68-13

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 68-13

FORT NELSON, BRITISH COLUMBIA (94J)

(Report and Map 3 — 1968)

G. C. Taylor and D. F. Stott

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ABSTRACT

Sedimentary rocks ranging in age from Late Devonian to Late Cretaceous are described from outcrops within the Fort Nelson map-area (94J).

The stratigraphic succession has a maximum thickness of 10,800 feet. Approximately 3,400 feet of Paleozoic strata have been subdivided into four formations which are, in ascending order, the Besa River, Prophet, Kindle, and Fantasque Formations. These units are overlain by about 2,100 feet of Triassic strata comprising the Grayling, Toad, and Liard Formations. The Lower Cretaceous Gething Formation and the Fort St. John Group, 800 feet thick and 4,500 feet thick, respectively, overlie the Triassic rocks. The stratigraphic succession is capped by the Late Cretaceous Dunvegan Formation, about 500 feet thick, and, locally, by the younger Kotaneelee Formation.

The Fort Nelson map-area lies partly within the Interior Plains and partly within the Rocky Mountain Foothills structural provinces. Folds are the dominant structures of the Foothills.

INTRODUCTION

Fort Nelson map-area (94J), in northeastern British Columbia, is bounded by latitudes 58° and 59° N and longitudes 122° and 124° W. It forms a part of the region investigated by Operation Liard (Taylor, 1965, 1966) during the summers of 1964 and 1965. It is bordered on the north by Maxhamish Lake (940) map-area (Taylor and Stott, 1968) and on the south by Trutch(94G) map-area (Pelletier and Stott, 1963).

FIELD WORK AND ACKNOWLEDGEMENTS

The Geological Survey party on Operation Liard comprised E.W. Bamber, R.T. Bell, D.F. Stott, and G.C. Taylor. Other officers of the Survey who availed themselves of the facilities of the operation for specific projects include W.S. MacKenzie, B.S. Norford, R.M. Procter, R. Thorsteinsson, and E.T. Tozer. Discussions with these geologists have been of great value during all phases of the structural and stratigraphic investigations.

The staff was ably assisted in the field during 1964 by D. Hetherington, M.E. Wooding, R. Armstrong, and D. MacDougal; and during 1965, by W.R. Craig, L.G. Grainger, and B.J. Reive. Cooks were S.W. McWhinnie and I. Severson. Helicopters were supplied by Bullock Wings and Rotors Limited and manned by J. Davies, H. Tetz, M. Brown, and P. Ettinger. To all these men who helped so much, the writers and other officers of the party extend their appreciation.

Paleozoic fossils were identified and dated by E.W. Bamber; Triassic fossils, by E.T. Tozer; Cretaceous fossils by J.A. Jeletzky; and Cretaceous plants, by W.A. Bell.

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PREVIOUS WORK

The first geological information bearing directly on this area was published by Williams (1923) after a trip made from Fort St. John north to Sikanni Chief River and down Sikanni Chief and Fort Nelson Rivers to Liard River. Reconnaissance studies within the Fort Nelson map-area were initiated during the Second World War to determine the economic potential of the region and were facilitated by the opening of the Alaska Highway. Hage (1944) studied the geology adjacent to the highway as far north as Fort Nelson. Williams (1944) studied the geology along the highway west from Fort Nelson to beyond the map-area. Kindle (1944) decended the Fort Nelson River and then continued westward up the Liard River. McLearn (1945) became interested in the fossils collected by Kindle and published the first of many reports dealing with the Triassic and Cretaceous faunas of northeastern British Columbia. McLearn and Kindle (1950) published a summary of the known geology of northeastern British Columbia.

Pelletier (1960, 1961, 1962, and 1963) and Stott (1967, 1968) have published on studies of the Triassic and Cretaceous rocks respectively that occur in the general region.

PHYSICAL FEATURES

The Fort Nelson map-area lies mainly within the Interior Plains but, in the southwest corner, includes a part of the Rocky Mountain Foothills. That part of the map-area within the Plains comprises several physiographic elements. The central and northeast part, the Fort Nelson lowland (Holland, 1964), is covered by muskeg and small lakes. Timber covers considerable areas of the lowland where the underlying surface is relatively well drained. Prominent west-facing cuestas, the Dunedin and Muskwa escarpments, and the Tsoo tablelands mark the west boundary of the Plains. Well-developed mesas have been formed in the western escarpments as a result of erosion through the cap of Dunvegan conglomerate, the underlying Sully shales, and into the relatively competent sandstones of the Sikanni Formation. The Trutch escarpment, occurring in the southeast corner of the map-area, merges with the Fort Nelson lowlands southwest of Klua Creek.

