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GEOLOGY AND OIL PROSPECTS OF
LONE MOUNTAIN AREA
BRITISH COLUMBIA
(Report and Map)

BY

F. H. McLearn and J. F. Henderson



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GEOLOGY AND OIL PROSPECTS OF LONE MOUNTAIN AREA, BRITISH COLUMBIA

INTRODUCTION

Lone Mountain area lies in Northeastern British Columbia about 45 miles southwest of Beaverlodge, Alberta. Graded roads suitable for trucks in dry weather extend from Beaverlodge to within 5 miles of the British Columbia border. A wagon road known locally as the Monkman "Highway" may be followed for the remaining 25 miles to the area. The road is in poor condition and many of the smaller bridges are inadequate for heavy loads.

This report and the accompanying map give the results of field work by the authors in 1942.

STRATIGRAPHY

The strata outcropping within the area range in age from Lower to Upper Cretaceous. Rock exposures are small and scattered. They are confined largely to the harder, more resistant sandstone members of the formations, and are lacking over large areas. No complete section of any of the formations was found.

Lower Cretaceous

Lower Cretaceous strata comprise sandstones and conglomerates overlain by dark marine shale, and are considered to represent a large part of the Fort St. John group. The sandstones and conglomerates outcrop along an anticline in the southwestern part of the area and are overlain to the northeast and southwest by the marine shales.

Sandstone and Conglomerate. The sandstones are light grey, ~~to~~ medium to coarse grained rocks, and are commonly crossbedded. Conglomerates form beds and lenses up to several feet thick interbedded with the sandstones. They are composed of well rounded, pea-sized, grey, black, and occasionally green chert pebbles in a matrix of coarse sandstone or grit. A collection of poorly preserved fossil leaves from the sandstone, studied by W. A. Bell of the Geological Survey, includes a species in common with the fossil flora of the Commotion formation (Wickenden and Shaw, 1943)¹ of the Mount

¹For list of references See last page of this report.

Hulcross-Commotion Creek map-area, 90 miles to the northwest. It has been dated as probably late Lower Cretaceous. Because of this and their similar lithology and stratigraphic position, the sandstone and conglomerate beds of Lone Mountain area are correlated tentatively with the Commotion formation. As the Commotion is at least partly of the same age as the Peace River formation of the Sexsmith-Bison Lake area to the northeast, a

tentative correlation can also be made with that formation (See Table 1):

Table 1

		Mount Hulcross- Commotion Creek Area (1)	Lone Mountain Area	East Peace River (2) or Sexsmith-Bison Lake Area (3)
CRETACEOUS	UPPER		Wapiti	Wapiti
			Smoky Group	Upper shale
				Badheart
			Kaskapau	Kaskapau
		Dunvegan	Dunvegan	Dunvegan
	LOWER	Cruiser	Fort St. John Group	Shaftesbury
		Goodrich		
		Hasler		
		Commotion	Sandstone and conglomerate	Peace River
		Moosebar	?	Loon River

- (1) "Mount Hulcross-Commotion Creek Map-Area" - Geol. Surv., Canada, Paper 43-13.
- (2) McLearn, F. H., Geol. Surv., Canada, Sum. Rept., 1918, Pt. C. pp. 1-7.
- (3) Geol. Surv., Canada, "Sexsmith-Bison Lake", preliminary map.

Dark Marine Shale. The shales overlying the sandstones and conglomerates are dark grey to black with many thin, somewhat silty beds near the base which grade up into black fissile shales. A few thin beds containing small rusty-weathering clay-ironstone concretions occur throughout the formation. A fragment of an ammonite found in the upper part of the shales may belong to the species Neogastrolites cornutus (Whiteaves). Apart from this fragment and numerous fish scales in some of the concretionary beds, no other fossils were found. The lithology and stratigraphic position suggest a correlation with the Shaftesbury formation¹ of the Sexsmith-

¹The name "Shaftesbury" is herewith proposed for the formation lying between the Peace River and Dunvegan formations in the eastern part of the Peace River district. The type area is along Peace River Valley between Dunvegan and the town of Peace River. The shales of this formation were formerly included in the Fort St. John formation (McLearn, 1918, 1932). The latter name has now been raised to group rank by Wickenden and Shaw (1943) in which usage the present writers concur.

