GEOLOGICAL SURVEY OF CANADA · 1842 ·

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 61-10

DAWSON CREEK MAP-AREA, BRITISH COLUMBIA

93 P

(Report, Map 19-1961, and correlation table)

D. F. Stott

Price 50 cents

1961

CANADA

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By

D. F. Stott

DEPARTMENT OF

MINES AND TECHNICAL SURVEYS

CANADA

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DAWSON CREEK MAP-AREA, BRITISH COLUMBIA

INTRODUCTION

Dawson Creek map-area is bounded by latitudes 55 and 56°N and longitudes 120°W (the Alberta-British Columbia boundary) and 122°W. The John Hart Highway—between Dawson Creek and Prince George—and many secondary roads, provide easy access to the northeastern part of the area. A forestry road is now under construction between Mount Puggins and Stony Lake south of the map-area. Roads to abandoned wells near Kelly Lake and the headwaters of Tupper Creek may be passable, but these were not travelled by the writer during the present study. Forestry roads from Twidwell Bend, south of Chetwynd on the John Hart Highway, provide access to the region around Lone Prairie and Sukunka River. A ferry on Pine River at Twidwell Bend was operated by the British Columbia Government during 1960.

Travel is more difficult in other parts of the area, particularly west of Sukunka River and south of Bullmoose Mountain. Only a few trails are present and these were in poor condition.

This report is, primarily, a preliminary account of a regional study of Cretaceous stratigraphy in the Foothills of Alberta and British Columbia. Field work was carried out during parts of the summers of 1959 and 1960. The report supplements one on the Cretaceous rocks in the region south of Dawson Creek map-area (Stott, 1960)[1] as well as more detailed accounts of the Cretaceous succession (Stott, 1961a, 1961b). The accompanying map is incidental to the stratigraphic study and represents only a preliminary reconnaissance. It is based on widely spaced ground traverses supplemented by the interpretation of air photographs in the intervening regions, and is, therefore, incomplete.

Previous geological studies were made by Spieker (1921), Williams and Bocock (1932), and Williams (1939). The most detailed study within the area is that of Wickenden and Shaw (1943) who mapped along Pine River in the vicinity of Hasler and Commotion Creeks.

Capable assistance was given in the field in 1959 by H.N. Wilkinson, T.J. Pinnacle, and W.E. Koepke; and in 1960 by A.A. Wilkins and J.P. Hill. The writer is also grateful to E. Moberly,

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[1] Names and dates in parentheses refer to publications listed in References.

I. Severson, R. Howatt, D. Dalgleish, F. Letendre, G. Rautenstrauch, H. A. Dalgleish, Ralph Moberly, J. Aird, O. Gauthier, and C. J. Stojan.

PHYSICAL FEATURES

Three physiographic provinces comprise the Dawson Creek map-area. The northeastern half lies within the Plains and most of the remainder is in the Rocky Mountain Foothills; the extreme southwest corner is within the Rocky Mountains.

The Plains region is relatively flat with some low rolling hills—the result of glacial action. A prominent escarpment, formed at the erosional edge of Cretaceous sandstones, extends westward from Dawson Creek to Murray River, and thence southeastward along Flatbed Creek. North of the escarpment, land underlain by Cretaceous shales has been used for farming.

The Foothills in the southwestern part of the map-area are higher and more rugged than farther north, and many of the ridges extend above tree-line. Bullmoose Mountain — the highest peak in the Foothills—has an elevation of 6,627 feet. Maximum elevations decrease towards Pine River where most of the hills are tree-covered. Maximum relief in the area is in the order of 4,000 feet.

The major rivers occupy deep glaciated valleys. Four main glacial drainage channels—the ancestral Murray, Sukunka, Pine, and Moberly Rivers—apparently converged near Peace River. The present Murray River, incised in the glacial valley, has steep banks of bedrock along its lower reaches. The present drainage of Pine River differs from that of glacial times. The ancient river outlet was via a broad valley in which the underfit Centurion Creek now flows. Jackfish Lake and several other narrow lakes are remnants of the ancient Pine river-channel. Apparently the Sukunka drainage captured that of Pine River in the vicinity of Twidwell Bend. Moberly and Gwillim Lakes have formed behind dams of glacial debris (see Spieker, 1921, p. K13).

Glaciation within the Foothills appears to have been mainly of alpine origin. Glacial boulders of sedimentary rocks on top of the highest ridges show that the Foothills were completely glaciated. Granitic and metamorphic rocks, presumably an indicator of continental glaciation, are found in abundance only in the eastern Plains region of the map-area.

TABLE OF FORMATIONS

Series	Group	Formation	Thickness (feet)	Lithology
Upper Cretaceous		Wapiti	0-1,500	Conglomerate, fine- to coarse-grained sandstone; carbonaceous shale, and coal
	Smoky Group	Puskwaskau	700±	Dark, silty marine shales with fine-grained, brown, well-sorted sandstone at top
		Bad Heart	40-75	Fine-grained sandstone; some carbonaceous sandstone and shale
		Muskiki	125-200	Dark grey, marine, silty shales with sideritic concretions
		Cardium	125-150	Fine-grained, grey to brown, well-sorted sandstone; some carbonaceous sandstone, shale, coal, and conglomerate
		Kaskapau	2,000-2,500	Dark grey, calcareous and sideritic marine shales; much siltstone and sandstone; some conglomerate
		Dunvegan	600-1,200	Fine- to coarse-grained sandstone; conglomerate; carbonaceous shale, and coal
	Fort St. John Group	Cruiser[1]	800	Dark grey marine shale with sideritic concretions
Lower Cretaceous		Goodrich[1]	100-600	Fine-grained sandstone; some shale and conglomerate
		Hasler[1]	700-900	Silty, dark grey marine shale with sideritic concretions and some siltstone
		Commotion	1,100-1,600	Fine-grained, brown sandstone interbedded with carbonaceous shale, coal, and conglomerate; dark grey marine shale; coarse-grained sandstone and conglomerate
		Moosebar	400-500	Dark grey marine shale with sideritic concretions; some glauconitic sandstone at base
		Gething	600-700	Fine- to coarse-grained, brown, carbonaceous sandstone; coal, carbonaceous shale, conglomerate
		Cadomin	45-200 (?)	Massive conglomerate
Jurassic and Lower Cretaceous		Nikanassin	300-4,000	Interbedded fine-grained sandstone and dark carbonaceous shale

