareous; cross-bedded; platy, brownish weathering	41	1,155
68	Covered. Some sandstone	25	1,114

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
67	Sandstone, fine-grained, brown, laminated, calcareous; cross-bedded; brown-weathering; massive but platy-weathering	23	1,089
66	Covered	26	1,066
65	Sandstone, fine-grained, laminated, brown; platy; some coarse-grained lenses	20	1,040
64	Sandstone, fine-grained, laminated, brown; platy	18	1,020
63	Sandstone, fine-grained, laminated, brown; crossbedded; platy; brown-weathering; more thickly bedded in upper 2 feet	49	1,002
62	Covered	25	953
61	Sandstone, grey; thickly bedded; grey-weathering	1	928
60	Sandstone, fine-grained, brown; laminated platy; calcareous; crossbedded; massive	40	927
59	Covered. Some medium-grained sandstone	4	887
58	Sandstone, fine-grained, brown, laminated, platy	4	883
57	Covered	11	879
56	Sandstone, fine- to medium-grained, grey; thickly bedded; grey-weathering	5	868
55	Sandstone, fine-grained, brown, laminated, calcareous; crossbedded; massive; brown-weathering, platy-weathering	79	863

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
54	Covered	57	784
53	Sandstone, fine-grained, brown, laminated, calcareous; platy; crossbedded; brown-weathering	8	727
52	Covered	30	719
51	Sandstone, fine-grained, brown, laminated, calcareous, platy	8	689
50	Sandstone, fine-grained, laminated to homogeneous, calcareous, grey; medium-bedded	4	681
49	Covered	42	677
48	Sandstone, fine-grained, brown, calcareous; platy; crossbedded	2	635
47	Covered	5	633
46	Sandstone, fine-grained, brown, calcareous; platy; crossbedded; lenses out	3	628
45	Covered	9	625
44	Sandstone, fine-grained, brown, laminated, calcareous; platy; crossbedded; brown-weathering	4	616
43	Covered	12	612
42	Sandstone, medium- to coarse-grained, grey; massive; some crossbedding; grey-weathering	6	600
41	Covered	21	594
40	Sandstone, fine-grained, brown, homogeneous to laminated; flaggy; crossbedded	13	573

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
39	Covered	39	560
38	Sandstone, fine-grained, brown, laminated; platy; crossbedded; brown-weathering	7	521
37	Covered	5	514
36	Sandstone, fine-grained, brown, laminated, slightly calcareous; platy; crossbedded; brown-weathering	3	509
35	Covered	11	506
34	Sandstone, fine-grained, brown, laminated, slightly calcareous; platy; crossbedded; brown-weathering	2	495
33	Mostly covered. Some carbonaceous siltstone and shale with plants at top	18	493
32	Sandstone, fine- to medium-grained, grey, homogeneous to laminated; massive; grey-weathering	2	475
31	Sandstone, fine-grained, brown, laminated; massive; calcareous; crossbedded; platy-weathering, brown-weathering	27	473
30	Covered	3	446
29	Sandstone, medium-grained, homogeneous, brownish grey; massive; slightly crossbedded; grey-weathering	28	443

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
28	Sandstone, fine-grained, brown, laminated, calcareous; platy; crossbedded; brown-weathering	28	415
27	Covered	14	387
26	Sandstone, fine-grained, laminated, brown, slightly calcareous; platy	3	373
25	Covered. Shaly talus	10	370
24	Sandstone, fine-grained, laminated, slightly calcareous, brown; platy	4	360
23	Covered	9	356
22	Sandstone, fine-grained, grey, homogeneous, calcareous	1	347
21	Sandstone, fine-grained, laminated, brown, calcareous; platy; crossbedded	2	346
20	Covered. Shaly talus	20	344
19	Sandstone, fine-grained, laminated, brown, calcareous; platy; crossbedded	4	324
18	Covered. Shaly talus	11	320
17	Sandstone, argillaceous, brown, laminated; platy	2	309
16	Covered. Shaly talus	15	307
15	Sandstone, fine- to medium-grained, laminated, brownish grey, calcareous; massive but weathers platy; crossbedded	15	292