The topography of the Foothills largely reflects the structure of the underlying bedrock. Many anticlinal hills are stripped surfaces on the upfolded Triassic or Paleozic formations. The softer Cretaceous shales tend to be preserved only in the synclinal valleys.

Three major rivers, the Prophet, Muskwa, and Fort Nelson drain the area. Little bedrock is exposed along these rivers within the Plains. Good exposures are found as rimrock of the cuestas and mesas, and in many of the smaller tributary creeks. Within the Foothills, good exposures are generally confined to the upper parts of the main ridges and in the bottoms of small creeks that cross the structural grain.

TABLE OF FORMATIONS

Upper Cretaceous	Kotaneelee		Dark marine shale	?
	unconformity			
	Dunvegan		Massive conglomerate and coarse-grained sandstone; carbonaceous shale and sandstone	500
Lower Cretaceous	Fort St. John Group 2,500-4,500	Sully	Dark marine shale; concretions	300-700
		Sikanni	Sandstone, fine-grained, platy to thick-bedded; platy siltstone; intercalated shale	380-800
		Buckinghorse	Dark marine shales; reddish brown-weathering sideritic concretions; some fine-grained sandstone	2,000-3,500
	Gething		Sandstone, fine-grained, thick-bedded; glauconitic sandstone at top; dark marine shale in middle	0-800+
UNCONFORMITY				
Triassic	Liard		Sandstone, medium-grained calcareous, thick-bedded	0-300+
	Toad		Siltstone, shale, minor limestone thick-bedded	600'+
	Grayling		Dark, shale, siltstone, minor sandstone	1,200'+
UNCONFORMITY				
Permian	Fantasque		Black chert, intercalated dark shale	0-70'
	unconformity			
	Kindle		Dark grey calcareous siltstone shale, sandstone	0-33'
UNCONFORMITY				
Mississippian	Prophet		Limestone, cherty, fragmental; silty dolomite; chert	0-550
Devonian	Besa River		Black, pyritic shale	2,800'
Older formations not exposed at surface				

Continental ice-sheets covered the entire map-area during Pleistocene time. Glacial deposits are thin or entirely absent on the higher land whereas they are thick on the adjacent lowlands. A water well drilled near the Fort Nelson airport encountered 760 feet of drift before reaching bedrock (Hage, 1944).

STRATIGRAPHY

All bedrock studied within the map-area is of sedimentary origin. The strata range in age from late Devonian to late Cretaceous and have an aggregate thickness of 10,800 feet. Middle Devonian rocks are known from well penetrations to underlie the map-area in the subsurface, and this succession has been summarized by Griffin (1965).

PALEOZOIC ROCKS

Rocks of Paleozoic age are exposed in three anticlines within the foothills portion of the map-area. The succession can be subdivided into four formations, although two of these (Kindle and Fantasque Formations) are each represented by less than 100 feet of strata. For mapping purposes these beds are included with the Prophet Formation.

DEVONIAN AND MISSISSIPPIAN

Besa River Formation

The Besa River Formation (Kidd, 1962, 1963) crops out in the core of the Muskwa anticline. The base of the formation is not exposed. At the type section, 5 miles south of the map-area, approximately 2,200 feet of black, pyritic shale is exposed (Bamber, et al., 1968). The shale is present also in Pacific SR Candel Kledo c-14-G well (c-14-G/94-J-13) and Stanolind Sheep Creek #1 well (d-95-D/94-J-12). In the subsurface, east of these wells, the formation loses its character and the equivalent interval has been given different formational names (see Bamber et al., 1968).

The Besa River Formation is conformable and transitional with the overlying Prophet Formation. At the north end of the Muskwa anticline the formation includes beds equivalent to Member A of the Prophet. The Besa River Formation is Middle Devonian to Late Mississippian in age.

MISSISSIPPIAN

Prophet Formation

Cherty limestones of the Prophet Formation (Sutherland, 1958) are exposed on the flanks of Muskwa anticline, and in a small anticline near Chlotapecta Creek. An abrupt east to west facies change can be seen across the axis of the Muskwa anticline. There, the thick, cherty limestones on the east limb pass laterally into thinner, dark grey chert and mudstones on the west limb. The following section of the Prophet Formation was measured near Chlotapecta Creek by E.W. Bamber.

