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## Summary Report, 1919, Part C

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OTTAWA  
THOMAS MULVEY  
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY  
1920

# SUMMARY REPORT, 1919, PART C.

## NOTES ON THE IRON ORES OF THE MACKENZIE RIVER VALLEY.

By *E. M. Kindle.*

The efforts which are now being made to ascertain and develop the oil resources of the Mackenzie valley justify a brief statement concerning our knowledge of the iron ores of this extensive and imperfectly known region.

The practicability of utilizing iron ore depends in many regions upon a number of factors, among which are transportation facilities, proximity to coal, and agricultural development. Some observations on these factors in the Mackenzie valley may, therefore, be offered as a preliminary to a discussion of the ores themselves.

The completion of the railway to Clearwater river has linked up the railways of western Canada with the Mackenzie River system of waterways, thus affording continuous steamer and railway transportation from any part of Mackenzie river to Edmonton, except for an interruption of 16 miles of rapids above Fort Smith, where freight is portaged by motor trucks and wagons.

Lignite of fair quality occurs in the bank of the Mackenzie at Norman in a bed about 5 feet thick.

Fur constitutes the sole commercial product of the country. Agricultural development is limited to the gardens of the fur-trading posts located about 160 miles apart, along the Mackenzie. These gardens, however, demonstrate that potatoes and various other vegetables can be grown successfully as far north as the Arctic Circle. The surprisingly luxuriant growth that wild grasses attain around the trading posts suggests the possible future development of stock-raising. The excellent herd of cattle which the Roman Catholic mission has kept near Fort Smith for many years has fully demonstrated the value of the wild grasses for grazing purposes. The first frost came during the present season (1919) on September 2, though in some years it is reported much earlier.

The first published information regarding the iron ore of the Mackenzie district appears in the report of Keele on Gravel river,<sup>1</sup> one of the western tributaries of Mackenzie river which it joins about 4 miles above Norman. Keele reports the presence of hematite, about 100 feet thick, coarsely laminated with red siliceous slates, about 100 miles west of Mackenzie river below Shezal canyon. No precise information is available regarding the quality of the Gravel River ore or the horizon at which it occurs.

The most northerly occurrence of iron ore observed was noted in shales of Cretaceous age above the head of the ramparts. A large stream entering the east side of the Mackenzie 5 miles above the ramparts and some 30 miles south of the Arctic Circle exposes a section of 120 feet of clay shale just above its mouth. Thin bands of limonite, the thickest of which is 10 inches, occur in this shale.

Another occurrence of iron ore of rather insignificant thickness was found in the Bear Mountain section near Norman. The occurrence of a bed of lignite coal within 3 miles of the Bear Mountain ore, however, suggests the advisability of prospecting in the Norman district for thicker beds of ore than the one mentioned. The southern slope of Bear mountain shows a series of reddish gypsiferous shales 30 feet or more in thickness. A bed of drab clay shale, which follows the red gypsiferous shale, carries near the top a one-foot band of limonite. This ore has a distinctly botryoidal

<sup>1</sup> "A reconnaissance across the Mackenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and Northwest Territories," Geol. Surv., Can., 1910, 54 pp., 19 pls., 1 map.

surface on the upper side. Though no fossils were found in beds immediately associated with the ore, it is believed to lie near the top of the Silurian series. The lowest Devonian fossils found in this section occur some hundreds of feet above the ore.

The most promising bed of iron ore known in the Mackenzie valley was discovered by Mr. Joseph Hodgson. It is a hematite, outcropping about 20 miles east of the river, on the eastern face of a mountain range that represents the eastern front of the Rocky mountains.

The thickness of the ore and its relations to the beds in which it occurs are shown in the following section, measured in descending order, on the eastern slope of Cap mountain near the eastern end of an Indian trail that leaves the Mackenzie at the mouth of a ravine about one mile north of Wrigley. The total thickness of this section is in the neighbourhood of 5,000 feet, but only the part exposed in the eastern face of the mountain is given here.