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
14	Shale, not well exposed	4	277
13	Sandstone, fine- to medium-grained, laminated, calcareous	3	273
12	Sandstone, fine-grained, brown, laminated, calcareous; massive but weathers platy; crossbedded; brown-weathering	15	270
11	Sandstone, fine-grained, brown, laminated, slightly calcareous; platy; crossbedded	14	255
10	Sandstone, argillaceous, brown; platy to flaggy; crossbedded; brown-weathering	5	241
9	Covered	56	236
8	Sandstone, fine-grained, brown, laminated; flaggy; brown-weathering; 4 inches of very coarse grained sandstone with pebbles at top	3	180
7	Covered	29	177
6	Sandstone, fine-grained, brown, laminated, slightly calcareous; crossbedded; massive but weathers platy; brown-weathering; shaly intervals; some mottling	28	148
5	Siltstone to mudstone, platy, olive-brown, olive-brown-weathering	3	120
4	Sandstone, very fine grained, homogeneous to laminated; flaggy	6	117

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Covered	79	111
2	Conglomerate, well-indurated, grey; pebbles average about 1/4 inch in diameter but some are as much as 2 inches	1	32
1	Sandstone, fine-grained, brown, laminated; platy; crossbedded; trace of angiosperm fragments	31	31
	Hasler Formation		
1	Covered	877	877
	Commotion Formation		
39	Sandstone, fine-grained, laminated; massive; some conglomerate at base	7	1,311
38	Covered	34	1,304
37	Sandstone, fine-grained, brown, laminated; platy to flaggy	12	1,270
36	Sandstone, very coarse grained, to conglomeratic; massive; grading upwards into conglomerate	13	1,258
35	Covered	44	1,245
34	Sandstone, fine-grained, brown, laminated; flaggy	6	1,201
33	Covered	107	1,195

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
32	Conglomerate, well-indurated, grey; weathers into rounded masses; pebbles up to 1 1/2 inches, green, grey, black, chert, quartzite; pebbles decrease in size towards top	40	1,088
31	Sandstone, fine-grained, grey, clean, laminated to homogeneous; massive to thickly bedded; grey-weathering; some crossbedding; few thin streaks of conglomerate towards top; becomes coarser-grained towards top	94	1,048
30	Covered	64	954
29	Sandstone, fine-grained, brownish grey, laminated; thick- to massive-bedded; grey-weathering	35	890
28	Covered. Downslope another massive sandstone appears 10 feet above base but lenses out northward	62	855
27	Sandstone, fine-grained, homogeneous to laminated, grey, clean; massive to thick-bedded; crossbedded; grey-weathering; few concretionary zones; few small lenses of fine conglomerate	38	793
	Middle Member		
26	Siltstone, argillaceous, laminated, grey; platy; rusty-weathering; well-indurated; sandier towards top; grades into overlying beds	55	755
25	Covered	124	700

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
24	Mudstone, silty; grading upwards into argillaceous siltstone, grey, platy; rusty-weathering	46	576
23	Siltstone, argillaceous, laminated, grey; platy; grey- to rusty-weathering	10	530
22	Covered	169	520
	Lower Member		
21	Sandstone, fine-grained, laminated, limonitic; platy	5	351
20	Covered	20	346
19	Sandstone, fine-grained, grey, laminated; massive to thick-bedded; platy-weathering; limonitic	17	326
18	Conglomerate, grey; massive; pebbles as much as 1 inch in diameter; matrix of fine-grained sandstone; lenses and beds of fine-grained sandstone	10	309
17	Sandstone, fine-grained, grey, laminated; crossbedded; massive; weathers platy and brownish grey	8	299
16	Covered	20	291
15	Sandstone, fine-grained, brown, crossbedded, platy	2	271
14	Covered. Talus suggests olive-brown rubbly mudstone with some siltstone	53	269