Section 23BR64. Measured on the west limb of anticline approximately 3½ miles south of Chlotapecta Creek. (Lat. 58° 27', Long. 123° 56')

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Base of Triassic strata		
	Fantasque Formation		
	Chert, dark grey, conchoidal fracture	73	647
	Kindle Formation?		
	Covered interval	23	574
	Prophet Formation (Total thickness - 551 feet)		
27	Chert, medium and dark grey; contains lenses of limestone, medium grey, fragmental, up to 2 feet thick. Fossil loc. GSC 66690, 543 feet above base of formation Horn coral indet.	41	551

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
26	Chert, medium grey with some light grey stringers; contains lenses of medium to dark grey, fragmental limestone. Fossil loc. GSC 66686, 487 feet above base of formation cf. Timania sp. Ekvasophyllum sp. Age: middle Meramecian GSC loc. 66687, 492-493 feet above base of formation auloporid coral productoid brachiopod ? Ekvasophyllum sp. Age: late Mississippian GSC loc. 66689, 508 feet above base of formation cf. Timania sp. horn coral indet. Age: middle Meramecian	28	510
25	Chert, medium to dark grey; rare lenses of medium grey, finely crystalline limestone	34	482
24	Chert, dark grey, lenticular; rare thin lenses of medium grey, finely crystalline limestone	21.5	448
23	Limestone, siliceous, dark grey	1.5	426.5
22	Limestone, medium brown, coarse fragmental	3.0	425
21	Covered interval	13	422
20	Limestone, medium to coarse fragmental, medium to dark grey; lenticular beds alternating with lenticular beds of chert GSC loc. 66684, 409 feet above base of formation cf. Timania sp. Echinoconchus sp. Age: middle Meramecian GSC loc. 66682, 386 feet above base of formation ?Ekvasophyllum inclinatum Parks		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	cf. Timania sp. Age: middle Meramecian GSC loc. 66681, 365 feet above base of formation cf. Timania sp. Age: middle Meramecian GSC loc. 66680, 356-359 feet above base of formation cf. Timania sp. Lithostrotionella cf. banffensis (Warren) algae indet. Age: middle Meramecian GSC loc. 66685, 354 feet above base of formation Lithostrotionella sp. Age: late Mississippian, probably Meramecian	58	409
19	Limestone, siliceous, light to medium grey, mottled	7	351
18	Limestone, medium to coarse fragmental, medium brownish grey to dark grey; lenticular; contains 1 inch- to 6 inch-thick lenses and beds of dark grey chert	17	344
17	Chert, dark grey, lenticular; 70 per cent of outcrop; alternating with dolomite, silty, medium to dark greyish brown, finely crystalline; and limestone, dark grey, finely crystalline	34	327
16	Covered interval	5	293
15	Limestone, siliceous, medium to dark grey with brown mottling, finely crystalline	25	288
14	Limestone, medium to dark grey, finely to medium crystalline	5	263

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Limestone, siliceous, medium to dark grey with brown mottling, finely crystalline; upper half contains thin beds of dark grey, finely crystalline limestone and lenticular beds of dark grey chert	46	258
12	Dolomite, silty, medium to dark brownish grey, finely crystalline; contains stringers of dark grey chert	5	212
11	Chert, dark grey; 60 per cent of unit; limestone, silty, dark grey, finely crystalline GSC loc. 66679, 170 feet above base of formation productellid brachiopod Age: late Mississippian, probably Meramecian		
10	Chert, dark grey; 60-65 per cent of unit; with limestone, silty, dark grey, finely crystalline GSC loc. 66679, 170 feet above base of formation productellid brachiopod Age: late Mississippian probably Meramecian	44	207
9	Dolomite, silty, dark to medium brownish grey, finely crystalline; contains numerous thin blebs and stringers of dark grey chert	3.5	163
8	Chert, calcareous, white, mottled with light brown	5.5	159.5
7	Dolomite, silty, dark to medium brownish grey, finely crystalline; contains numerous blebs and stringers of dark grey chert	4.0	154
6	Covered interval	9.0	150
5	Limestone, medium to dark grey, finely to medium crystalline; 40 per cent of unit; limestone, silty, dark grey, finely crystalline; 20 per cent of unit; limestones alternate with chert, dark grey, in thin irregular beds; contains rare, thin beds of dolomite, silty, medium brownish grey, and one 1-foot thick bed of coarse, fragmental, medium grey, fossiliferous		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	limestone GSC loc. 66678, 138 feet above the base of the formation ?Echinoconchus biseriatus (Hall) orthotetid brachiopod productellid brachiopod Brachythyris sp. Spirifer sp. Ovatia sp. Pleurodictyum sp. algae indet. fenestrate bryozoan Trilobite pygidium Age: late Mississippian, probably Meramecian	42.0	141
4	Dolomite, silty, medium brownish grey, finely crystalline; 20 per cent of unit is dark grey chert	4.0	99
3	Limestone, silty, dark grey, finely crystalline, lenticular; 60 per cent of unit; alternates with lenses of dark grey chert; 40 per cent of unit; contains some beds of medium brown, coarse, fragmental limestone and rare beds of silicified limestone GSC loc. 66677, 94 feet above the base of the formation ?Crurithyris sp. Age: indeterminate	49.0	95
2	Limestone, silty, dark grey, finely crystalline, lenses and lenticular beds, 60 per cent of unit; alternate with lenticular beds of dark grey chert	21.0	46
1	Limestone, silty, dark grey, finely crystalline	25.0	25
	Base of section. Section ends at small fault in core of anticline		

