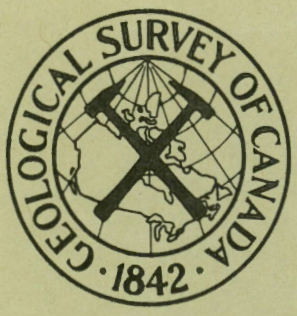

GEOLOGICAL
SURVEY
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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

PAPER 68-12

MAXHAMISH LAKE, BRITISH COLUMBIA (94-O)

(Report and Map 2 — 1968)

G. C. Taylor and D. F. Stott

Price, $1.50

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CONTENTS

ABSTRACT

Strata, ranging in age from Mississippian to late Cretaceous and having an aggregate thickness in excess of 9,000 feet, are described from occurrences in the Maxhamish Lake map-area.

The oldest rocks exposed are carbonates of the Mississippian Flett Formation. These are overlain by the erosional remnant of the Mississippian Mattson Formation consisting of sandstone. The Lower Cretaceous Fort St. John Group, comprising the Buckinghorse, Sikanni, and Sully Formations, unconformably overlies the Paleozoic strata. Upper Cretaceous strata, that occur mainly in the western half of the area, are included in the Dunvegan, Kotaneelee, and Wapiti Formations.

The map-area lies wholly within the Interior Plains physiographic province. Nevertheless the bedrock has been deformed into several structures similar to those of the more mountainous areas to the west and north.

MAXHAMISH LAKE, BRITISH COLUMBIA

INTRODUCTION

Maxhamish Lake map-area (940), in northeastern British Columbia, is bounded by latitudes 59° and 60° N and longitudes 122° and 124° W. It forms part of the region investigated by Operation Liard (Taylor, 1965, 1966) during the summers of 1964 and 1965.

FIELD WORK AND ACKNOWLEDGMENTS

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 to carry out 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. Granger, and B.J. Reive. Cooks were S.W. McWinnie 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 the writers and other officers of the party extend their appreciation.

Mississippian fossils were identified and dated by E.W. Bamber; Cretaceous microfauna, by T.P. Chamney.

PREVIOUS WORK

Little geological information has been published concerning the map-area. A geological reconnaissance of the region was first made by McConnell (1890). Later explorers used Fort Nelson and Liard Rivers on their way north into the regions now known as Yukon and Northwest Territories. Reconnaissance studies within Maxhamish Lake 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. Kindle (1944) descended the Fort Nelson River and continued westward along Liard River. Hage (1945) examined part of the region bordering this area during his ascent

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of Petitot River from Fort Liard on Liard River. In 1957, the Geological Survey undertook comprehensive regional studies immediately to the north of Maxhamish Lake map-area. Douglas and Norris (1959) published on the geology of the Fort Liard sheet (1959); Stott (1960), on Cretaceous stratigraphy; and Harker (1961; 1963) on the Permian and Carboniferous rocks.

PHYSICAL FEATURES

The Maxhamish Lake map-area lies within the Interior Plains physiographic division so that much of the region is low-lying, nearly flat ground covered by muskeg and small lakes. Exposures are very rare and, with the exception of the area south of Fort Nelson River and west of the Poplar Hills, occur mainly along the principal rivers and along the escarpments. In the southwest part of the map-area, remnants of the Alberta Plateau, here called the Tsoo tablelands, have been deeply dissected. The gently rolling surface of these plateau remnants is developed on the Dunvegan conglomerates which are well exposed as rimrock.

A prominent cuesta, trending north-northeasterly, extends for 50 miles between Fort Nelson and Petitot Rivers. Holland (1964, p. 122) named this feature the Bovie lineament, interpreting its origin as the result of Paleozoic chert and limestone having been thrust over Cretaceous shale. The cuesta is, in fact, the upturned edge of the Cretaceous Dunvegan Formation on the east margin of the Liard syncline and, to avoid confusion, is here referred to as the Maxhamish escarpment. The only exposures of Paleozoic rocks in the area occur in a range of low hills formed by the Bovie anticline mid-way along the northern boundary of the map-area.

During Pleistocene time, the map-area was covered by a continental ice-sheet. Ground moraine, that now covers extensive areas, was reworked by the ice into long, low, parallel ridges. Meltwater channels were carved into the moraine at the time of deglaciation and, outwash plains, on which large dune fields developed, were formed at the egress of the meltwater channels. Thick deposits of glacial silts filled most of the pre-existing watercourses which are now actively being re-excavated. In the southeast corner of the map-area, a prominent linear mound, not more than 30 feet high, trends southeast and can be followed for a distance of 20 miles to where it extends beyond the map-area. It is interpreted as a fluvial deposit resulting from the filling a longitudinal crack in dead ice.