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Siltstone, argillaceous, brown; olive-brown-weathering; blocky	2	216
12	Poorly exposed. Shale to mudstone, silty, olive-brown; brown-weathering	23	214
11	Siltstone, argillaceous, olive-grey	1	191
10	Poorly exposed. Mudstone, silty, greenish grey, olive-grey to olive-brown; few hard siltstone beds	15	190
9	Sandstone, fine-grained, brown, platy, laminated; brown-weathering	25	175
8	Covered	12	150
7	Conglomerate; pebbles up to 1 inch	1	138
6	Sandstone, fine-grained, laminated; platy; crossbedded; brown-weathering	5	137
5	Covered	40	132
4	Sandstone, fine-grained, brown, laminated; thick-bedded to massive; grey- to brown-weathering; limonitic; upper half shows crossbedding and weathers platy	34	92
3	Sandstone, fine-grained, brown, laminated; thickly bedded; some shaly interbeds; crossbedded	14	58
2	Shale, silty, platy; grading upwards into argillaceous siltstone	5	44

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Sandstone, fine-grained, brown, laminated; thickly bedded with some platy intervals; upper part is more crossbedded and tends to weather platy; worm burrows, tracks and trails	39	39
	Moosebar Formation		
8	Mudstone, rubbly, silty; grading upwards into platy argillaceous siltstone, brownish grey	26	91
7	Siltstone, argillaceous, dark grey; massive; grey-weathering; rusty-weathering concretionary spots	7	65
6	Mudstone, very silty, dark grey; grey-weathering; blocky to rubbly	39	58
5	Sandstone, fine-grained, brownish grey, laminated, platy	2	19
4	Shale, brownish grey, rubbly	2	17
3	Sandstone, fine-grained, brown, laminated; medium-bedded; few shaly intervals	7	15
2	Covered	4	8
1	Sandstone, fine-grained, brown, laminated; thinly bedded to platy; some crossbedding; limonitic; brown-weathering	4	4
	End of exposure.		

Section 2. Moosebar and Commotion formations; small creek flowing westward off Dokie Ridge, Dawson Creek map-area, B. C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Commotion Formation		
	Massive conglomerate in upper member does not outcrop in creek, but judging from ridge exposures, it lies approximately 140 feet above the first exposure		
45	Siltstone, interbedded with dark grey shale; grading upwards into platy sandstone	46	882
44	Sandstone, fine-grained, brown, laminated to homogeneous; massive; concretionary zones, pebbles in upper surface	34	836
	Middle Member		
43	Covered. Apparently is mainly argillaceous siltstone	33	802
42	Siltstone, argillaceous, dark grey; blocky; rusty-weathering	7	769
41	Covered	21	762
40	Mudstone, silty, dark grey; rusty-weathering	15	741
39	Siltstone, argillaceous, dark grey; flaggy; slightly rusty-weathering	18	726
38	Mudstone, dark grey; blocky	17	708
37	Mudstone, dark grey; blocky; grades into siltstone	42	691

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
36	Mudstone; blocky; grading upwards into siltstone	38	649
35	Mudstone, silty, dark grey; blocky; grey-weathering; grading upwards into argillaceous and sandy siltstone, laminated, grey, hard	38	611
34	Mudstone, silty; grading upwards into siltstone, argillaceous, laminated flaggy	30	573
33	Covered	24	543
32	Mudstone, silty, dark grey; blocky	26	519
31	Mudstone, silty, dark grey; blocky to platy	30	493
30	Mudstone, silty; grading into siltstone, blocky, argillaceous, sandy, dark grey, grey-weathering	34	463
29	Mudstone, silty, dark grey; grading upwards into blocky, argillaceous, dark grey siltstone	13	429
28	Siltstone, argillaceous, dark grey; blocky to flaggy; brownish-grey-weathering	23	416
27	Covered	23	393
26	Siltstone, argillaceous, dark grey; flaggy	4	370
25	Siltstone, argillaceous, dark grey; massive	3	366

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
24	Siltstone, argillaceous, dark grey; blocky	8	363
	Lower Member		
23	Sandstone, not well exposed	6	355
22	Sandstone, fine-grained, brown, homogeneous to laminated; massive; lenses of conglomerate and coarse-grained sandstone; pebbles up to 2 1/2 inches	15	349
21	Sandstone, argillaceous, dark grey; wavy bedding	9	334
20	Covered	30	325
19	Sandstone, fine-grained, brown, laminated; flaggy (sheared at top)	41	295
18	Sandstone, fine-grained, brown, laminated; thickly bedded to flaggy	5	254
17	Shale, silty, dark grey; blocky; rusty-weathering; grading upwards into siltstone, argillaceous, blocky, dark grey	33	249
16	Shale to mudstone, silty, dark grey; blocky; grading upwards into interbedded siltstone and shale	29	216
15	Siltstone, argillaceous; massive	3	187
14	Shale, silty, grey; rubbly to blocky; grey-weathering	27	184