[1] In the Plains, equivalents of the Cruiser, Goodrich, and Hasler formations are included in the Shaftesbury formation.

DESCRIPTION OF FORMATIONS

JURASSIC AND LOWER CRETACEOUS

Nikanassin Formation

The term Nikanassin formation is used here for sandstones and shales lying between the Jurassic Fernie formation and conglomerates of the overlying Cadomin formation[1]. The Nikanassin has been mapped in the southwestern corner of the map-area and it also occurs in a small area along Bullmoose Creek. The formation has not been studied in detail.

The formation shows considerable variation in thickness within the map-area. According to reports of the British Columbia Department of Mines (1960), the Nikanassin formation, in the northeast corner of the map-area, has a thickness in the order of 300 to 400 feet. It is about 1,500 feet thick in (Phillips) Puggins No. 1 well. Its thickness in the western Foothills is not well known but is estimated to be at least 4,000 feet.

Fine-grained, finely laminated sandstone is the predominant rock type, although carbonaceous shale and coal do occur. Some chert-pebble conglomerate is present in the upper part of the formation. The lower part contains marine fossils but the carbonaceous upper part is of nonmarine origin.

LOWER CRETACEOUS

Cadomin Formation

This formation is well exposed on ridges between Wolverine River and Bullmoose Creek. Its distribution northwest of Sukunka River is not known.

Only 45 feet of conglomerate was included in the formation on the ridge between Bullmoose Creek and Wolverine River. The formation is considered to be 171 feet thick in (Phillips) Puggins No. 1 well. In wells farther northeast, it ranges between 70 and 140 feet thick (B.C. Dept. Mines, 1960).

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[1] Other subdivisions for these rocks in neighboring areas have been used by Mathews (1946), Warren and Stelck (1958), and Ziegler and Pocock (1960). As no detailed studies have been made of these rocks during this project, the validity of any of these proposed successions has not been tested.

Rounded pebbles of chert, quartzite, and quartzitic sandstones occur in a matrix of well-indurated coarse-grained sand. The average size of pebbles in this area is smaller than those found farther south. The maximum size of cobbles is about 3 inches.

Gething Formation

The Gething is best exposed north of Wolverine River where it is 677 feet thick (Stott, 1960, sec. 3). About 300 feet is exposed at the falls on Sukunka River, and the upper 175 feet of the formation outcrops on Hasler Creek.

The Gething formation consists of a cyclic succession of coal, carbonaceous shales, fine-grained sandstones, and conglomerate. The formation appears to contain finer sediments in this area than in the Foothills farther south, although one 10-foot-thick conglomerate unit occurs on Sukunka River. In the exposure on Hasler Creek, all the sandstones are fine grained.

Fort St. John Group

In the Foothills of the map-area, the Fort St. John group comprises the five formations defined by Wickenden and Shaw (1943)—in ascending order, the Moosebar, Commotion, Hasler, Goodrich, and Cruiser. Data from well records within this area indicate that the divisions proposed by the Alberta Study Group (1954)—in ascending order, the Bluesky, Spirit River, Peace River, and Shaftesbury formations—may be used in subsurface studies of the Fort St. John group. The tentative lithologic correlation of these two successions is indicated in Table I, although more information is required to fully substantiate these relationships.

More than 4,800 feet of Fort St. John strata was measured in one continuous section outside the map-area, only a few miles northwest of Hasler Creek (see Stott, 1961b, sec. 1). The group is about 3,600 feet thick in (Phillips) Puggins No. 1 well; its thickness decreases to about 2,750 feet in Imperial Pacific Kilkerran 12-31-79-14 well[1].

Moosebar Formation

The Moosebar has been recognized in the Foothills from Wolverine River to Hasler Creek. It is well exposed on Bullmoose Mountain (Stott, 1961b, sec. 2) and on the ridge north of Wolverine

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1 Well data from report of B. C. Dept. Mines, Petrol. Res., 1960.

River (Stott, 1960, sec. 3). The basal shales are exposed on Hasler Creek although the actual contact with the Gething formation is covered. The thickness increases from 410 feet in the southeast to 461 feet on Bullmoose Mountain; farther northwest, beyond the map-area, studies indicate continued thickening in that direction. Much of this increase in shale is due to a lateral facies change from sandstone included in the Commotion formation to shales included in the Moosebar formation (see Stott, 1960, Fig. 1).

The dark grey shales of the Moosebar contain numerous sideritic concretions in the lower part. Toward the top, siltstone becomes more abundant and finally grades upward into sandstone. Highly glauconitic sandstone near the base of the formation on Bullmoose Mountain may be equivalent to the Bluesky formation of the Peace River plains. The rest of the Moosebar is lithologically equivalent to the Wilrich member of the Spirit River formation in the subsurface Peace River plains.