STRATIGRAPHY

The rocks examined in the map-area are all of sedimentary origin. They range in age from Mississippian to Upper Cretaceous and have an aggregate thickness of over 9,000 feet. Devonian strata underlie the Mississippian and younger rocks described in this report but are not exposed. Within the map-area several wells have penetrated the Devonian section and the succession has been summarized by

TABLE OF FORMATIONS[1]

Era	Period or Epoch	Group	Formation and Thickness	Lithology
Mesozoic	Upper Cretaceous		Wapiti 200'+	Conglomerate; fine- to coarse-grained sandstone; carbonaceous shale and coal
			Kotaneelee 600'+	Dark grey, marine shale; minor amounts of sandstone
		UNCONFORMITY		
			Dunvegan 570'	Massive conglomerate; fine- to coarse-grained sandstone and carbonaceous shale
	Lower Cretaceous	Fort St. John Group 2,000'-4,300'	Sully 300-400'	Dark grey marine shale
			Sikanni 0-1,000'	Fine-grained, well-sorted to silty sandstone; interbedded shale
			Bucking-horse 1,500'-2,000'	Dark grey marine shale; siltstone; sideritic concretions
UNCONFORMITY				
Paleozoic	Mississippian		Mattson 0-2,200'	Quartzose sandstone; sandy shale
			Flett 1,200'±	Limestone, crinoidal, sandy, argillaceous; shale

[1]Only those formations occurring at surface are shown in this table.

Belyea and Norris (1962), and Griffin (1965). Triassic rocks occur in the subsurface of the western part of the map-area but are not known to be present either in outcrop or in the subsurface east of the Bovie fault.

UPPER PALEOZOIC ROCKS

Upper Paleozoic rocks are exposed along the Bovie anticline as well as on the Petitot River 25 miles east of the anticline and just inside the District of Mackenzie. They are assumed to be present on the British Columbia side of the boundary although no exposures were actually observed. The succession is divisible, in ascending order, into the Flett Formation, Mattson Formation, and Fantasque Formation but the latter is not known to be exposed within the map-area. Douglas and Norris (1959) reported the Fantasque (Harker, 1961) to occur at the surface where the Texaco Northern Foothills Agreement Bovie Lake No. 1 well was spudded (lat. 60° 12' 09" N., long. 122° 58' 36" W.), but no outcrop of this formation was seen to the south where Petitot River breaches Bovie anticline. According to R.M. Procter (pers. comm.) the formation is known, from well data, to occur farther west beneath the Liard syncline.

Flett Formation

Bioclastic limestones of the Flett Formation (Harker, 1961) are exposed on Petitot River in the core of the Bovie anticline. About 200 feet of these beds are exposed at the surface. The only other surface occurrence of the Flett limestone is also on Petitot River but 25 miles farther east. There, just to the north of the map-area, five feet of strata dip at a small angle to the southwest. The formation is assumed to underlie the surface within the map-area. Beds, in the subsurface, equivalent to the Flett Formation are well known throughout the area from well penetrations but are generally assigned to the Debolt Formation (Bamber et al., 1967). Where complete, the formation has an average thickness of 1,200 feet.

In areas west and northwest of Maxhamish Lake map-area, the Flett Formation is exceedingly fossiliferous. A small collection of fossils from near Petitot River has been identified by E.W. Bamber:

GSC loc. 70480: North side of Petitot River, west limb of Bovie anticline, 59° 59' N., 122° 57' W.

Ekvasophyllum proteus Sutherland
caninid coral indet.
Lithostrotion (Siphonodendron) oculinum Sando
fish plate

Age: Late Mississippian - probably early Meramecian. E. proteus and L. (S.) oculinum are present in the lower Debolt Formation of the subsurface to the south in British Columbia.

Mattson Formation

Fine-grained, well-rounded, quartzose sandstones of the Mattson (Patton, 1958) overlie limestones of the Flett Formation. Approximately 300 feet of the Mattson Formation are exposed at the surface on the flanks of the Bovie anticline but, east of this anticline, these strata have been removed by pre-Cretaceous erosion (Bamber et al., 1967). The Mattson Formation is known also from well penetrations beneath the Liard syncline and, in this region, progressive eastward truncation can be demonstrated. Thickness of the formation decreases from approximately 2,200 feet in Imperial Pan Am La Biche b-55-E well (b-55-E/94-0-13) near the west boundary of the map-area to approximately 1,460 feet in the Imperial Pan Am Viscount a-77-D well (a-77-D/94-0-11) near the Maxhamish escarpment. The Permian Fantasque Formation overlies the Mattson beds at both localities. The thickness of the Mattson decreases abruptly from 1,460 feet in the Viscount well to only 280 feet in the B.C. Oil Lands Bekami Lake No. 1 well (d-29-A/94-0-11) where Mississippian beds are overlain by Cretaceous sediments.