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Siltstone, sandy, argillaceous, grey; thickly bedded; grey-weathering; interbedded silty shale; tracks and trails	13	157
12	Shale, silty, grey; platy to blocky	11	144
11	Sandstone, fine-grained, grey, mottled; grey-weathering; few scattered pebbles, especially on upper surface	2	133
10	Conglomerate in fine-grained sandstone matrix; pebbles up to 3 inches	1	131
9	Sandstone, fine-grained, laminated, brown; massive; brown-weathering	5	130
8	Covered	14	125
7	Sandstone, fine-grained, brown, laminated; brown-weathering; thin- to medium-bedded; some interbedded shale	6	111
6	Shale, very silty; platy to blocky; some interbedded siltstone	12	105
5	Sandstone, fine-grained, brown, laminated; thin- to medium-bedded; some interbedded shale	17	93
4	Shale, silty, dark grey; some interbedded siltstone and sandstone towards top	5	76

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Sandstone, fine-grained, laminated, brownish grey, brown-weathering; massive towards top; interbedded shale and siltstone at base	24	71
2	Siltstone, argillaceous, laminated, grey; bedded; some sandstone	24	47
1	Sandstone, fine-grained, brown, laminated; thick- to massive-bedded; brown-weathering	23	23
	Moosebar Formation		
20	Shale, rubbly; grading upwards into interbedded siltstone and sandstone	37	952
19	Shale, rubbly; grading upwards into argillaceous siltstone, blocky	36	915
18	Siltstone, argillaceous, dark grey; blocky; grey-weathering; sandier towards top	23	879
17	Sandstone, siltstone, and shale, thinly interbedded with massive sandstone at top	11	856
16	Sandstone, fine-grained, brown, laminated; thinly bedded; some shale; 2 feet of thick-bedded sandstone at top; tracks and trails	8	845
15	Shale, siltstone, and sandstone; thinly interbedded	19	837
14	Shale, grading into argillaceous siltstone; very sandy at top	11	818

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Shale, grading into argillaceous siltstone	14	807
12	Shale, silty, dark grey; blocky; grading into argillaceous siltstone at top	21	793
11	Siltstone, very argillaceous, laminated, dark grey; blocky to flaggy	18	772
10	Shale, rubbly; becoming siltier and blocky towards top	34	754
9	Shale, dark grey; rubbly at base; becoming very blocky at top	19	720
8	Shale, dark grey to black; rubbly to blocky; grey- to rusty-weathering	98	701
7	Shale, dark grey to black; rubbly; rusty-weathering; numerous small round marcasite concretions; some reddish-brown-weathering sideritic concretions	74	603
6	Shale, dark grey to black; rubbly to slightly blocky; rusty-weathering	65	529
5	Shale, rubbly at base; blocky towards top; concretionary bed at top	81	464
4	Shale, dark grey to black; rubbly; becoming blocky at top; rusty-weathering	91	383

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Shale, dark grey to black; rubbly; blocky at top; rusty-weathering; rare concretionary layer	75	292
2	Shale to mudstone, slightly silty, dark grey to black; rubbly to blocky; rusty-weathering; few concretionary layers	43	217
1	Shale, dark grey to black; rubbly; rusty-weathering; siltier towards top	174	174
	Beds below are folded and faulted.		