The Prophet Formation is unconformably overlain by the Permain Kindle Formation and Lower Triassic Grayling Formation. It is of late Mississippian age and equivalent to the Debolt Formation of the adjacent subsurface, and the Flett Formation of the District of Mackenzie (Bamber et al., 1968).

PERMIAN

Kindle Formation

The Kindle Formation (Laudon and Chronic, 1949), locally present within the map-area as a thin erosional remnant, is much thinner than it is farther to the west. It is present on the anticlines near Chlotapecta Creek, and on the west limb of the Muskwa anticline. The following section was measured on Chlotapecta Creek, by E.W. Bamber.

Section 24BR64. Measured on west flank of anticline along Chlotapecta Creek. (Latitude 58° 28', Long. 123° 58')

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Base of Triassic strata		
	Fantasque Formation (Total thickness - 70 feet)		
6	Chert, conchoidal fracture, dark grey; contains irregular beds of shale, silty, dark grey; in upper 10 feet chert grades to dark grey siltstone with numerous pyrite blebs	66	108
5	Siltstone, pyritic, dark grey; grades to dark chert lenses with silty shale partings	4	42
	Kindle Formation (Total thickness - 33 feet)		
4	Shale, very calcareous, silty; grades to calcareous, argillaceous siltstone in part. Fossil loc. GSC 66696, 28-31 feet above base of formation ?Licharewia sp. Spiriferella sp. Choristites sp.		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Echinoconchus sp. ?Cancrinella sp. stenoscismatacean brachiopod productoid brachiopod Age: Permian	8	38
3	Covered interval	9	30
2	Siltstone, very calcareous, argillaceous; grades to silty mudstone, beds separated by thin, even beds of shale. Fossil loc. GSC 66694, 15 feet above base of formation ?Waagenoconcha sp. Age: probably Permain	16	21
	Prophet Formation (Upper beds only measured)		
1	Limestone, medium to coarse fragmental, medium to dark grey, alternates with medium to dark grey chert in lenses and lenticular beds. Fossil loc. GSC 66692, four feet above base of unit Ekvasophyllum inclinatum Parks ?Eumetria sp. Spirifer bifurcatus Hall chonetid brachiopod pelecypod indet. Age: middle Meramecian Fossil loc. GSC 66691, one foot above base of unit Ekvasophyllum inclinatum Parks rhynchonellid brachiopod Age: middle Meramecian	5	5

The Kindle Formation is Permian in age. It is correlated with the lower part of the Belloy Formation of the adjacent subsurface (Bamber et al., 1968) and with Permian beds in the Foothills between Halfway and Peace Rivers, which were included by Irish (1963) in the upper part of the Stoddart Group, and by McGugan (1967) in the Mount Greene beds.

Fantasque Formation

The Fantasque Formation (Harker, 1961; see also Bamber et al., 1968) is present only locally within the map-area. It is underlain unconformably by the Kindle Formation, and is overlain unconformably by Triassic strata. Fantasque beds have been removed from the east limb of the Muskwa anticline, but are present locally on the west limb. Approximately 70 feet of Fantasque chert are present on the flanks of Chlotapecta anticline as described in the preceding measured section 23BR64.

The Fantasque Formation is Permian in age. It contains almost no fossils other than sponge spicules. Helicoprion sp. and poorly preserved productoid brachiopods have been collected from strata 81 feet below the top of the formation on Dunedin River in the Tuchodi Lakes map-area (GSC loc. 66707).

MESOZOIC ROCKS

TRIASSIC

Outcrops of Triassic strata in the Fort Nelson map-area occur within the fold belt of the foothills and form relatively high ranges in the southwest corner of the map-area. The Triassic strata have been subdivided into the Grayling, Toad, and Liard Formations by Pelletier (1960). South of Gathto Creek, Pelletier (1963) also reports exposures of the Halfway Formation and "Grey Beds". These were re-examined in the course of this investigation.