Bison Lake area. A tentative correlation can also be made with the Hasler, Goodrich, and Cruiser formations of the Mount Hucross-Commotion Creek area to the northwest (Wickenden and Shaw, 1943).

Upper Cretaceous

The Upper Cretaceous rocks include the Dunvegan formation of marine and non-marine sandstones and shales overlain by the Smoky group². The latter consists

²It is proposed that the name "Smoky River" as formerly used, be shortened to "Smoky".

of the Kaskapau formation of dark marine shale succeeded by a thick sequence of marine sandstones, shales, and conglomerate. The Smoky group is, in turn, overlain by the non-marine Wapiti group of sandstones and shales.

Dunvegan Formation. This formation is composed of massive to thinly layered, fine to medium grained, buff to brownish grey sandstones interbedded with grey sandy shales and siltstones. Much of the thinly bedded sandstone carries small mica plates along the bedding planes. Prostrate fossil stems, small pieces of drift wood, and small vertical rootlets were observed in many of the beds. Marine invertebrate fossils were found in some beds and freshwater forms and plant remains in others.

Four collections of fossil leaves from the Dunvegan have been identified by W. A. Bell of the Geological Survey as being of probable Upper Cretaceous age. These, together with invertebrate collections that in-

clude Unio dowlingi McLearn indicate that the formation may be correlated in part at least with the Dunvegan formation of the Peace River section (See Table 1). However, due to poor exposures, it cannot be said positively that its downward limit in this area corresponds with the Dunvegan in the type area. No sandstone comparable with the Goodrich of the Mount Hucross-Commotion Creek area (Wickenden and Shaw, 1943) has yet been recognized in this area.

Kaskapau Formation. Kaskapau shale is exposed in out banks of a small creek west of Yoho Mountain. The shale is black, fissile, and somewhat carbonaceous and includes a few thin harder beds of sandy shale. Thin beds containing yellow to rusty weathering clay ironstone concretions are locally abundant. Several specimens of Inoceramus capulus var. corpulentus (McLearn) were obtained from the concretionary beds. The shales are correlated with the Kaskapau formation of the Sexsmith-Bison Lake area where they form the lower part of the Smoky group (McLearn, 1926).

Marine Sandstone, Shale, and Conglomerate. A thick succession of sandstones, shales, and conglomerates overlies the Kaskapau shale. The sandstone beds form a series of pronounced asymmetric ridges with gentle slopes in the direction of dip of the beds. Yoho and Thunder, Lone, and Squaw mountains are formed of sandstone ridges of this type, - Yoho mountain being constructed of northeasterly-dipping sandstone ridges on the southwest flank of the Rat Lake syncline, and Thunder, Lone, and Squaw mountains of southwesterly-dipping sandstone ridges on the northeast flank of the syncline. The ground between the ridges is underlain, in large part, by shales and siltstones that are rarely exposed.

The sandstones include massive, medium to coarse-grained grey sandstone, red weathering medium to fine grained platy, crossbedded sandstones, and fine grained muddy sandstones with worm trails. The shales between the sandstone ridges are black, friable, and somewhat carbonaceous. Conglomerate outcrops on Lone Mountain southeast of Caribou Creek and also southeast of Monkman road west of the gas seepage. It forms beds and lenses in the massive sandstones. Most of it is composed of well rounded pea-sized black, grey and occasionally green chert pebbles, but in places the pebbles are up to $\frac{1}{2}$ inch or more in size.

Fossil collections from the sandstones and shales include Scaphites ventricosus Meek and Hayden and Inoceramus cf. pontoni McLearn. These marine sandstones, shales, and conglomerates are believed to be the equivalent of the upper part of the Smoky group (See Table 1).

Wapiti Group. This group of sandstones and shales overlies the marine sandstones, shales, and conglomerates of the Smoky group. The typical sandstone is a medium to rather coarse grained greenish-yellow rock with local conglomeratic facies. It weathers rusty brown and readily disintegrates to a brownish sand. The beds range from a few inches to 5 feet or more in thickness

and are interbedded with dark greenish-grey friable sandy shales and siltstones. Black carbonaceous plant debris occurs along many of the bedding planes and as small particles in the sandstones. Carbonized stems and vertical rootlets occur in some of the sandy shales.