Section 3. Moosebar and Commotion formations, northeast ridge, Bullmoose Mountain, Dawson Creek map-area, B. C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Commotion Formation		
	Highest beds not exposed.		
42	Shale, dark grey, silty; rusty-weathering	30	828
41	Siltstone, sandy, laminated; medium-bedded; rusty-weathering	15	798
40	Conglomerate; pebbles as much as 1/2 inch; cut-and-fill base	1	783
	Lower Member		
39	Siltstone, brown, hard; platy; plant fragments	8	782
38	Mudstone, dark grey to olive-grey; few concretions; some siltstone	66	774
37	Siltstone, argillaceous; platy	5	708
36	Sandstone, fine-grained, laminated; massive; brown-weathering; plant fragments in talus	8	703
35	Mudstone, olive-grey; partly covered	23	695
34	Sandstone, fine-grained, brown, laminated; brown-weathering	5	672
33	Covered. Apparently mudstone	12	667
32	Sandstone, brown; platy	5	655

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
31	Covered. Some small exposures of olive-grey mudstone	80	650
30	Sandstone, fine-grained, brown; platy	8	570
29	Siltstone, sandy, laminated, olive-grey, argillaceous	16	562
28	Covered. Appears to be shale to mudstone, olive-grey	35	546
27	Shale, rubbly, olive- to dark-grey, some interbedded siltstone	10	511
26	Sandstone, silty, laminated, rusty-brown	2	501
25	Shale, olive-grey; rubbly; olive-brown-weathering; few small reddish-brown-weathering concretions	20	499
24	Siltstone, very argillaceous, dark grey; blocky	19	479
23	Sandstone, silty, brown; thickly bedded; thin conglomerate at base	22	460
22	Sandstone, fine-grained, brown, laminated	5	438
21	Shale, dark grey; rubbly; few reddish-brown-weathering concretions	72	433
20	Siltstone, argillaceous, laminated, dark grey; blocky; 6-inch conglomerate bed at base	12	361
19	Sandstone, fine-grained, brown; massive; grey-weathering	4	349

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
18	Siltstone, argillaceous, laminated, brown; platy; plant fragments	15	345
17	Covered. Siltstone and coal in talus	27	330
16	Sandstone, medium-grained, grey, laminated; massive; platy-weathering; grey-weathering	13	303
15	Covered	16	290
14	Conglomerate; massive; few lenses of coarse-grained sandstone; pebbles 1/2 inch to 2 inches, chert, quartzite, grey, white, black, pale green	29	274
13	Sandstone, fine-grained, laminated, brown; massive but weathers platy; some crossbedding; lenses of conglomerate near base	17	245
12	Covered	11	228
11	Conglomerate, massive; pebbles average 1/2 inch but few are up to 4 inches and rare one is 6 inches	14	217
10	Covered	11	203
9	Sandstone, fine-grained, brown, laminated; platy	10	192
8	Covered	23	182
7	Conglomerate, grey; massive; pebbles average about 1/2 inch	33	159
6	Covered	16	126

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Conglomerate, grey; massive; pebbles average about 1/2 inch	20	110
4	Covered	25	90
3	Sandstone, fine-grained, grey, laminated; massive	25	65
2	Covered	2	40
1	Sandstone, fine-grained, grey, laminated; grey-weathering; thickly bedded	38	38
	Covered (Moosebar shales?) A fault occurs at approximately this position in the section, and much of the lower member is repeated	107	
31	Sandstone, fine-grained; platy; rusty-weathering	3	594
30	Sandstone, fine-grained, silty, grey; thickly bedded	3	591
29	Covered	9	588
28	Sandstone, fine-grained, laminated, brown; platy; crossbedded; brown-weathering	5	579
27	Mostly covered. Some mudstone and coaly shale in talus	39	574
26	Conglomerate, massive; pebbles average about 1/2 inch, some are 2 inches	30	535
25	Sandstone, fine-grained, grey; massive; grey-weathering	12	505

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
24	Covered	29	493
23	Conglomerate, massive; pebbles up to 1/2 inch	9	464
22	Sandstone, fine-grained, brownish grey, laminated; massive; grey-weathering	8	455
21	Sandstone, fine-grained, brown, laminated to homogeneous; massive	26	447
20	Sandstone, fine-grained, brown, laminated; platy to flaggy; more massive at top; 6 inches of conglomerate at 10 feet	28	421
19	Covered	18	393
18	Sandstone, fine-grained, brown, laminated; flaggy	6	375
17	Covered	10	369
16	Conglomerate; massive; pebbles average 1/2 to 1 inch, becoming smaller towards top of unit	16	359
15	Sandstone, fine-grained, brown, laminated; thickly bedded to massive but platy-weathering; brown-weathering	25	343
14	Covered	12	318
13	Sandstone, fine-grained, laminated, brown; thickly bedded; few shaly intervals; some crossbedding; trace of few small pebbles at base	28	306