Commotion Formation

The Commotion formation outcrops along ridges between Wolverine and Pine Rivers. Formed of resistant sandstone and conglomerate, it has a pronounced topographic expression. Excellent sections were examined north of Wolverine River and on Bullmoose Mountain where the formation is 1,614 and 1,598 feet thick respectively. The thickness apparently decreases slightly towards the northwest and to a greater degree towards the northeast. Wickenden and Shaw (1943) defined the formation on Commotion and Hasler Creeks but the exposures there are incomplete.

Three members are recognized in the Commotion formation. The lower member contains much fine-grained sandstone, some carbonaceous shale, and coal. The basal part of the member is apparently marine. The upper beds, of nonmarine origin in the south, grade laterally into marine sandstones farther north. The middle member is dark grey marine shale. The upper member is composed mainly of fine- to coarse-grained sandstone and conglomerate but does contain carbonaceous mudstones and siltstones at the top.

The Commotion formation is considered equivalent to the Peace River formation and to the Notikewin and Falher members of the Spirit River formation of the subsurface Peace River plains (see Table I, Stott, 1960).

Hasler Formation

This formation outcrops along a narrow belt that extends from Murray River to Sukunka River. In the vicinity of Hasler Creek and Pine River, it is almost flat lying and occurs in the lower part of the valleys.

Inasmuch as no complete section of the Hasler formation was found in the Dawson Creek map-area, only an estimated thickness can be given. Wickenden and Shaw (1943) suggested a thickness of 1,100 to 1,200 feet in the vicinity of Pine River. Only 868 feet was included in the type section (Stott, 1961b). Facies changes in the overlying Goodrich formation and convergence southeastward may account for variations in thickness.

Exposures in the vicinity of Bullmoose Mountain and Hasler Creek indicate that the formation consists of silty, dark grey marine shale containing sideritic concretions. The base is marked by a thin layer of coarse-grained sandstone or chert pebbles in a matrix of mudstone.

Goodrich Formation

The Goodrich formation has a distribution similar to that of the Hasler formation. It shows a remarkable increase in thickness between Murray and Pine Rivers. Fine-grained, marine sandstone, about 50 feet thick on a tributary of Wolverine Creek, was assigned to the Goodrich formation. From there towards the northwest corner of the map-area, the Goodrich increases to more than 1,300 feet thick. Wickenden and Shaw (1943) estimated that the formation was 550 to 600 feet thick near Boulder Creek where the author measured 463 feet of exposed beds (Stott, 1961b).

The Goodrich formation consists mainly of fine-grained, crossbedded, laminated sandstone. Shale intervals between sandstone units are poorly exposed. A prominent bed of conglomerate occurs near the base of the formation just west of Hasler Creek, within the map-area.

Cruiser Formation

The Cruiser formation occurs mainly in a broad synclinal structure between Murray and Sukunka Rivers, along the valleys of Sukunka and Pine Rivers, and at low elevations in the vicinity of Moberly Lake. The most complete exposure is the type section east of Young Creek where 752 feet was measured (Stott, 1961b).

The Cruiser consists of dark grey silty marine shales and mudstones; it becomes sandier westward. As the Goodrich and Dunvegan formations are traced eastward, apparently some of their upper sandstones and lower sandstones respectively grade laterally into shale of the Cruiser formation. Accordingly, the stratigraphic interval of the Cruiser formation varies from one locality to another.

Shaftesbury Formation

The Shaftesbury formation was originally defined as including shale beds lying between the Peace River and Dunvegan formations (McLearn and Henderson, 1944). As this interval is approximately equivalent to the interval between the Dunvegan and Commotion formations, the Shaftesbury is stratigraphically equivalent to the combined interval of the Hasler, Goodrich, and Cruiser formations. Where the Goodrich is not present, the interval is predominantly shale and the term Shaftesbury is used (see also Stott, 1960). Thus, north of Moberly Lake, the Goodrich sandstone does not appear to be present, and the beds below the Dunvegan formation are included in the Shaftesbury. Similarly, in subsurface, the Goodrich sandstone grades laterally northeastward into shale, and these beds are included in the Shaftesbury interval (see structure-section on map).

UPPER CRETACEOUS

Dunvegan Formation

The Dunvegan formation underlies a large area west of Gwillim Lake and forms the top of ridges near the junction of Pine and Sukunka Rivers. An erosional edge of the Dunvegan trends northeasterly along the old glacial valley of Pine River, towards Peace River. A large area between Chetwynd and Moberly Lake and several small ones north of the lake are capped by Dunvegan sandstones.

No complete section of the Dunvegan formation was measured in this area, and thick exposures are rare due to the heavy cover of vegetation. The formation is approximately 500 feet thick in Kelly Lake No. 1 well, and its thickness appears to increase to more than 1,200 feet west of Chetwynd (Wickenden and Shaw, 1943). Although some thickening is probably due to increased sedimentation, most is due to facies changes. Shales above and below the Dunvegan formation of the southeastern Foothills and Plains grade laterally into sandstones towards the northwest and these beds are there included in the Dunvegan formation. Probably all the beds equivalent to the Pouce Coupe sandstone and underlying shales of the Kaskapau formation have been included in the Dunvegan in the vicinity of Pine River.

In 1921, Spieker gave the name 'Sukunka member' to upper beds of the Dunvegan formation which were composed of green shale, mudstone, some sandstone, and coal. Stelck and Wall (1955, Fig. 5) suggested in a diagram that the Sukunka member was equivalent to a large part of the Kaskapau formation. However, the beds of the Sukunka member appear to dip beneath the Kaskapau formation in the vicinity of Trapper Mountain just east of sections studied by Spieker.