No recognizable fossil remains were found but the stratigraphic position of this typical non-marine assemblage above the Smoky group indicates that it is correlative with the lower part of the Wapiti group of Sexsmith-Bison Lake area (See Table 1).

STRUCTURE

Within the area mapped the formations lie in a series of three nearly symmetrical, northwesterly trending, anticlinal folds with average maximum dips on the flanks of 25 to 30 degrees. On the most southwesterly structure the Lower Cretaceous sandstone and conglomerate is exposed along the crest with overlying marine shales outcropping on the flanks. The structure is plunging southeast at 5 to 6 degrees. It is adjoined to the northeast by a syncline in which Dunvegan sandstone is exposed. A southwesterly-dipping thrust fault intersects the syncline along its northeast flank, southwest of Stony Lake, causing some repetition of the Dunvegan. On the adjoining anticline, to the northeast of the syncline, the Lower Cretaceous marine shale is exposed along the crest with the overlying Dunvegan sandstone on the flanks. To the northeast the Dunvegan is overlain by northeasterly-dipping Kaskapau shale and by upper marine sandstones and shales of the Smoky group. These lie in a broad shallow syncline with its axis trending northwest through Rat Lake. The syncline is succeeded to the northeast by the third or Lone Mountain anticline.

Lone Mountain Anticline

Lone Mountain anticline extends southeast from the Monkman road for at least 4 miles and has been traced northwest from the road for 9 miles. The anticline is in sandstones, shales, and conglomerates that form the upper part of the Smoky group. The structure falls into three natural sections separated by two major stream valleys. The southeast or Squaw Mountain section extends southeast from Redwillow Creek valley; the central or Lone Mountain section occupies the 4-mile interval between Redwillow and Caribou Creek valleys; and the northwestern or Thunder Mountain section extends for at least 5 miles northwest of Caribou Creek.

Southeast or Squaw Mountain Section. Within this section rock outcrops are few and the structure is not well defined. Exposures on the southeast nose of the anticline indicate that the structure is reasonably symmetrical in section and that it plunges 2 to 5 degrees southeast. Dips on the southwestern flank of the anticline vary from 17 to 35 degrees and, on the northeastern flank, from 14 to 24 degrees. Three miles farther northwest the dips on the southwestern flank range from

20 to 30 degrees and a single exposure on the northeastern flank has a dip of 37 degrees. Due to lack of exposures along the crest and northeast flank it is impossible to state whether or not the structure is faulted. No evidence of faulting was found between the crest of the structure on Squaw Mountain and Yoho Mountain 8 miles to the southwest, and the strata in the intervening area are believed to form a broad shallow syncline.

A large seepage of gas occurs on or near the crest of this section of the structure a little more than a mile southeast of the Monkman road. A sample of the gas, collected by G. S. Hume, Geologist for the Oil Controller, was analysed by the Division of Fuels, Bureau of Mines, Department of Mines and Resources, with the following result:

Per cent by volume	
Carbon Dioxide	0.95
Oxygen	1.16
Methane	85.12
Ethane	12.21
Nitrogen (by difference) ..	0.56
	<hr/> 100.00

Sp. Gr. -- weighed 0.644 (air- 1.000)
 Sp. Gr. -- calculated 0.632

Central or Lone Mountain Section. Along this section of the structure more bedrock is exposed than along the other two sections. On the southwestern flank, across a width of 2 miles, the dips range from 20 to 25 degrees. Massive sandstone and conglomerate beds are exposed across the broad crest of the fold and form the high flat-topped hill 1 mile southeast of Caribou Creek. The dip of the massive sandstone beds along the crest of the fold indicates a plunge of 4 to 10 degrees southeast in this section. Along the northeast flank of the anticline, on the northeast side of the flat-topped hill, a longitudinal thrust fault has brought the sandstones and shales of the Smoky group in contact with overlying Wapiti sandstone. The fault is marked by a pronounced scarp and at one place along it, in a creek valley where beds of Smoky and Wapiti groups are separated by only a few feet of drift, the rocks are highly sheared and slickensided. To the northwest, near the base of the hill, massive beds of Smoky sandstone dipping 4 to 5 degrees northeast are overlain at a higher elevation by Wapiti sandstone with no apparent discordance in strike or dip and no evidence of faulting along the contact. Evidently the fault either dies out or swings to the west away from the contact in this direction. To the southeast there are no outcrops and nothing is known about the extension of the fault.