Red quartzite and sandstone (summit of mountain). (Dip 10° to 15° to W.)	500+
Red shale and ferruginous sandstone	50
Hematite	20
Red sandstone with high percentage of iron	50
Dark shales	150
Greyish to drab shale	225

Average samples collected from each of four different levels in the bed indicate a rather siliceous ore too low in iron to be commercially valuable at the present time. A composite sample made from equal weights of these four samples was found on analysis<sup>1</sup> to contain metallic iron, 12 per cent. A selected sample collected by Mr. Joseph Hodgson of Fort Wrigley gave the following analysis<sup>2</sup>:

	Per cent.
Iron, metallic	56.01
Silica	15.42
Sulphur	0.014
Phosphorus	0.021

Five or six hundred feet of horizontal exposure of this ore was examined and showed no noticeable variation in thickness. Though this bed of ore has not been seen in any other sections, its considerable thickness apparently justifies the expectation of a rather extended distribution in a north and south direction, which is the direction of its line of probable outcrop. To the eastward the mountain range holding the ore bed faces a wide plain. Under this plain the ore would generally lie some thousands of feet below the surface and have consequently no economic interest. The gentle westerly dip of the rocks would likewise bring the ore to considerable depth at Mackenzie river. In the immediate vicinity of the river this horizon is unlikely to be above drainage. The Halysites beds which lie far below the ore in the Mount Cap section were found as far north as Bear river in the Mount Charles section. Very probably, therefore, the mountain structure will bring this horizon near the surface over a considerable part of the narrow zone, representing the eastern face of the most easterly range of the Rocky mountains from Bear river to Willow river, a distance of about 200 miles.

The geological horizon of the Mount Cap ore bed can be stated only approximately, since fossils have not been found in immediate association with the bed. It appears to lie within the limits of the upper Silurian and occurs above beds with middle Silurian fossils and below the first appearance of Devonian fossils.

1, 2 Analyses by Mines Branch, Dept. of Mines, Can.

# OIL AND GAS POSSIBILITIES IN NORTHEASTERN BRITISH COLUMBIA.

*By J. S. Stewart.*

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## INTRODUCTION.

In July, 1919, the writer was attached to a geological party sent out by the Provincial Government of British Columbia to investigate the oil and gas possibilities of northeastern British Columbia. To Professor Gwillim, of Queen's University, who was in charge of the party, thanks are accorded for many favours received. A general reconnaissance was made of the region south of Hudson Hope.

The region is most easily reached by steamer from the town of Peace River. The river is navigable for light draught steamers as far as Hudson Hope, about 240 miles upstream from the railway terminus at Peace River, and a fairly regular service was maintained by two transportation companies during the 1919 season.

The part of the foothills region traversed south of Hudson Hope is inhabited only by a few Indians and trappers; consequently there are no roads and the only means of transport away from the river is by pack-horse, and the routes of travel are, for the most part, old Indian trails.

The country is well timbered, rough, and hilly. A relief of 1,500 feet is common, and in places the higher ridges rise over 3,000 feet above the adjacent river valleys. Peace river being the main waterway to which all the streams of this region are tributary has the lowest elevations; the higher altitudes are attained by the most westerly ridges. Eastward the uplands gradually become less irregular and blend into a high-level plateau. The main streams flow for the most part in deep, narrow, V-shaped valleys and except in a few places, at times of low water, are too deep to be forded.

The months of July and August seem to be periods of comparatively heavy precipitation; and during that time vegetation is rapid and some plants attain very large size.

## STRATIGRAPHY.

The order in which the strata were laid down in this region, that is the stratigraphic succession, and the age, was determined by F. H. McLearn,<sup>1</sup> and the appended table is based on his work.

<sup>1</sup> McLearn, F. H., Geol. Surv., Can., Sum. Rept., 1917, p. 14C; 1918, p. 1C.

Table of Formations.

Period	Group	Formation	Character of the strata
Upper Cretaceous	Montana	Smoky River	Two shale series divided by a sandstone series. Total estimated thickness 550 feet.
	Colorado	Dunvegan	Mainly thick-bedded sandstone with lesser amounts of shale and thin sandstone; thickness about 530 feet.
		St. John	Upper member 1,300 feet dark shale; middle member 50 to 80 feet sandstone; lower member 800 feet dark shale.
Lower Cretaceous		Bullhead Mountain	Sandstone, shale, and coal above, massive sandstone below; total thickness 2,000 feet.
Jurassic			
Triassic			Limestone, sandstone, and shale.