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
12	Siltstone, argillaceous, brownish grey, laminated; some inter-bedded sandstone towards top	35	278
11	Sandstone, fine-grained, laminated, brown; massive; brown-weathering; slightly irregularly bedded	26	243
10	Talus covered. Appears to be mainly argillaceous siltstone	80	217
9	Sandstone, fine-grained, olive-brown; massive; argillaceous at top	16.5	137
8	Siltstone, argillaceous, olive-brown to grey; blocky to massive	9	120.5
7	Sandstone, fine-grained, olive-brown; silty; thickly bedded	2.5	111.5
6	Siltstone, argillaceous, brownish grey; blocky to massive	13	109
5	Mudstone, very silty, grey; some siltstone	47	96
4	Mudstone, silty, grey; grades upwards into silty sandstone	10	49
3	Sandstone, very argillaceous, to siltstone, fine-grained, laminated, brownish grey	11	39
2	Siltstone, very argillaceous, dark grey, laminated; blocky; sandier towards top	16	28

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Sandstone, fine-grained, laminated, argillaceous, brown; thickly bedded; some interbedded siltstone and shale	12	12
	Moosebar Formation		
17	Shale, very silty, grading upwards into thinly bedded, silty sandstone	6	461
16	Siltstone, sandy, laminated, brown; brown-weathering; interbedded shale	2	455
15	Siltstone, very argillaceous, laminated, brownish grey; blocky; some interbedded silty shale	18	453
14	Talus covered. Farther downslope rock is exposed but is inaccessible. Mudstone, blocky, becoming siltier towards top with interbedded flaggy siltstone in upper part. Small dark round concretions in lower part	187	435
13	Shale, flaky; becoming blocky at top	15	248
12	Siltstone, argillaceous; blocky; large concretionary masses (2 1/2 x 3 to 5 feet)	2.5	233
11	Shale, flaky, black; rare small concretions	98	230.5
10	Shale, black, flaky; numerous reddish-brown-weathering concretions, 4 by 6 inches; few small dark concretions at top	32	132.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Shale, dark grey to black, flaky; numerous sideritic concretions and some 6-inch by 2-foot oval siliceous concretions	15	100.5
8	Shale, black; flaky to rubbly; numerous sideritic concretions, 4 to 6 inches by 6 inches to 2 feet	10	85.5
7	Shale, dark grey, flaky; rubbly; some sideritic concretions, 4 x 6 inches to 1 foot	28	75.5
6	Shale, black to dark grey; flaky to blocky; dark-grey-weathering	17	47.5
5	Bentonite, brown; 4-inch shale bed in middle	1	30.5
4	Sandstone, very argillaceous, medium-grained, highly glauconitic, dark greenish grey; massive; dark-grey-weathering	4	29.5
3	Shale, black; flaky; dark grey to rusty-weathering; few small sideritic concretions	11	25.5
2	Sandstone, medium- to coarse-grained, argillaceous, highly glauconitic; few small pebbles; massive; dark greenish grey; dark grey to rusty-weathering	4.5	14.5
1	Covered. Contact with underlying formation not exposed.	10	10
	Gething Formation		
	Sandstone, medium-grained, grey; massive		