The Dunvegan formation consists mainly of fine-grained, finely laminated and crossbedded sandstones. Carbonaceous shale and coal occur throughout but appear to be more abundant in the upper beds in the vicinity of Pine River. Some coarse-grained sandstone and conglomerate also occur within the formation.

Smoky Group

The Smoky shales, originally named by Dawson (1881, p. 115b) were divided by McLearn (1919, 1926) into three members—in ascending order, the Kaskapau, Bad Heart, and "Upper Shale". These units have, in the course of time, assumed formational status (McLearn and Kindle, 1950, p. 102).

In the region west of the type locality on Smoky River, the occurrence of Cardium sandstone in the succession below the Bad Heart formation necessitates some modification of existing terminology. The shales between the Dunvegan and Cardium sandstones are included in the Kaskapau formation (see Stott, 1960, 1961a), thereby reducing its stratigraphic interval within the Foothills. Shales between the Cardium and Bad Heart formations are included in the Muskiki formation (Stott, 1961a). The "Upper Shale" has been called the Wapiabi formation (Gleddie, 1949; Stelck, 1955; Stott, 1960). However, a new formational name—Puskwaskau—was proposed for this unit (Wall, 1960, p. 6). This new name is preferable inasmuch as the type Wapiabi formation includes beds equivalent to the Muskiki and Bad Heart formations (see Stott, 1961a). Accordingly, the name Puskwaskau is applied here to a similar stratigraphic succession which has been mapped in the Foothills from Smoky River to Mount Puggins. The succession of the Smoky group in the Foothills becomes, in ascending order, the Kaskapau, Cardium, Muskiki, Bad Heart, and Puskwaskau formations.

The Smoky group outcrops in a large region between Sukunka, Pine, and Murray Rivers, and northeastward towards Dawson Creek. The upper part of the group is eroded in the northeastern corner of the map-area, but in the vicinity of Murray River, the group is about 3,000 to 3,500 feet thick.

Kaskapau Formation

The Kaskapau formation underlies a large part of Dawson Creek map-area, but at only a few localities is it well exposed. Throughout most of the area, the formation is more or less flat-lying, and because of its considerable thickness complete sections are rare. The greatest exposed thickness was measured on a small creek between Nini and Nunki Hills and on Nini Hill where the formation is more than

2,250 feet thick (see Appendix, sec. 1). At that locality the contact with the underlying Dunvegan formation is not exposed and apparently lies below river level. The thickness is comparable to that found in (Phillips) Puggins No. 1 and Canadian Southern and Associates Kelly Lake No. 1 wells.

A very prominent facies change is evident within the Kaskapau formation in Dawson Creek map-area. Shales in the central part of the formation grade laterally into sandstone as the formation is traced northwestward along Flatbed Creek towards Lone Prairie. Several distinct sandstones appear, and these would be mappable as separate units in detailed work. The succession on Tuskoola Mountain was originally described by Spieker (1921). Subsequently, Stelck (1955) applied the names Wartenbe and Tuskoola to two of the more prominent sandstones.

In the basal part of the Kaskapau formation in the northeast corner of the map-area, three other sandstones have been named—the Doe Creek and the Pouce Coupe (Warren and Stelck, 1940), and the Howard Creek (Stelck and Wall, 1954).

Several hundred feet of interbedded sandstone and shale was measured on a hillside north of the junction of Wolverine and Murray Rivers. These beds apparently all lie within the Kaskapau formation and appear to be equivalent to sandstones below the Wartenbe sandstone.

On the escarpment south of Lone Prairie, extending from Tuskoola Mountain to west of Elephant Ridge, much of the middle part of the Kaskapau formation is exposed (see Appendix, secs. 2 and 3). The best exposures of the lower part of the section are in a gully west of Elephant Ridge. Much of the rock is inacessible and the beds were measured by climbing along covered slopes at the edge of the gully. The Wartenbe sandstone and overlying beds are well exposed on the north end of Elephant Ridge. The most accessible section is on Tuskoola Mountain but many of the beds are covered.

The Nini Hill section (Appendix, sec. 1) differs considerably from that on Elephant Ridge. At the former locality, the Wartenbe sandstone is the only prominent one, and a lateral change from sandstone to shale has apparently occurred in the underlying beds. The Nini Hill section bears more resemblance to the Kaskapau formation as it occurs in the Foothills south of the map-area. The upper 600 feet of concretionary mudstone and platy shale (map-unit 13e) appear to be equivalent to the Opabin and Haven members (Stott, 1961a, see also Table I). The Wartenbe sandstone lies at or near the top of the Vimy member, as black platy shales below the Wartenbe sandstone are similar to the shales of the Vimy member elsewhere. Rusty shales at the base of the section near Nini Hill are considered equivalent to the Sunkay member.

On Nini Hill the Wartenbe sandstone consists mainly of fine-grained massive sandstone with a 15-foot interval of interbedded conglomerate and sandstone at the top. The conglomerate is lensy and grades laterally into sandstone; in some places it occupies most of the interval but in others it may be almost absent. On Elephant Ridge, more conglomerate is present and the whole Wartenbe interval is thicker. The Wartenbe sandstone is a useful mapping horizon and has been traced from Tuskoola Mountain to Gwillim and Moose Lakes and along Flatbed Creek. It can be mapped in the vicinity of Mount Puggins and has been traced northward beyond Nini Hill, almost to Coldstream Creek.