*Triassic.* No rocks of this age were seen in the area examined, but are believed to be present at depth. They are included in the table in order that the reader may better understand the following descriptions.

*Bullhead Mountain Formation.* This formation appears to outcrop for the most part in the west of the strip of country examined. It is described by F. H. McLearn as a sandstone of freshwater deposition.

*St. John Formation.* The St. John consists mainly of marine shales and presents very much the same appearance over the entire region. In places, sandstone lenses are interlayered, but, generally, exposures show either a dark, thinly fissile shale or an arenaceous rusty or dark reddish brown shale. Fossils occur in a few bands only, and in some considerable thicknesses appear to be altogether absent. In a few places, the thickness of the formation, roughly estimated, is at least 2,200 feet, and the base was not seen.

*Dunvegan Formation.* The Dunvegan is composed essentially of sandstone; the bedding is much thicker and the grain coarser than in the exposures of this formation along Peace river, described by F. H. McLearn. An exposure on the south shore of Rocky Mountain lake shows a continuous section of over 100 feet of massive sandstone with bands of conglomerate varying from thin streaks to beds 3 or 4 feet in thickness. This conglomerate member which is about 500 feet above the top of the St. John shale and is overlain by at least 250 feet of sandstone, is considered also to form part of the Dunvegan formation giving it a total observed thickness of about 850 feet. The top of the formation was not seen. Another section, about 14 miles north of Rocky Mountain lake, showed an almost continuous series of sandstone about 1,200 feet in thickness, immediately above the St. John. At the top of this sandstone

series there is a calcareous bed composed largely of oyster shells, overlain by about 200 feet of thin-bedded, sandy shales—the highest beds seen in this section. The conclusion must be drawn, therefore, that the Dunvegan beds thicken considerably in this region or that the lower part of the Smoky River series is much more sandy and