Grayling Formation

Recessive dark grey shales and siltstones of the Grayling Formation unconformably overlie the Paleozoic rocks. The formation is rarely completely exposed. Pelletier (1960) measured 1,050 feet of Grayling strata on Chischa River and estimated an additional 150 feet for the complete interval.

Fossils are rare in the Grayling strata. Tozer (1967) has dated the formation as of Early Triassic age.

Toad Formation

The Toad Formation conformably overlies the Grayling Formation and is well exposed in draws on the higher ridges within the map-area. Dark grey to black, "sooty", fine-grained sandstones, siltstones, and intercalated shales comprise the formation. Pelletier (1960) has shown an east to west thickening of the formation from less than 800 feet near the eastern edge of the Foothills to more than 1,600 feet in sections immediately west of the map-area.

The Toad Formation is Early and Middle Triassic in age (Tozer, 1967).

Liard Formation

The Liard Formation conformably overlies the Toad Formation and is well exposed capping most of the higher ridges of the Foothills. The lower beds of the Liard Formation are gradational with the finer, darker, sandstones of the underlying Toad Formation. The contact rises stratigraphically to the west, where strata included in the Toad Formation are the lateral equivalents of the Liard Formation. Sandstones of the Liard Formation consist of medium-sized quartz grains cemented with calcite. Pre-Cretaceous erosion has removed the Liard Formation from much of the adjacent subsurface and surface near the eastern margin of the Foothills. South and west from Chischa River, the formation increases in thickness from 53 feet to 287 feet on Chlotapecta Creek. South of Gathto Creek, Pelletier (1963) reports 736 feet of Liard strata as well as an additional 462 feet of post-Liard beds.

The Liard Formation is of Middle Triassic age

CRETACEOUS

Cretaceous rocks of this area comprise a succession of fine to coarse, clastic rocks deposited in alluvial, deltaic, and marine environments. Basal transgressive marine sandstones are included in the Gething Formation. Several thousand feet of dominantly marine, Lower Cretaceous shale with some large wedges of sandstone are placed in the Fort St. John Group. Extensive deltaic to alluvial, Upper Cretaceous conglomerates and finer carbonaceous sediments are assigned to the Dunvegan Formation. An Upper Cretaceous marine transgression represented by the Kotaneelee Formation may be present in one small area.

Lower Cretaceous

Gething Formation

The Gething Formation extends northward from its type section on Peace River (McLearn, 1923; see also Stott, 1968) almost to Tuchodi River. It unconformably overlies Triassic strata in several small folds between Gathto Creek and Tuchodi River but is not recognized beyond there. More than 500 feet of Gething strata were measured at Gathto Creek. Farther east, basal Cretaceous beds overlie Mississippian strata.

Within the Fort Nelson area, the Gething Formation comprises fine-grained sandstone and dark grey, marine shale, Northward along the Foothills, the sandstone grades laterally into shale and is apparently replaced by a shale facies beyond Tuchodi River. It appears that the Gething in this region represents, in part at least, an eastern shoreline of a marine embayment. The sandstones do not extend far to the east and equivalent beds do not appear to be present in wells east of the Muskwa escarpment.

The Gething of this region can be divided into three units; two thick sandstone sequences separated by concretionary mudstones and siltstones. The basal sandstones are dominantly fine-grained, siliceous, platy to thick-bedded, and rusty brown-weathering. A few beds of medium- to coarse-grained sandstone are present but no conglomerate was noted. The middle mudstones are silty, dark grey to black, weather rubbly to blocky, and contain some large sideritic concretions. These mudstones grade upward into fine-grained sandstone similar to the basal unit.

The uppermost beds of the Gething consist of abundantly glauconitic silty sandstone. In some places, the uppermost beds are concretionary and the contact with the overlying Buckinghorse shales is abrupt. In other places, the contact has a more transitional appearance. Coaly fragments of logs are present at the top of the formation near Gathto Creek.

The Gething lies below Buckinghorse shales dated as ? early to middle Albian. Farther south, it overlies beds dated as Valanginian. The Gething can therefore be dated as late Neocomian to ? early Albian.

Fort St. John Group

Lower Cretaceous rocks of predominantly marine origin are included in the Fort St. John Group which, in this area, comprises the Buckinghorse, Sikanni, and Sully Formations. In the vicinity of Chischa River and Chlotapecta Creek, tributaries of Muskwa River, the Buckinghorse contains two major sandstone sequences. These sandstones are approximately equivalent to the type Scatter

Formation of Liard region to the north, but for present purposes, it is more convenient to include them as members of the Buckinghorse.