The Pouce Coupe sandstone, in the basal part of the formation, is well exposed at its type locality at the junction of Saskatoon Creek and Pouce Coupe River. It consists of massive, fine-grained, light-brown-weathering sandstone. This sandstone is fairly widespread, but in the Foothills of Dawson Creek map-area it is not readily distinguished from the underlying Dunvegan sediments.

Cardium Formation

The Cardium is not well exposed in this area. There are some incomplete exposures in a quarry 4 miles south of Pouce Coupe and also along a prominent escarpment southwest of Dawson Creek. The formation can be traced by means of air photographs from Flatbed Creek to Coldstream Creek, and thence eastward along the escarpment to Pouce Coupe River. The formation is estimated to be 125 to 150 feet thick near Murray River.

Only massive sandstone of the Cardium formation is exposed in this area but some shaly beds may occur in the upper part of the formation. The section south of Pouce Coupe (see Appendix, sec. 4) is of the lower part of the formation, as Kaskapau shales are exposed in road-cuts just below the quarry floor. In that section, 19 feet of coarse-grained sandstone with disseminated pebbles overlies massive fine-grained sandstone that is similar to the basal Cardium sandstones elsewhere. On the escarpment, south of tp. 77, rge. 19, W6th mer., 60 feet of fine-grained flaggy sandstone is overlain by 25 feet of coarse-grained massive sandstone with lenses and streaks of small chert pebbles.

Muskiki Formation

Rusty-weathering, dark grey shales overlying the Cardium formation have been included in the Muskiki formation (see Stott, 1961a). This unit has been traced northward from near Smoky River to Mount Puggins. Exposures within Dawson Creek area are poor. The formation is estimated to be about 125 feet thick in this area. Dark grey marine shales with numerous sideritic concretions are exposed in road-cuts on Mount Puggins and are considered to lie within the Muskiki formation.

East of Kiskatinaw River the equivalents of the Muskiki and Bad Heart formations have been included in map-unit 17b because the Bad Heart sandstone has not been recognized on the surface. As the formations are recognized in wells south of the escarpment, more detailed work may reveal their presence at the surface.

Bad Heart Formation

This formation has a distribution similar to that of the Muskiki. It has been mapped along Flatbed Creek, on the top of ridges between Murray and Gwillim Rivers, and in the vicinity of Mount Puggins.

The Bad Heart formation is exposed at the top of Mount Puggins, where it consists of massive fine-grained sandstone with a few chert pebbles scattered along the bedding surfaces.

Puskwaskau Formation

In the type region, the Puskwaskau formation contains concretionary and calcareous shales and fine-grained sandstone. Within this marine succession, five members of the type Wapiabi formation are recognized—in ascending order, the Dowling, Thistle, Hanson, Chungo, and Nomad. A similar subdivision is possible in the Foothills although the uppermost Nomad member does not appear to be everywhere present.

Few exposures of the Puskwaskau formation were examined and no complete outcrop section is known to occur within the map-area. The formation is estimated to be about 700 feet thick in the vicinity of Murray River.

Of the five members of the Puskwaskau formation, the Chungo is the most prominent. This sandstone occurs throughout the Foothills; it is generally massive, fine grained, clean, and weathers light brown. Lithologically, it is nearly similar to sandstones in the Bad Heart and Cardium formations. This sandstone, exposed on a ridge east of Kiskatinaw River and also east of Swan Lake, is assumed to occur throughout the area (map-unit 18).

East of Kiskatinaw River, the Bad Heart sandstone is not recognized on the surface, and therefore the interval between the Cardium and Wapiti formations has been mapped as a single unit (17b). This unit includes beds equivalent to the Muskiki, Bad Heart, and Puskwaskau formations. This succession is stratigraphically equivalent to the Wapiabi formation of the Alberta Foothills.

Wapiti Formation

The Wapiti formation underlies the southeastern corner of the map-area. Its northern erosional edge is more or less parallel to that of the Cardium and Bad Heart sandstones and is most pronounced on Salt and Oetata Ridges.

Within Dawson Creek map-area, the maximum thickness of the Wapiti is about 1,500 feet.

Few exposures of Wapiti sediments were examined in this area. Farther south the formation consists of fine- to coarse-grained sandstone, carbonaceous siltstone, and shale, and most of these rocks have a greenish or brownish colour.

STRUCTURE

Dawson Creek map-area is divisible into two structural units: the Plains in the east, underlain by gently dipping beds, and the Foothills in the west where the strata are folded and faulted. Throughout the region, the folds and southwest-dipping thrust faults have a northwesterly trend and an en échelon pattern. Deformation decreases eastward from the western Foothills towards the Plains.

The extreme southwest corner of the map-area, which has not been mapped, probably contains folded and faulted rocks of Triassic and Palaeozoic age.

Along the southwestern side of the Foothills, Nikanassin and Fort St. John strata are brought to the surface in a large anticlinal structure which appears to plunge northwestward to Pine River and southeasterly to Kinuseo Creek beyond the map-area (see Stott, 1960). Smaller folds, imposed on this major structure, are most prominent near Wolverine River where several anticlines, synclines, and minor faults have been mapped. West of Bullmoose Mountain, a large area of Nikanassin rocks lies southwest of a major fault. Bullmoose Mountain is situated on the eastern flank of a shallow synclinal structure. This syncline is bounded on its western side by a small anticline and on its eastern side by a low-angle thrust fault having some associated minor faults. The fault lies on the west flank of a tightly folded anticline which forms the easternmost element of the major anticlinal structure. The anticline, in whose core the lower member of the Commotion formation is exposed, plunges southeastward to Wolverine River and apparently culminates near Sukunka River.