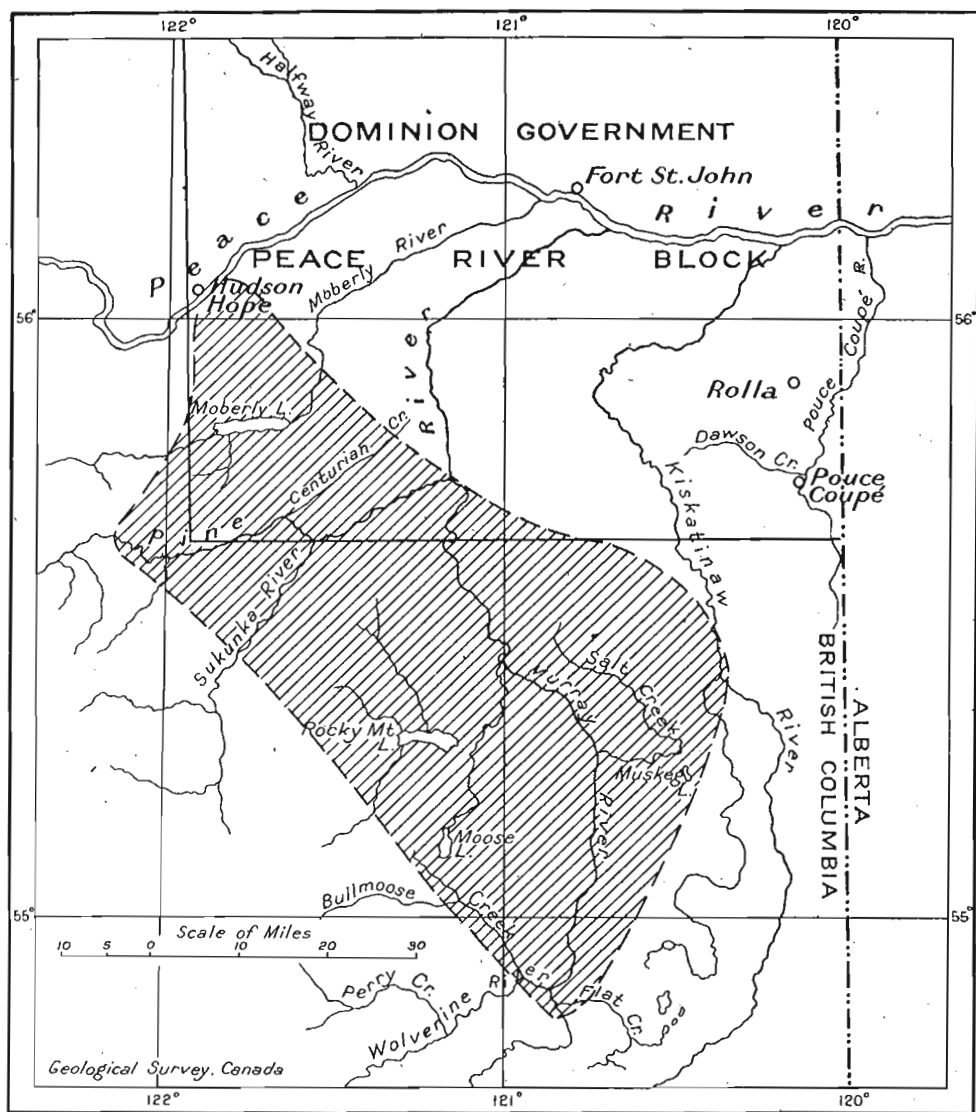


Figure 1. Sketch map, Moberly River area.

coarser or, as is quite possible, that both of these things happen, that is, the Dunvegan thickens and the lower Smoky River shales change to sandstone toward the west. At any rate, the line of division between Dunvegan and Smoky River formations is hard to define. A few fossils were collected but it is not likely they will prove of diagnostic value in separating the formations under discussion, the lower half of the Smoky River series being, like the Dunvegan, Colorado in age.

*Smoky River Series.* A complete section of beds belonging unquestionably to the Smoky River series was not observed. Except for a few erosion remnants on top of some of the higher ridges the formation is confined largely to the region east of the part examined.

It was found to be generally true in this area, as it is in the foothills farther south, that the formations are progressively thicker and coarser toward the west.

*Structure.* The width of the area examined was determined largely by the width of a narrow belt where the folding was diversified and the dips were comparatively gentle. In other words the work was confined to a strip of country where the structure is most favourable for the accumulation of oil or gas. In this belt at least two, and perhaps three, anticlinal folds appear to be persistent for considerable distances along the strike of the rocks. The maximum dip of the limbs of these folds is about 15 degrees. The rocks to the west of this gently folded belt are much more intensely folded and faulted, but to the east of it, dip very gently northeast in monoclinical fashion, and the dip must be measured in feet per mile rather than in degrees.

#### CONCLUSION.

No seepages of oil or gas were observed within the area examined. The tar sands exposed along the Athabaska near McMurray and found also in several of the deep borings near the town of Peace River, are, probably, equivalent in age to part of the Bullhead Mountain formation, but no oil or gas seepages in the latter series of rocks have been reported. The absence of oil or gas seepages in a region does not, however, indicate barrenness at depth.

Generally speaking four factors are essential in an oil field. These are:

- (1) A porous bed or sand by which oil may be absorbed.
- (2) A suitable structural condition to permit concentration at a particular locality.
- (3) Presence at one time or another of water as an accumulating agent.
- (4) Petroleum originally diffused through the rocks of a reasonably large area surrounding the favourable structural centre.

Putting the area under discussion to these tests, it is found that there are places along the anticlinal folds where the structural conditions are probably fulfilled. There are plenty of porous sands in the Bullhead Mountain formation and it may be assumed that there has always been plenty of water to act as an accumulating agent.

The anticlinals are for the most part eroded well down into the lower part of the St. John shales, yet there is a possibility that porous absorbent sandy lenses occur in places. The underlying Bullhead Mountain formation is composed largely of coarse sandstone, but this formation is mainly of freshwater origin, and excepting coal deposits, contains very little organic matter likely to produce petroleum. There is, however, a possibility in places of an interfingering of marine shales from the east with the Bullhead series of the west. Below the Bullhead Mountain formation is a series of dark calcareous shales, sandstones, and limestones of Triassic age. These beds contain numerous fossils which indicate that they are probably all of marine origin.