No continuously exposed section of the Fort St. John Group is known in this area. The group, estimated to be approximately 4,500 feet thick along the Muskwa escarpment, decreases in thickness eastward to about 2,500 feet on the eastern side of the map-area.

Buckinghorse Formation

Silty, marine shales of the Buckinghorse Formation (Hage, 1944) extend northward from the type section into the Fort Nelson map-area. The shales extend in a broad belt along the eastern Foothills, and are well exposed along Muskwa River south of Chischa River. The formation occurs at the surface over a large part of the plains region of the map-area, outcropping in high cliffs along Prophet River. Only a few exposures are present in the valleys of the lower Muskwa and lower Fort Nelson Rivers but the formation can be recognized in wells drilled in the eastern and northern regions.

A section of the lower Buckinghorse was described by Stott (1967, sec. 64-3) on Tetsa River just beyond the western limit of the map-area, where about 2,100 feet of strata are exposed. Upper beds of the formation were described (Stott, 1967, sec. 64-25) on the escarpment east of Muskwa River. An estimate, based on these sections, suggests a thickness in that region of about 3,500 feet. Thicknesses in that order occur in Pacific SR Candel Kledo c-14-G well (c-14-G/94-J-13) and CDR Pac. Sinc. Prophet d-21-B well (d-21-B/94-J-3). Farther east beyond Fort Nelson, the Buckinghorse Formation has descreased in thickness to about 2,000 feet in B.A. Shell Klua Creek b-49-F well (b-49-F/94-J-9) and slightly less than 2,000 feet in B.A. Shell Klua Creek No. 2 well (a-56-H/94-J-9).

Where Buckinghorse shales lie on the Gething Formation, there is a fairly abrupt change from glauconitic, concretionary sandstone to rubbly, rusty-weathering shales. A thin bed of pebbles may occur at the base of the shales.

Basal sandstones occurring on Chlotapecta Creek and Chischa River may represent some part of the Gething Formation but for mapping purposes have been included in the Buckinghorse Formation. On Chlotapecta Creek, 48 feet of sandstone lie on the Triassic Liard Formation. The sandstones are fine-grained, grey, thick-bedded with some intercalated silty shale. Some conglomerate occurs near the top. At the westernmost exposure of Cretaceous beds along Chischa River, black shale appears to lie directly on Triassic rocks although 2 to 3 feet of fine-grained sandstone occurs about 10 feet above the base. On the western flank of the next anticline downstream, the basal Cretaceous beds comprise 9 to 10 feet of fine-grained, siliceous, massive sandstone with some pebbles embedded in the upper surface.

In the Tuchodi-Tetsa region, the Buckinghorse Formation is readily divisible into three major units, corresponding in large part to the Garbutt, Scatter, and Lepine Formations of the Liard region (see Stott, 1968). Black, rusty-weathering shales with large sideritic concretions occur at the base of the formation and are overlain by rubbly to flaky shales. These basal shales are well exposed on Chischa and Tetsa Rivers and Chlotapecta Creek. An overlying succession consisting of two sandstone sequences separated by dark shale, is similar to the Scatter Formation. The lower sequence of interbedded, silty sandstone and shale is not prominent. The second succession of sandstone, separated from the first by dark shales, is approximately equivalent to the upper Scatter sandstone. It is well exposed at the junction of Chlotapecta Creek and Muskwa River and on Chischa River (see Stott, 1967, sec. 64-29). It consists of several units of fine-grained, platy to thick-bedded sandstone with intercalated silty mudstone. The sandstones are well indurated with siliceous cement and weather brown. The upper Buckinghorse shales, well exposed east of Muskwa River (see Stott, 1967, sec. 64-25), are mainly equivalent to the Lepine Formation. That succession consists of concretionary shale at the base, rusty flaky shale in the middle, and silty shale with platy siltstone in the upper part.

The Buckinghorse Formation in the type region to the south is dated as ? early to middle Albian (see Stott, 1968). It is possible that shales equivalent to the Gething Formation are included in the Buckinghorse Formation within the Fort Nelson map-area and, therefore, the basal beds of the Buckinghorse would be somewhat older.

Sikanni Formation

The Sikanni Formation extends northward from its type locality on Sikanni Chief River into the Fort Nelson map-area. It forms the surface bedrock east of Prophet River and of several, large, erosional remnants east of Muskwa River, but is best exposed along the Muskwa escarpment. Exposures are scarce north of Mile 230 on the Alaska Highway but the formation does crop out along Jackfish Creek and for several miles along Fort Nelson River in the vicinity of Klua Creek.