Within the west flank of the major synclinal structure of the eastern Foothills, which lies northeast of the anticline, higher beds of the Fort St. John group dip at gradually decreasing angles towards the axial region in the vicinity of Flatbed Creek and Gwillim and Moose Lakes. This major structure is bounded by intermittent thrust faults on its northeastern side. The youngest beds within this syncline are of the Kaskapau formation. West of Gwillim Lake the east flank of a small anticline is broken by a northwesterly trending fault. Farther east, another southwest-dipping thrust fault is apparently the continuation of a fault traced northwestward from Lone Mountain near Stony Lake (see Stott, 1960). Farther north, in the vicinity of Commotion Creek, an anticline whose axis lies along the creek, and the fault along its eastern flank, have been described by Wickenden and Shaw (1943). East of the Commotion Creek structures, only gentle folds and minor faults are found in Dunvegan strata lying north of Pine River.

Along the eastern side of the Foothills, structures are mainly gentle folds with only minor faults of small displacement and short extent.

East of Murray River, Upper Cretaceous rocks of the Plains dip gently northeastward, but they are nearly horizontal in the vicinity of Dawson Creek where the regional dip appears to have a slight southerly component.

ECONOMIC GEOLOGY

PETROLEUM AND NATURAL GAS

Considerable drilling has been carried on in the northeastern part of the map-area where three gas fields—Dawson Creek, Sunrise, and Pouce Coupe—produce from the Cadotte sandstone (upper Commotion equivalent of the Fort St. John group). Only a few wells have been drilled near or within the Foothills and all of these have been abandoned.

Suitable reservoir rock may exist at several horizons in the Cretaceous succession. Sandstones equivalent to the Commotion and Cadomin formations are productive in nearby regions. Upper Cretaceous sandstones, such as the Wartenbe, Cardium, and Bad Heart, are too close to their erosional edge throughout most of the area to be considered potentially productive.

In the Foothills of the map-area, folding in pre-Cretaceous strata may have produced structures favorable for the accumulation of oil and gas. Such structures might be complicated by the faults occurring in this region. More gentle flexures may occur beneath the Plains.

The lithology of pre-Cretaceous rocks has been described from nearby areas in northeastern British Columbia by McLearn (1940, 1941, 1946, 1947), McLearn and Kindle (1950), Laudon et al. (1949), Sutherland (1958), McCauley (1958), Rutgers (1958), Hunt and Ratcliffe (1959), and Muller (1961). Within the Foothills, pre-Cretaceous strata were not tested by the B. C. Government Pine River No. 1 and Anglo Bralsaman Little Prairie No. 1 wells. Triassic sediments, however, were encountered in (Phillips) Puggins No. 1 and Imperial Pacific Kilkerran 12-31-78-14 wells.

COAL

At present, no coal is mined for commercial purposes within the map-area. Small tonnages have been obtained from the Gething formation on Hasler Creek but that mine is no longer operating; McKechnie (1955, p. 12) estimated the mine's reserves of low-volatile bituminous coal at 8 million short tons.

Both the Gething and Commotion formations are coal-bearing within the map-area. In the Commotion formation the coal is more likely to be found in mineable quantities south of Bullmoose Mountain, where it occurs in both the upper and lower members. Coal also occurs in the Dunvegan formation.

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APPENDIX

Section 1. Kaskapau formation, Nini Hill.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Overlying beds (Cardium formation) not exposed.		
	Opabin Member		
55	Sandstone, fine-grained, laminated, brownish grey; thinly bedded to flaggy; interbedded shale, silty, dark grey; sandstone increases towards top	27	2,259.5
54	Sandstone and shale (50 - 50); sandstone, fine-grained, laminated; argillaceous at base	29	2,232.5
53	Mudstone, very silty, dark grey; blocky; some interbedded siltstone and sandstone (20%); some concretions, reddish-brown-weathering	36	2,203.4
52	Shale, rubbly; rusty-weathering; some interbedded siltstone; some concretions, reddish-brown-weathering	41	2,167.5
51	Sandstone, fine-grained, argillaceous, laminated	1	2,126.5
50	Mudstone, to shale, dark grey, very silty; rubbly to blocky at top; siltier at top; concretionary layers	38	2,125.5
49	Mudstone, rubbly, grading upwards into siltier beds; concretionary layers, reddish-brown-weathering	8	2,087.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
48	Sandstone, coarse-grained, concretionary	0.5	2,079.5
47	Shale, dark grey, rubbly, rusty-weathering; numerous small reddish-brown-weathering concretions	80	2,079
46	Shale, rubbly, rusty-weathering; siltier at top; reddish-brown-weathering concretions	57	1,999
	Haven Member		
45	Shale and platy siltstone interbedded (70 - 30); some concretions, reddish-brown-weathering	26	1,942
44	Mudstone, dark grey, rubbly to platy; rusty-weathering; reddish-brown-weathering concretions	44	1,916
43	Shale and platy siltstone interbedded (70 - 30); rusty-weathering	12	1,872
42	Shale, rubbly to platy; rare concretion, reddish-brown-weathering	167	1,860
41	Siltstone, platy	1	1,693
40	Shale, rubbly to platy	3	1,692
39	Covered	125	1,689
38	Shale, silty, platy, dark grey; rusty-weathering	100	1,564