No fossils were found in the Mattson Formation in the Maxhamish Lake map-area. The lower part of the Mattson was assigned a Chesterian age by Harker (1963). To the south, the Mattson passes laterally into the Stoddart Formation (Bamber et al., 1967).

LOWER CRETACEOUS ROCKS

Fort St. John Group

The Fort St. John Group (Dawson, 1881; see also McLearn and Kindle, 1950; Stott,1968) includes a thick succession of Lower Cretaceous, marine shales. A major sandstone sequence occurs in the upper third of the group in the southwestern part of the map-area and, there, it is subdivided, in ascending order, into the Buckinghorse, Sikanni, and Sully Formations. The Sikanni Formation can be mapped as far north as Fort Nelson River but, eastward, its distinctive character is lost. In the region north of Fort Nelson River and east of Maxhamish Lake, the Sikanni sandstones do not appear to be present and the Fort St. John Group is not subdivided for the purposes of surface mapping.

Much of the Fort St. John Group is exposed along Petitot River in the vicinity of the Bovie anticline where a thickness occurs in the order of 3,000 feet or more. Sandy strata occurring in the lower part of the group may represent some part of the Scatter Formation of the Liard River region. However, those sandstones are not recognized as a formal mapping unit within the Maxhamish map-area. Similarly, in the subsurface, east of the Maxhamish escarpment, a sandy to silty unit occurring near the base may be equivalent to the Scatter Formation.

The Fort St. John Group is about 4,300 feet thick in Imperial Pan Am Labiche b-55-E well (b-55-E/94-0-13) and 4,000 feet in the Imperial Pan Am Viscount a-77-D well (a-77-D/94-0-11). A marked reduction in the thickness of the basal shale unit occurs east of the Bovie fault, indicating that the fault was active in pre-Cretaceous time and possibly during deposition of the Cretaceous sediments. As the upper Fort St. John is eroded over much of the area, an accurate thickness is impossible to obtain at most places. However, well data from Pan Am A-1 Komie a-51-A well (a-51-A/94-0-8) and the occurrence nearby of the overlying Dunvegan Formation, indicates an approximate thickness of 2,000 feet in the eastern part of the map-area.

In wells west of Maxhamish escarpment, the group lies unconformably on Triassic sediments. Along Petitot River, on the west flank of the Bovie anticline, the Fort St. John Group appears to lie unconformably on the Mississippian Mattson Formation and, farther east along the river, on the older Flett Formation. The basal beds on the west flank of the anticline comprise thirty-eight feet of fine-grained, lithic sandstone that weathers to brown and rust colours. Beds are thin and somewhat irregular and the uneven appearance is further intensified by numerous fillings of worm burrows. These beds are 900 feet in horizontal distance from the beds described in the following section. The covered interval between the two exposures, which could represent some 600 feet of basal Fort St. John beds, may contain the Bovie Lake fault and thus the following succession may not be continuous with the basal sandstones.