In the type region, to the south, the Sikanni comprises four units of sandstone separated by silty shales. In the western part of the Fort Nelson area, the number of sandstones increases to as many as eleven and the total thickness of the formation increases from 380 to more than 800 feet along the Muskwa escarpment. (see Stott, 1967, sec. 64-27).

The lower beds are transitional into the underlying Buckinghorse shale and the boundary lies at no persistent stratigraphic horizon. These beds are well exposed at Mile 351, on the Alaska Highway.

Sandstones along the Muskwa escarpment are fine-grained, laminated, brown, and flaggy to thick-bedded. Shales are silty, dark grey to black, platy to blocky, with some sideritic concretions. The sandstones grade laterally eastward into interbedded sandstone, siltstone, and shale, losing their prominent ridge-forming character east of Prophet River.

The formation is exposed in a series of road-cuts along the Alaska Highway in the vicinity of Steamboat Mountain between Miles 350 and 356. There, the lower, thick-bedded sandstone units form resistant cliffs. To the north of Kledo Creek, the Sikanni beds are not well exposed but their ridge-forming character permits mapping them from aerial photographs. Farther east, the Sikanni Formation is assumed to cap broad, flat-topped ridges extending toward Fort Nelson. Several exposures of very silty, platy to thin-bedded sandstone occur in gullies of small streams flowing off the south side of these ridges.

Beds of the Sikanni Formation are well exposed in Jackfish Creek west of the Alaska Highway and farther east along Fort Nelson River and Klua Creek. They consist of thin, flaggy beds of very fine-grained, grey, laminated sandstone and argillaceous siltstone with interbedded rubbly, rusty-weathering shale.

No exposures were found between Fort Nelson and the northern and eastern boundaries of the map-area. The formation has been extended into this region on the basis of topographic expression and data from wells drilled there.

Posidonia nahwisi var. goodrichensis (McLearn) and P. nahwisi var. moberliensis (McLearn) were collected by Stott at Mile 353 on the Alaska Highway; Posidonia ? nahwisi (McLearn) f. type was collected from the talus of the Sikanni Formation north of Steamboat Mountain; and P. ? nahwisi (McLearn) s. lato? was collected from a road-cut south of the map-area. A similar fauna (including Neogastroplites ?) was collected by Williams (1944) from road-cuts near Steamboat Mountain. This fauna is considered by Jeletzky to be of late Albian age.

Sully Formation

Recessive shales lying between the cliff-forming Sikanni and Dunvegan sandstones are included in the Sully Formation (Stott, 1960). The formation is commonly covered and not well exposed on the ground, but the interval is readily recognized and mapped from aerial photographs.

The base of the formation occurs above successively older beds from west to east, and the thickness of the shales increases eastward as additional strata are included. The upper beds are usually transitional into the overlying Dunvegan sandstone but appear to lie beneath a remarkably persistent sandstone along the Muskwa escarpment.

The Sully maintains a fairly uniform thickness of about 300 feet along the Muskwa escarpment but increases eastward to as much as 700 feet. The increased thickness is directly related to the lateral eastward facies change from Sikanni sandstone to shale.

Although the Sully Formation is shown as underlying a large area between Klua Lakes and Fort Nelson, only a few surface exposures are known there. They occur along Klua Creek and consist of black, rubbly shale that weathers rusty. The shales contain some sideritic concretions and silty, platy sandstone. Directly east and just beyond the map-boundary, the Sully is exposed along the lower part of the Sikanni Chief River where several large cliffs are formed of soft muddy shale coated with a yellow efflorescence and containing abundant small selenite crystals.

Only a few outcrops of Sully shales were found along the Muskwa escarpment. Farther north at Steamboat Mountain, about 275 feet of Sully beds are fairly well exposed. The shales are dark grey to black, rubbly to blocky, and much harder than in the eastern exposures. They contain sideritic concretions which weather reddish brown. Some silty to argillaceous, platy sandstone occurs toward the top of the formation.

The Sully Formation, lying between the late Albian Sikanni sandstones and the Cenomanian Dunvegan beds is dated as latest Albian to early Cenomanian.

Upper Cretaceous

Dunvegan Formation

Massive Upper Cretaceous sandstone and conglomerate, assigned to the Dunvegan Formation, is well exposed along the Muskwa escarpment where the formation is about 500 feet thick (see Stott, 1967, sec. 64-31). The highest outcrops on the hills to the east are of these sediments and they occur in almost continuous exposures in vertical cliffs around isolated erosional remnants near Klua Lakes. A section at the headwaters of Adsett Creek was found to be 491 feet thick.