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
37	Conglomerate; coarse-grained matrix; pebbles 1/4 - 1/2 inch	1	1,464
36	Siltstone, flaggy, argillaceous, dark grey; few concretions, reddish-brown-weathering	34	1,463
35	Shale and siltstone interbedded, (70 - 30); platy; rusty-weathering; siltier at top	16	1,429
34	Shale, silty, rubbly, dark grey; rusty-weathering; few concretions	40	1,413
33	Shale, rubbly, dark grey; 2 - 3 inches of conglomerate at top with 1/2-inch pebbles	4	1,373
32	Shale, silty, dark grey; platy; some sandy siltstone beds; rare concretions; thin 3- 4-inch beds of conglomerate at top	9	1,369
31	Sandstone, silty; thickly bedded	6	1,360
30	Mudstone, silty; few siltstone beds; some concretions	3	1,354
29	Siltstone, argillaceous, platy, dark grey; some interbedded shale, rare concretions	11	1,351
28	Shale and siltstone interbedded; argillaceous, dark grey; some sandstone at top capped by 3-inch coarse-grained sandstone	3	1,340
27	Sandstone, fine-grained, argillaceous, dark grey; thickly bedded; few scattered pebbles	5	1,337

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
26	Shale, silty, with interbedded argillaceous siltstone; few small reddish-brown-weathering concretions	10	1,332
	<u>Wartenbe Sandstone</u>		
25	Sandstone, fine-grained, grey, argillaceous; thickly bedded	4	1,322
24	Conglomerate with lenses of fine-grained sandstone; pebbles average 1/4 - 1/2 inch but some are 2 1/2 inches (conglomerate changes thickness along cliff face)	5	1,318
23	Sandstone, fine-grained, grey; massive; lenses and pockets of conglomerate	10	1,313
22	Conglomerate; pebbles 1/4 - 1/2 inch; fine-grained sandstone at base	1	1,303
21	Mudstone	1	1,302
20	Sandstone with patches of pebbles	1	1,301
19	Sandstone, fine-grained, grey, laminated; massive but shows some flaggy weathering; brown-weathering; few shaly intervals; bedding not too apparent in lower half but more pronounced towards top	92	1,300
18	Sandstone, argillaceous, laminated, dark grey; thickly bedded	6	1,208

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
17	Siltstone, argillaceous, sandy, dark grey; flaggy to thickly bedded; few shaly intervals	10	1,202
16	Covered. Approximately	455	1,192
	(Section continues in creek between Nini and Nunki Hills.)		
15	Siltstone and shale interbedded; several 6-inch to 1-foot beds of fine-grained laminated sandstone	14	737
14	Siltstone, argillaceous, and shale interbedded; platy; thin 2- 3-inch beds of sandstone	17	723
13	Shale, dark grey; rubbly to platy; slightly-rusty-weathering; siltier and platy towards top; rare concretion	107	706
12	Shale and siltstone, very thinly interbedded; dark grey; rusty-weathering	12	599
11	Shale, dark grey, platy; becoming silty towards top	75	587
10	Mudstone, dark grey, silty; blocky to rubbly; silty at top; concretions	55	512
9	Sandstone, fine-grained, laminated; thickly bedded	2	457
8	Shale, rubbly; rusty-weathering; becoming much siltier towards top with some thin beds of siltstone and sandstone; few concretions, reddish-brown-weathering	148	455

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Shale, very rubbly, rusty-weathering; few small concretions; 2-inch bentonite bed at top	63	307
6	Shale, fissile to rubbly; slightly rusty weathering	50	244
	Sunkay Member (?)		
5	Siltstone to mudstone, flaggy, dark grey	19	194
4	Mudstone, dark grey; rubbly; rusty-weathering; siltier towards top; concretions	55	175
3	Mudstone, rubbly to blocky; rusty-weathering; siltier at top; some concretions	15	120
2	Mudstone, rubbly, dark grey; rusty-weathering; some small reddish-brown-weathering concretions	75	105
1	Mudstone, dark grey; rubbly to blocky; rusty-weathering; small concretions; a few larger septarian concretions	30	30
	End of continuous exposure. Dunvegan formation is not exposed at mouth of creek and Murray River.		

Section 2. Kaskapau formation, Elephant Ridge.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Top of ridge. End of exposure.		
28	Sandstone, fine-grained, brownish grey, laminated; brown-weathering; platy	7	492.5
27	Interbedded siltstone and shale, dark grey	9	485.5
26	Sandstone and shale, interbedded (40 - 60); beds 3 - 6 inches. Sandstone, fine-grained, argillaceous, laminated, brownish grey	11	476.5
25	Mudstone, silty, dark grey; blocky; siltier towards top with inter-bedded siltstone; small sideritic concretions in lower part	47	465.5
24	Mudstone, dark grey; some interbedded siltstone at top; beds 2 inches; small reddish-brown-weathering concretions	42	418.5
23	Mudstone, argillaceous, dark grey; grading upwards into interbedded siltstone and shale; some con-cretions	18	376.5
22	Mostly covered. Appears to be argillaceous siltstone	23	358.5
21	Siltstone, argillaceous, sandy, flaggy, grey	3	335.5
20	Conglomerate; rounded pebbles average 1/2 inch; sandy matrix	1	332.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
19	Sandstone, fine-grained, brownish grey; flaggy to medium-bedded; brown-weathering; 4-inch conglomerate bed at 29 feet	37	331.5
18	Covered	4	294.5
17	Sandstone, medium- to coarse-grained; 4-inch conglomerate bed at base; few pebbles scattered throughout sandstone	1.5	290.5
16	Mudstone, dark grey	1	289
15	Sandstone, fine-grained, grey, laminated to homogeneous; argillaceous; thickly bedded to massive; grey-weathering	15	288
14	Covered	3	273
13	Sandstone, fine-grained, argillaceous, grey; thickly bedded; grey- to rusty-weathering	4	270
12	Covered	13	266
11	Sandstone, fine-grained, argillaceous, laminated, grey; thickly bedded	6	253
10	Mudstone, argillaceous, dark grey	3.5	247
9	Sandstone, argillaceous, laminated, brownish grey; flaggy to thickly bedded; grey-weathering	12.5	243.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Wartenbe Sandstone		
8	Sandstone, fine- to coarse-grained; thickly bedded to massive; lenses of conglomerate, especially in lower half. Along ridge, upper half grades into massive conglomerate	29	231
7	Sandstone, fine-grained, brown; thickly bedded; brown-weathering	19	202
6	Covered	35	183
5	Sandstone, fine-grained, brown, laminated; flaggy	23	148
4	Sandstone, coarse-grained, grey; brownish-grey-weathering; thickly bedded	5	125
3	Covered	26	120
2	Sandstone, fine-grained, brown, laminated; flaggy, wavy-bedded; brown-weathering	9	94
1	Covered	85	85
	Underlying beds may be traced into beds described in Section 3.		