Section 57-112. Fort St. John Group: Petitot River, N.W.T., downstream from Bovie Lake anticline, Maxhamish Lake map-area, B.C., 59° 59' N., 122° 58' W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Overlying beds not exposed although shale and sandstone do occur farther downstream		
27	Shale to mudstone, silty; bedded; rusty-weathering; rare concretionary layer	32	813
	GSC loc. C-79 Gaudryina - Verneuilinoides spp. Trochammina cf. T. mcmurrayensis Mellon & Wall Lentinculina sp. Ammobaculites cf. A. fragmentarius Cushman ?Reophax sp. Age: Albian		
26	Mudstone, blocky; rusty-weathering; some thin beds of siltstone	22	781
25	Shale to mudstone, rubbly; rusty-weathering; few concretions	35	759
24	Mudstone, silty; some sandstone	12	724
23	Mudstone to shale, rubbly; rusty-weathering	57	712
	GSC loc. C-77 Miliammina cf. M. manitobensis Wickenden ? Siphotextularia sp. Ammobaculites spp. Haplophragmoides spp. Trochammina sp. Saccammina cf. S. lathrami Tappan ? Reophax (Proteonina) sp. Gaudryina - Verneuilinoides spp. Age: Late Albian		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
22	Siltstone to mudstone, rusty-weathering; dark grey to black	6	655
21	Mudstone, to shale, rubbly; rusty-weathering	13	649
	GSC loc. C-78 Miliammina cf. M. manitobensis Wickenden Haplophragmoides spp. Gaudryina sp. Ammobaculites cf. A. sp. A. Wickenden Trochammina sp. Reophax sp. Age: Late Albian		
20	Sandstone, fine-grained, greenish grey, finely laminated	3	636
19	Mudstone, rubbly, rusty-weathering; few concretions	48	633
	GSC loc. C-76 Gaudryina sp. Haplophragmoides cf. H. gigas minor Nauss Miliammina cf. M. manitobensis Wickenden Ammobaculites cf. A. sp. A. Wickenden Age: late Albian, Miliammina manitobensis zone		
18	Sandstone, as above	1	585
17	Shale to mudstone, rubbly to slightly blocky rusty-weathering, greyish black; few concretions; large 3' concretion at top	104	584
	GSC loc. C-75 Trochammina sp. Haplophragmoides spp. Bathysiphon sp. Miliammina sp. Ammobaculites sp.		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Gaudryina sp. ? Reophax (Proteonina) sp. Age: Albian		
16	Shale to mudstone, as above	104	480
15	Mudstone, greyish black; blocky; rusty-weathering	15	376
14	Siltstone, bedded, light brownish grey, platy	20	361
13	Shale, silty, greyish black; rusty-weathering	25	341
12	Siltstone, thinly bedded, and shale, rubbly, rusty-weathering; contains more sand at top	25	316
11	Shale to mudstone, blocky, rusty-weathering; few concretions and thin siltstone beds	40	291
10	Shale, rubbly to blocky at top, rusty-weathering; greyish black; some large reddish brown concretions	40	251
	GSC loc. C-73 Gaudryina sp. Verneuilinoides spp. Trochammina cf. T. mcmurrayensis Mellon & Wall ? Textularia - Spiroplectammina spp. Ammobaculites cf. A. fragmentarius Cushman Bathysiphon cf. B. brosgei Tappan Haplophragmoides cf. H. eilete (Tappan) Age: Albian		
9	Mostly covered. Appears to be rubbly, rusty-weathering shale	25	211
8	Siltstone, argillaceous to mudstone, silty; rusty-weathering; some concretions and thin beds of sandstone	46	186

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Sandstone and siltstone with shale. Sandstone, fine-grained, brownish grey, 1" - 2" beds; few concretions	57	140
6	Mudstone to shale, silty; rusty-weathering; few concretions	13	83
5	Sandstone and shale, interbedded, as below	11	70
4	Shale, silty; rusty-weathering	9	59
	GSC loc. C-72 Ammobaculites cf. A. fragmentarius Cushman Gaudryina cf. G. subcretacea Cushman ? Siphotextularia sp. Haplophragmoides cf. H. sp. Wickenden Haplophragmoides spp. Trochammina sp. Pelosina sp. Gaudryina cf. G. nanushukensis Tappan Age: late middle Albian		
3	Sandstone, fine-grained, greenish grey, finely laminated; thinly bedded with beds of shaly siltstone	23	50
2	Mudstone to siltstone, very thinly bedded; rusty-weathering; becomes more silty at top	25	27
1	Sandstone, fine-grained, laminated; thinly bedded; shale and concretionary beds	2	2
	GSC loc. C-71 Siphotextularia sp. Haplophragmoides sp. Age: Albian		
	Underlying beds are covered. An interval, 600 feet in stratigraphic thickness, separates the above beds from the following strata. A fault may be present in this interval.		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Sandstone, fine-grained, grey; thin-bedded; brown-weathering; irregularly bedded; worm burrows	38	38
	Underlying beds are not exposed. Next outcrop contains sandstone of the Mississippian Mattson Formation		

The Fort St. John Group of Maxhamish Lake area can be dated in part by its microfauna, by extrapolation to neighboring regions, and from its stratigraphic position. Middle shales of the group along Petitot River yielded a microfauna dated by T.P. Chamney as middle to late Albian. The lower beds of the group are probably as old as the basal beds of the type Buckinghorse Formation, that is, ? early to middle Albian age, and the basal beds may possibly be somewhat older in the northwestern region. The Fort St. John Group is overlain by the Cenomanian Dunvegan Formation and, therefore, includes beds of ? early Albian to Cenomian age.

Buckinghorse Formation

No completely exposed section of the Buckinghorse Formation occurs south of Fort Nelson River. In the southwestern corner of the area, the Cretaceous beds may be underlain by Triassic strata but, to the northeast, they lie on Mississippian strata.