Section 4. Commotion formation; east flank of anticline, most southerly ridge off main peak of Bullmoose Mountain, Dawson Creek map-area, B. C.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Hasler Formation		
	Mudstone, silty, dark grey; rubbly; reddish-brown-weathering concretions		
	Contact with Commotion not readily seen at this locality.		
	Commotion Formation		
55	Sandstone, fine-grained, laminated, brown	3	1,145.5
54	Siltstone, brown, laminated; platy; brown-weathering	2	1,142.5
53	Covered	36	1,140.5
52	Siltstone, dark grey; blocky to flaggy; rusty-weathering	6	1,104.5
51	Sandstone, very fine grained, grey; flaggy; rusty-weathering; grading downward into more argillaceous sandstone	18	1,098.5
50	Mudstone, silty, dark grey; rubbly	8	1,080.5
49	Siltstone, argillaceous, laminated; flaggy; rusty-weathering	8	1,072.5
48	Sandstone, medium-grained at base; grading upwards into fine-grained sandstone, argillaceous, brownish grey, laminated, massive; coarser-grained at base	20	1,064.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
47	Mudstone, silty, dark grey; rubbly; concretionary at base	12	1,044.5
46	Siltstone, argillaceous, brownish grey; flaggy to thinly bedded	9	1,032.5
45	Sandstone, medium- to coarse-grained, homogeneous, grey, massive; very coarse grained in lower half; grey-weathering	34	1,023.5
44	Conglomerate, grey; massive; pebbles 1/4 - 1/2 inch; coarse-grained sandstone matrix	14	989.5
43	Sandstone, medium-grained, laminated, brownish grey; thickly bedded	5	975.5
42	Sandstone, very fine grained, laminated, brown; platy; brown-weathering; some interbedded shale; traces of plant fragments; some olive-grey mudstone and very carbonaceous shale at base	14	970.5
41	Shale, black, coaly, brittle	6	956.5
40	Coal, shaly	1	950.5
39	Siltstone, very coaly	3	949.5
38	Mudstone, black; blocky	6	946.5
37	Covered	13	940.5
36	Sandstone, very coarse grained, grey, homogeneous to laminated; massive; lenses of conglomerate	7	927.5
35	Conglomerate, massive; pebbles average 1/2 inch; few sandstone lenses	27	920.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
34	Sandstone, fine-grained, grey, clean, homogeneous; massive; grey-weathering	15	893.5
33	Sandstone, fine-grained, laminated to homogeneous; thickly bedded; some shaly intervals	33	878.5
	Middle Member		
32	Siltstone, argillaceous, platy, dark grey; rusty-weathering; interbedded platy shale	40	845.5
31	Shale, silty, hard, dark grey; rusty-weathering	164	805.5
30	Siltstone and shale, as above	25	641.5
29	Shale, silty, dark grey; rusty-weathering	75	616.5
28	Siltstone, argillaceous, platy	11	541.5
	Lower Member		
27	Siltstone, brown, laminated; platy	0.5	530.5
26	Siltstone to sandstone, laminated, brown; flaggy; brownish-grey-weathering	15	530
25	Covered. Shale, coal, and fine-grained sandstone with plant fragments in talus	75	515
24	Shale, olive-grey, and siltstone	15	440
23	Sandstone, fine-grained, brown, laminated; platy	3	425

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
22	Mostly covered. Mudstone at base; plant fragments	19	422
21	Sandstone, fine-grained, brown, laminated; platy to flaggy; brown-weathering; some shaly intervals	18	403
20	Shale, olive-grey, flaky, carbonaceous	5	385
19	Sandstone, as above; platy to flaggy	12	380
18	Siltstone, argillaceous, laminated, olive-grey to brown; platy; grading downward into shale	22	368
17	Sandstone; silty, laminated, brown; platy	15	346
16	Mostly covered. Some silty shale and siltstone	52	331
15	Mudstone, dark grey, carbonaceous	14	279
14	Sandstone and siltstone; thinly interbedded; rusty-weathering	6	265
13	Sandstone, fine-grained, brown, laminated; platy	5	259
12	Covered	43	254
11	Sandstone, very fine grained, grey, carbonaceous	4	211
10	Covered. Some coaly shale and coal in talus	26	207
9	Mudstone, carbonaceous; some siltstone	3	181

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Sandstone, argillaceous, carbonaceous, brown, laminated; platy	11	178
7	Shale, black, carbonaceous	2	167
6	Coal	7	165
5	Conglomerate; massive; pebbles 1/2 - 1 inch, some as much as 2 inches	23	158
4	Sandstone, fine- to medium-grained; thickly bedded	15	135
3	Covered	20	120
2	Conglomerate and massive sandstone. Estimated.	40	100
1	Sandstone, fine-grained, flaggy. Estimated	60	60

Moosebar Formation