Northwest or Thunder Mountain Section. The crestral area of the fold in this section of the anticline is poorly defined as there are very few rock outcrops across a width of a mile or more along the crest. The axis appears to be continuous with and to extend

northwesterly from the axis on the Lone Mountain Section.

Exposures across a width of 2 miles on the southwestern flank of the structure indicate a fairly uniform southwesterly dip ranging from 12 to 25 degrees. Five miles northwest of where the axis crosses Caribou Creek the beds can be seen to swing around the nose of the fold and the dip of the beds near the assumed position of the axis indicates a northwesterly plunge of about 7 degrees.

The beds on the northeastern flank of the fold have a fairly uniform strike parallel to the anticlinal axis and dip from 8 to 23 degrees northeast. The proximity of the Smoky-Wapiti contact to the axis as compared with its corresponding position on the southwest flank, and the 60 degree dip of an isolated exposure near the axis $1\frac{1}{2}$ miles northwest of Caribou Creek suggest that the crestal area of the fold in this section may be intersected by a longitudinal thrust fault.

PROSPECTIVE OIL AND GAS HORIZONS

The gas seepage and the crest of the Lone Mountain anticline occur in sandstones and shales that form the Smoky group of Upper Cretaceous age. Nothing is known as to possible source beds either in these or in underlying Cretaceous formations, and, to date, only minor oil production has been obtained in western Canada from beds of this age. However, the presence of a gas seepage with an appreciable amount of ethane suggests, although it does not prove that source and reservoir beds for gas and oil are present. Sandstone horizons occur in the Smoky group and Dunvegan formation of Upper Cretaceous age, and in the Fort St. John and Bullhead groups of Lower Cretaceous age. The depth to the Bullhead group, below the horizon of the seepage on Squaw Mountain, is estimated to be approximately 6,000 to 7,000 feet providing there is no repetition of the beds by faulting. If the upper part of the Bullhead group, as elsewhere known (McLearn, 1922) is entirely non-marine, it would not be regarded favourably as an oil producer. The main possibilities, then, would lie in encountering some source beds and reservoir sands in strata overlying this group.

CONCLUSIONS

The Squaw Mountain section appears to be the best defined and most symmetrical part of the Lone Mountain structure, and the presence of a seepage of gas with ethane makes this part of the structure the most attractive as a possible oil producer.

There are, however, uncertain factors, particularly as regards the existence of a major overthrust fault along or near the axis of the anticline, and the presence or absence of source beds of oil and reservoir sands within the structure. Even a good structure may

not contain oil, at least not in commercial quantities. Consequently, though drilling is the only method by which the presence or absence of oil can be established, the possibility of exploration ending unsuccessfully must be recognized at the outset. If drilling of the structure is contemplated, the Squaw Mountain section of the anticline would appear to be the most favourable in which to locate the first exploratory well. In choosing the site for this well, the general experience that gas occurs on the highest part of a structure and oil on the flanks should be considered, and also the possible occurrence of an overthrust longitudinal fault along the northeast flank of the structure.

REFERENCES

- McLearn, F.H., Geol. Surv. Canada, Sum. Rept., 1917, Pt. C, pp. 14-21
" " " " " 1918, Pt. C, pp. 1-7
" " " " " 1922, Pt. B, pp. 4-5
" " " Bull. 42, 1926, pp. 117 to 119.
Trans. Roy. Soc. Canada, Vol. 26, 1932, sec. 4,
pp. 157 to 175.
- Wickenden, R.T.D., and Shaw, G., Mount Hulcross-Commotion Creek
Map-Area, Geol. Surv. Canada, Paper 43-13.
- Geol. Surv. Canada, 1943. "Sexsmith-Bison Lake". Preliminary map.