The lower part of the formation does not outcrop in the map-area although it probably is present in the vicinity of Bovie Lake anticline along Petitot River. The upper beds are poorly exposed at most places but occur as isolated outcrops beneath the Sikanni sandstones and along some of the small creeks.

Based on the thickness of Cretaceous beds present in the West Nat. et al. Evie Lake b-89-E well (b-89-E/94-J-15) located just south of Maxhamish map-area, it is estimated that the thickness of the Buckinghorse Formation in this region is between 1,500 and 2,000 feet. These marine shales are dark grey, rubbly, micaceous,

concretionary, and rusty-weathering.

The Buckinghorse Formation is dated as ? late early Albian to middle Albian in the region south of Maxhamish Lake map-area.

Sikanni Formation

The Sikanni Formation comprises a succession of fine-grained sandstone units separated by silty shales (Hage, 1944; Stott, 1960). It is the surface bedrock formation over large parts of the region south of Fort Nelson River.

The thickness of the formation within the map-area was not obtained but, 15 miles to the west, its total thickness is in the order of 1,000 feet. As the formation is traced eastward, it becomes much more silty, argillaceous, and recessive, and finally becomes inseparable from other beds of the Fort St. John Group. As successive sandstones grade laterally into these argillaceous sediments, the upper and lower boundaries of the formation are drawn at different stratigraphic levels so that the formation includes a thinner succession northeastward.

Along the Tsoo tablelands, Sikanni sandstones are fine-grained, finely laminated, siliceous, and weather brownish grey. Bedding is fairly uniform but can vary from flaggy to thick-bedded. Shales are silty and commonly include sideritic concretions that weather reddish brown. East of the tablelands, the Sikanni Formation consists of platy to flaggy, silty sandstone with interbedded siltstone and shale, and loses its prominent ridge-forming character. Its recognition on the flat ridges of the Poplar Hills south of Fort Nelson River is based on a few scattered outcrops and on the topographic expression.

The Sikanni Formation is not recognized around the margin of the Etsho escarpment and presumably has graded into a shale facies. Electric log characteristics from well records suggest that equivalent beds can be traced east across the map-area.

To the north on Petitot River, a sandstone unit occurring just beyond the northern limit of the map-area appears to represent some part of the Sikanni Formation. It consists of the following succession:

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Overlain gradationally by silty, rusty-weathering, platy shale with a few lenses of sandstone		
8	Sandstone, fine-grained, laminated grey; flaggy	25	123
7	Sandstone, fine-grained, grey; platy to flaggy	10	98
6	Mudstone, silty; platy; rusty-weathering	9	88
5	Sandstone, fine-grained, laminated, cross-laminated, grey; brownish grey weathering; few thin beds of shale	22	79
4	Sandstone, fine-grained, laminated, cross-laminated, grey; brownish grey weathering; silty shale at base	9	57
3	Sandstone, fine-grained, silty, laminated, cross-laminated; thin-bedded; some argillaceous siltstone	31	48
2	Sandstone, and shale	4	17
1	Sandstone, fine-grained, laminated; thin-bedded	13	13
	Underlying beds not exposed		

A fauna of the generalized zone of Neogastroplites, dated as late Albian by J.A. Jeletzky, was obtained from the Sikanni Formation some 25 miles south of the map-area. The Sikanni sandstones are therefore dated as late Albian.

Sully Formation

Dark marine shales lying between the sandstones of the Sikanni and Dunvegan Formations are included in the Sully Formation (Stott, 1960). They are recessive, commonly forming talus - or vegetation-covered slopes below the massive cliffs of Dunvegan conglomerate. The shales form a narrow band along the Tsoo tableland west of Poplar Hills and are considered to be present in the axis of the anticline north of La Biche River.

The formation is 300 to 400 feet thick along Dunedin River west of the map-area and probably is of the same order of thickness along the scarps of the Tsoo tablelands.

The base is considered to lie on successively older sandstones from west to east and the lower boundary probably changes stratigraphic position within short distances. Where the Sikanni Formation disappears, the Sully shales are indistinguishable from lower Fort St. John shales.

The Sully Formation is considered to be of latest Albian to early Cenomanian age. The widespread "Fish-Scale" marker zone of the Peace River Plains may lie within this interval.

UPPER CRETACEOUS ROCKS

Upper Cretaceous strata are included in the Dunvegan, Kotaneelee and Wapiti Formations. They occur mainly in the western half of the map-area but a large region on the east side is underlain by Dunvegan sediments. Although the Kotaneelee Formation underlies a substantial portion of the area, only a few scattered outcrops are present and the formation is not well known.