Section 3. Kaskapau formation, ridge northwest of Elephant Ridge.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
26	Sandstone, fine-grained, homogeneous to laminated; very mottled at base but more uniformly bedded at top; massive; crossbedded	75	874.5
25	Covered	15	799.5
24	Sandstone, fine-grained, laminated; massive but platy-weathering; crossbedded; shaly in middle	38	784.5
23	Covered	25	746.5
22	Sandstone, fine-grained, laminated, brownish grey; crossbedded; trough and planar crossbedding; massive but platy-weathering	22	721.5
21	Mostly covered. Shale at base; some sandstone at top	125	699.5
20	Sandstone and shale interbedded. Inaccessible	8	574.5
19	Sandstone and shale interbedded; beds 2 to 4 feet. Mostly inaccessible	74	566.5
18	Sandstone, fine-grained, laminated; beds 1 foot to 4 feet; shale intervals	12	492.5
17	Shale and interbedded sandstone. Inaccessible	18	480.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
16	Sandstone, fine-grained, laminated, grey; thickly bedded to massive; light-brown-weathering; some concretionary zones	23	462.5
15	Shale, grading upwards into mudstone, with interbedded fine-grained sandstone. Inaccessible	49	439.5
14	Shale, grading upwards into interbedded sandstone and shale; beds 3-4 inches. Inaccessible	29	390.5
13	Sandstone and interbedded shale, thinly bedded. Inaccessible	8	361.5
12	Shale. Inaccessible	34	353.5
11	Shale, dark grey; grading into blocky argillaceous siltstone at top; reddish-brown-weathering concretions. Mostly inaccessible	55	319.5
10	Sandstone, fine-grained, brownish grey, laminated	2	264.5
9	Shale, dark grey with small reddish-brown-weathering concretions. Inaccessible	106	262.5
8	Sandstone, fine-grained, grey, laminated; thickly bedded; light brown to rusty-weathering	27	156.5
7	Shale and siltstone, thinly interbedded; sandier towards top	9	129.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Sandstone, fine-grained, laminated to homogeneous, light brown to rusty-weathering; thickly bedded to massive; some crossbedding at base; few thin shale intervals near base	26	120.5
5	Sandstone, fine-grained, laminated, brownish grey; brownish-grey-weathering; some interbedded silty shale; some concretions; some trough crossbedding	5	94.5
4	Shale, dark grey; blocky; grey- to rusty-weathering; grading into argillaceous siltstone at top; some concretions	47.5	89.5
3	Siltstone, sandy; massive; rusty weathering	9	42
2	Siltstone, argillaceous and blocky	6	33
1	Siltstone, sandy, argillaceous; blocky to bedded; brown- to rusty-weathering; some concretionary layers, reddish-brown-weathering; sandy beds at top; worm markings	27	27

Section 4. Cardium formation, quarry south of Pouce Coupe

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Glacial drift.		
11	Sandstone, very coarse grained; massive; shaly interval at base	6	57'4"
10	Sandstone, very coarse grained to finely conglomeratic; massive; some interbeds of finer sandstone; some disseminated pebbles	6	51'4"
9	Shale, silty to sandy; finely interbedded with brown sandstone; much limonite	0'5"	45'4"
8	Sandstone, coarse-grained, homogeneous, friable, brownish grey; loosely consolidated; brown-weathering; disseminated chert pebbles up to 2 inches in diameter; some lamination and crossbedding; few small concretionary zones; traces of carbonaceous material; massive	7	44'11"
7	Sandstone, fine-grained, grey to brownish grey, homogeneous to laminated; brownish weathering; thickly bedded; platy at base; much limonitic stain	5	37'11"
6	Sandstone, fine-grained, laminated to homogeneous, brownish grey; brown-weathering; massive to thickly bedded; few thin platy intervals; concretionary zones	20'	32'11"
5	Shale, silty, medium-grey to brown, soft	0'2"	12'5"

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Sandstone, fine-grained, homogeneous, grey to brownish grey; light-brown-weathering; massive; much limonitic stain; rare concretionary zone	3'5"	12'3"
3	Shale and siltstone, finely interbedded; shale is silty, platy, medium-grey, soft; concretionary lenses and nodules as much as 5 inches thick	1'4"	8'10"
2	Sandstone, fine-grained, homogeneous, to slightly laminated, light to brownish grey; light-brown-weathering; thickly bedded (1-4 feet); few poorly developed concretionary zones, limonitic staining	7	7'6"
1	Shale, silty, medium-grey, platy to fissile	0'6"	0'6"

Kaskapau shales are exposed about 15 feet below floor of quarry along the highway.