The basal Dunvegan sandstone is gradational into the underlying Sully shales, the contact being drawn below the first unit of thick-bedded sandstone. Within most of Fort Nelson map-area, the Dunvegan conglomerates form the youngest bedrock, the upper surface being either exposed or thinly covered by Pleistocene deposits. It seems probable that some of the uppermost beds have been eroded.

The formation comprises a basal sandstone overlain by three cycles of carbonaceous mudstone, massive conglomerate, and coarse-grained sandstone. The basal fine-grained, well-indurat ed and well-sorted sandstone is commonly thick-bedded to massive. The massive conglomeratic units contain rounded to well-rounded pebbles and cobbles embedded in a matrix of medium- to coarse-grained sand. The pebbles consist dominantly quartz, quartzite, and chert of various shades of green, blue, grey, white, and black. They range in size from one-eighth inch to

6 inches in diameter. At Adsett Creek, the size of the pebbles is much less than along Muskwa escarpment and much of the massive conglomeratic units consists of coarse-grained sandstone. Thin, recessive intervals between the conglomeratic units contain poorly exposed, silty, friable sandstone and carbonaceous shales.

Fossil flora, collected by Stott from the Dunvegan Formation at the headwaters of Akue Creek, was identified by W.A. Bell as including

Menispermites reniformis Dawson
Populites wickendeni Bell
Laurophyllum sp. Bell
Platanus newberryana Heer
Pseudoprotophyllum boreale (Dawson) Hollick
Pseudoaspidiophyllum latifolum Hollick

Bell dated this flora as Cenomanian and indicated that it is characteristic of the Dunvegan Formation.

Kotaneelee Formation

No exposure of the Kotaneelee Formation is known within the Fort Nelson map-area but a small remnant may occur north of Kledo Creek in the northwest corner. Farther north, the Kotaneelee comprises dark, concretionary, marine shales of Late Cretaceous age. A disconformity between the underlying Dunvegan Formation and the Kotaneelee represents all of Turonian and probably most or all of Coniacian time.

STRUCTURE

The Fort Nelson map-area lies partly within the Interior Plains and partly within the Rocky Mountain Foothills structural provinces. Bedrock exposures are rare within the Interior Plains except on the bounding escarpments, whereas exposures of bedrock within the Foothills are relatively good.

INTERIOR PLAINS

The Interior Plains are underlain entirely by Cretaceous rocks within the Fort Nelson map-area. The Cretaceous strata at the surface have a gentle regional dip to the east. The sub-Cretaceous surface however has a gentle regional dip to the west. This phenomenon is the result of the eastward thinning of the Cretaceous stratigraphic units. Very low amplitude, broad folds have affected the Cretaceous and underlying strata. These dip reversals have very low values, but are significant in the entrapment of petroleum to the south of the map-area in the Beg West, Beg, Jedney, Bubbles, La Prise Creek, and La Prise East Creek gas fields.

ROCKY MOUNTAIN FOOTHILLS

Structure is the predominant control of the physiography of the Foothills. Major and minor folds trend northwest. Most of the folds are compound structures with intricate fold linkages. The folds themselves are slightly asymmetrical with steepened east limbs. Faults are rare, and have small displacements. All are reverse faults with steep westerly dips. The folds are demonstrably disharmonic, and are believed to reflect decollement movement at depth. Zones of the major decollement movements are located within the Besa River shales, Grayling shales, and Buckinghorse shales.

Two major anticlines bring Paleozoic rocks to the surface. The largest of these, the Muskwa anticline, extends into the map-area from the south. The second major anticline, Chlotapecta anticline, is similar to, though much smaller than, the Muskwa anticline. Both folds trend northwest, are doubly plunging, with steep, locally overturned, east limbs. Chlotapecta anticline has a small fault in its core.

The folds of the Foothills are, in general, disharmonic structures. The gross stratigraphic succession is an alternation of the relatively competent Dunedin (not exposed) Prophet, and Liard Formations and the incompetent Besa River, Grayling, and Buckinghorse Formations. Most folds, viewed in section, display marked changes in structural style relative to stratigraphic position. The lower competent units are commonly deformed into broad simple anticlines with a small thrust fault on one limb. The thrust passes into the overlying incompetent unit where the displacement is dissipated on multiple detachment surfaces. The next overlying competent unit must still reflect the same tectonic shortening and is disharmonically folded relative to the underlying structure into folds of lesser wave length and amplitude. The process continues upward until the curvature of the fold is sufficient to accomodate the original thrust displacement at depth.

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