Dunvegan Formation

The Dunvegan Formation (Dawson, 1881) occurs in spectacular cliffs along the edge of the Tsoo tablelands where it is 570 feet thick. It forms the massive walls of the canyon of Fort Nelson River and good exposures occur along the escarpment east and south of Maxhamish Lake. These rocks were previously called the Fort Nelson Formation or Conglomerate (Kindle, 1944). Considerable confusion has occurred as to the actual beds included in that formation and, as there is duplication in nomenclature, the name Dunvegan is preferred (see Stott, 1968). The formation does not crop out directly west of Bovie anticline within the map-area but reappears farther north along Petitot River (see Stott, 1960).

No exposures were discovered along the Etsho Escarpment where the whole region is covered by dense forest. However, stratigraphic cross-sections that include wells located in that immediate vicinity strongly support the assumption that this high area owes its prominence to the presence of the more resistant Dunvegan sandstones. It is assumed that the Dunvegan sediments are much finer-grained and less well-indurated in that area and have a greater tendency to disintegrate. For this reason no prominent cliffs develop.

In the western exposures, the formation comprises four, resistant, coarse clastic members separated by recessive, shaly units. The basal beds include fine- to coarse-grained, porous, laminated, crossbedded sandstone grading into the silty shales of the underlying Sully Formation. The upper three conglomeratic members are thick-bedded to massive, forming sheer cliffs. The conglomerates contain chert and quartzite pebbles up to three inches in diameter, commonly embedded in a matrix of coarse-grained, cherty sandstone. A more complete description of the formation along the Tsoo tablelands follows. The lower sandstone at that locality is unlike that seen elsewhere and its massive, conglomeratic nature is quite striking. The remainder of the section is similar although there is more coarse-grained sandstone and less conglomerate. Also, the pebble size is generally smaller.

Northeast of Patry Lake, the Dunvegan conglomerate includes pebbles as much as 3 inches in diameter. They are well-rounded, and composed of quartz, quartzite, chert, and quartzose sand. The matrix consists of coarse-grained sandstone and small pebbles. The conglomerate is crossbedded and well-indurated. At the mouth of La Biche River, the Dunvegan outcrops include massive, strongly crossbedded, coarse-grained sandstone and some conglomerate.

The Dunvegan Formation is dated on the basis of its flora and stratigraphic position as being of Cenomanian age (Stott, 1968).

Section 65-6. Dunvegan Formation; Tsoo tablelands north of Kledo Creek, Maxhamish map-area, British Columbia, 59° 02' N., 123° 32' W.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	DUNVEGAN FORMATION		
	Top of ridge, end of exposure		
19	Conglomerate, grey; massive, grey-weathering; pebbles 1/8" - 1", averaging ½", well-rounded; some coarse-grained sandstone matrix	55	570
18	Sandstone, coarse-grained; massive; grey-weathering; some crossbedding and channelling; small pebbles disseminated throughout; grades laterally into conglomerate as above	11	515
17	Covered	38	504
16	Conglomerate, grey, massive; grey-weathering pebbles 1/8" - 3", averaging ½" - 1"; much coarse-grained sandstone matrix	13	466
15	Sandstone, medium-grained, grey, soft to friable, recessive; thick-bedded to massive; brown-weathering; crossbedded	19	453
14	Conglomerate, grey; massive; grey-weathering; pebbles 1/8" - 1", averaging ¼" - ½"; much coarse-grained sandstone matrix; partly inaccessible	40	434
13	Conglomerate, grey; massive; grey-weathering; pebbles ½" - 2", averaging 1" - 1½"; much coarse-grained sandstone matrix	12	394
12	Conglomerate, as below; pebbles average ½", some are 2"; much sandstone matrix	12	382
11	Covered	8	370

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10	Conglomerate, grey; massive; grey-weathering pebbles, well-rounded, of quartz, quartzite, chert, argillite, 1/8" - 1½", averaging ¼" - ½", grey, blue, white, green, pink, black; much coarse-grained sandstone matrix	28	362
9	Covered	3	334
8	Conglomerate, grey; massive; grey-weathering; pebbles ¼" - ½"; much sandstone matrix	20	331
7	Covered	82	311
6	Conglomerate, grey; massive; crossbedding; grey-weathering; pebbles 1/8" - ½", averaging ¼" - ½" but larger toward top; much coarse-grained sandstone matrix	48	229
5	Covered. May include some conglomerate at top	120	181
4	Sandstone, fine-grained, laminated, cross-laminated, grey; flaggy to massive, crossbedded; brown-weathering	26	61
3	Sandstone, coarse-grained and conglomerate (30%); massive; brown-weathering; disseminated pebbles in sandstone	24	35
2	Conglomerate, grey; massive; pebbles ¼" - ½", well-sorted and rounded; some sandstone matrix	7	11
1	Sandstone, medium-grained, grey, siliceous, laminated; massive, crossbedded; brown-weathering	4	4
	Underlying beds not exposed		

Kotaneelee Formation

The Kotaneelee Formation forms the surface bedrock over much of the area west of the Maxhamish escarpment. Despite its large areal extent, only a very few outcrops are known and no continuous section was found.

The Kotaneelee Formation, in the District of Mackenzie, was believed to consist of 500 to 1,000 feet of dark grey shale (Hage, 1944; Stott, 1960). In the Imperial Pan Am La Biche b-55-E well (b-55-E/94-0-13), only the lower part of the formation is present. Farther south, in Imperial Pan Am Viscount a-77-D well (a-77-D/94-0-11), over 600 feet of strata are assigned to the formation.

A few exposures of the Kotaneelee Formation occur along Capot Blanc Creek. About 80 feet of strata outcrop, consisting of very rusty-weathering, soft, dark grey shale with small selenite crystals and large fragments of Inoceramus. Some glauconitic, argillaceous and pebbly sandstone, similar to that of the basal beds at the type section (Stott, 1960), was seen in the talus.

The upper 282 feet of the formation are poorly exposed at Joli Butte on the east side of Liard River. The succession there is as follows:

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	WAPITI FORMATION		
4	Conglomerate, massive; pebbles up to 3"	9	33
3	Sandstone, coarse-grained, crossbedded, brown; some pebbles; quartzite boulder, 6" in diameter	9	24
2	Conglomerate, massive; pebbles about 2" in diameter; much coarse-grained sandstone	5	15
1	Sandstone, fine- to medium-grained, brownish grey; massive; brown-weathering	10	10
	KOTANEELEE FORMATION		
5	Covered	122	282
4	Mudstone, silty; blocky; large concretions; sand grains and small pebbles	5	160

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Sandstone, fine-grained, homogeneous, grey; brown-weathering; thin- to thick-bedded; concretionary in upper 5'	45	155
2	Mudstone, dark olive-brown; blocky	10	110
1	Mostly covered. Mudstone; very argillaceous siltstone; rusty-weathering	100	100
	End of exposure		

The Kotaneelee Formation of the type region contains a fauna of Santonian age (see Stott, 1960, p. 18). No record of Turonian or Coniacian deposition has been found in this area of northeastern British Columbia. It is assumed that the base of the Kotaneelee marks a hiatus representing all of Turonian and probably part or all of Coniacian time.

Wapiti Formation

The Wapiti Formation is present only as small erosional remnants capping several hills west of Joli Butte and the upland region north of Maxhamish Lake.

Exposures are poor and most are not readily accessible. The best exposures are at Joli Butte. There, the basal beds consist of 10 feet of massive, fine- to medium-grained sandstone overlain by 23 feet of coarse-grained sandstone and conglomerate. Coal is known to occur within the formation a few miles northwest of the map-area.

STRUCTURAL GEOLOGY

Maxhamish Lake map-area lies wholly within the Interior Plains. Regardless of this physiographic assignment, the bedrock has been folded and faulted into several structures similar to those of the more mountainous areas to the west and north.

In the northeastern part of the map-area bedrock exposures are rare. The presence of gently dipping carbonate beds of the Flett Formation at the surface on Petitot River suggests a culmination of the Paleozoic surface in that vicinity.

To the west, the first major structure, the Bovie anticline, again exposes Paleozoic rocks at the surface 25 miles west along Petitot River. A shallow syncline of Cretaceous rocks separates the two localities. Bovie anticline is nearly symmetrical with steep (55 degrees) flanks south of Petitot River. The axis is offset to the west by several tight en echelon folds. Bovie anticline can be traced due south from the edge of the map-area for a distance of nine miles to where the Paleozoic rocks plunge under the covering Cretaceous sediments.

Immediately west of Bovie anticline, within the Cretaceous rocks, is Bovie fault. The writers have placed this fault west of Bovie anticline in opposition to Douglas and Norris (1959) for the following reason. In the B.C. Oil Bekami Lake No. 1 d-9-A well (d-9-A/94-0-11) 32 miles south of Petitot River, 285 feet of Mattson Formation were encountered. In the adjacent (1 mile west) Imperial Pan Am Tattoo a-26-B well (a-26-B/94-0-11) the Mattson is represented by approximately 1,150 feet of strata. In addition, approximately 400 feet of Triassic rocks are present in the Tattoo well, whereas none are present in the Bekami well. Clearly the fault, with its uplifted east side, passes between the two wells. The Mattson Formation at the surface along Bovie anticline has an estimated thickness of 300 feet, a thickness which is consistent with a position of the fault to the east.

The fault has had a complex history. Erosion of the Mattson Formation from the east side of the fault apparently occurred before deposition of the Triassic sediments. Most of the Triassic rocks were eroded from the east block prior to deposition of much of the Cretaceous Fort St. John Group. Movement on the fault was consistent in that the east side was always uplifted relative to the west side. The dip of the fault has not been determined. The surface trace of the fault is concave towards the west-northwest. This concavity, coupled with an apparent steep dip and relative uplift of the east side, suggests that the fault be classified as a normal fault.

West of the Bovie fault the flat-bottomed Petitot River syncline (Douglas and Norris, 1959) and the Liard anticline (the continuation of the Liard fault) link and cancel. Because of the small angles of dip and poor exposure in this area this linkage is not well-defined.

The largest structural element of the map-area is the Liard syncline. The syncline has an elongate, sinuous, flat-bottomed saucer shape with an ill-defined axis. Both east and west boundaries are well-defined by escarpments of the Dunvegan Formation. The Tsoo tablelands mark the southern termination of the structure; there, a gentle north plunge closes the syncline. At the junction of La Biche and Liard Rivers a secondary, south-east plunging anticline deforms the west limb of the Liard syncline.

REFERENCES

Bamber, E.W., Taylor, G.C., and Procter, R.M.
1967: Upper Paleozoic rocks of northeast British Columbia; in Report of Activities; Geol. Surv. Can., Paper 67-1, pt. B, pp. 67-72.

Belyea, H.R., and Norris, A.W.
1962: Middle Devonian and older Paleozoic Formations of southern District of Mackenzie and adjacent areas; Geol. Surv. Can., Paper 62-15.

Dawson, G.M.
1881: Report on an Exploration from Port Simpson on the Pacific Coast to Edmonton on the Saskatchewan, embracing a portion of the northern part of British Columbia and the Peace River Country. Geol. Nat. Hist. Surv., Canada, Rept. of Prog. 1879-80, pt. B, pp. 1-177.

Douglas, R.J.W., and Norris, D.K.
1959: Fort Liard and La Biche Map-areas, Northwest Territories and Yukon; Geol. Surv. Can., Paper 59-6.

Griffin, D.L.
1965: The Devonian Slave Point, Beaverhill Lake, and Muskwa Formations of northeastern British Columbia and adjacent areas; British Columbia Dept. Mines and Petrol. Res.; Bull. 50, pp. 90.

Hage, C.O.
1945: Geological Reconnaissance along lower Liard River, Northwest Territories, Yukon, and British Columbia; Geol. Surv. Can., Paper 45-22.

Harker, P.
1961: Summary Account of Carboniferous and Permian Formations, southwestern District of Mackenzie; Geol. Surv. Can., Paper 61-1.

1963: Carboniferous and Permian Rocks southwestern District of Mackenzie; Geol. Surv. Can., Bull. 95.

Holland, S.S.
1964: Landforms of British Columbia, A Physiographic Outline; British Columbia Dept. Mines and Petrol. Res.; Bull. No. 48.

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

McConnell, R.G.
1890: Report on an exploration in the Yukon and Mackenzie Basins; Geol. Surv. Can., Ann. Rept. 1888-1889, vol. IV, pt. D.

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

Patton, W.J.H.
1958: Mississippian succession in the south Nahanni River area, Northwest Territories; in Jurassic and Carboniferous of western Canada, Allan Memorial Volume, Am. Assoc. Petrol. Geol., pp. 309-326.

Stott, D.F.
1960: Cretaceous Rocks in the region of Liard and Mackenzie Rivers, Northwest Territories; Geol. Surv. Can., Bull. 63.

1968: Cretaceous Stratigraphy between Tetsa and La Biche Rivers; Geol. Surv. Can., Paper 68-14 (in press).

Taylor, G.C.
1965: Operation Liard; in Jenness, S.E., Compiler, Report of Activities: Field, 1964; Geol. Surv. Can., Paper 65-1, pp. 66-67.

1966: Operation Liard; in Jenness, S.E., Compiler, Report of Activities: Field, 1965; Geol. Surv. Can., Paper 66-1, pp. 92-93.