If the first three conditions are fulfilled in this region, and it is quite reasonable to presume that in places they are, then number 4 is the only unknown factor. The St. John shales are a source from which organic matter might have been derived to produce petroleum and the next most promising series of strata are those of the underlying Triassic. Hence in projected boring operations preparations should be made to penetrate at least the entire thickness of the Bullhead Mountain formation if the region is to be fairly tested. The depth necessary to reach the Triassic shales will, of course, be governed by the location, but in the most favourable places in the region examined these shales are probably at least 3,000 feet below the surface.

## DRILLING OPERATIONS ON PEACE RIVER.

During the years 1917-1919 several companies were drilling for oil along the valley of Peace river. All the test wells are located close to the river from the town of Peace River to a point 16 miles downstream. Although some of the wells struck small showings of gas and oil, there is no production from this region and the results on the whole have been rather disappointing.

The Peace River Oil Company's wells Nos. 1 and 2 have been abandoned. The same company's No. 3 was down 1,255 feet early in September. A small flow of gas was struck at 605 feet and there was a showing of oil at 960 feet, below which depth there has been continuous trouble with salt water, nearly every sand yielding a new supply to be contended with.

The Tar Island Oil Company's well struck gas at about 800 feet and heavy oil came in with water at 970 feet. The last reported depth of this well early in September was 1,022 feet.

The Three Creeks Oil Company is making a determined effort to shut off a strong flow of water by pumping in mud fluid under pressure. The depth reached in this well at the time of writing was 1,159 feet. It is the intention of the company to continue drilling when the water is shut off.

The Albersas-Victory Oil Company is at present drilling a well near Peace River. This well, which struck salt water at 250 feet, was 356 feet deep about the middle of June, since which time considerable progress has been made and the last reported depth was 800 feet.

On the whole, progress at the wells has been slow, due to the distance from sources of supply of material.

## COAL AREAS NORTHWEST OF BRULÉ LAKE, ALBERTA.

By John MacVicar.

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## Illustration.

Figure 2. Areas of coal-bearing rocks, Kootenay formation, between Athabaska and Smoky rivers, Foothills, Alberta . . . . .	9c
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## INTRODUCTION.

During the field season of 1919 the writer carried on exploration work in the coal areas northwest of Brulé lake, an expansion of Athabaska river, Alberta, in continuation of that undertaken in 1916. The main object was to determine what further Kootenay coals might be found in the region and the feasibility of a railway line to them, and to the Smoky River areas, by way of the foothill country. Figure 2 shows the country covered.

The writer wishes to acknowledge courtesies and assistance received from Mr. Finlayson and Mr. Bagley, of the Forestry Branch. R. T. Hollies, of the University of Alberta, proved a satisfactory assistant. The death of S. Mahon, one of the party, somewhat hampered the work near its close.

## GENERAL DESCRIPTION.

Sedimentary rocks ranging in age from Devono-Carboniferous to Quaternary make up the strata in the area.

The outer range of the Rocky mountains is composed of limestone, and the remainder of the area of shales, sandstones, and conglomerates, with coal seams at varying intervals. Glacial drift covers the greater part of the area.

A number of coal seams that will yield bituminous coal suitable for steam, metallurgical, and domestic use were found in the area. No seam was seen with coal similar to the anthracitic coal on Smoky river, described in the 1916 Summary Report.

The Cretaceous coal areas were followed northwesterly from where Hay river cuts through the outer range of the Rockies in tp. 53, range 1, W. 6th mer., to tp. 55, range 1, W. 6th mer. The area is bounded on the west by older rocks of Devono-Carboniferous age, which form the outer range of the Rockies. To the east and north they are overlain by the newer Cretaceous strata. An area extending east to the 6th meridian and north to the 15th base-line was examined during the season's work.

The limestones which form the western boundary of the area examined between Hay and Muskeg rivers, present a toothlike, mountainous wall. The rugged scenery of this rock wall is in striking contrast to the verdure-clad slopes of the adjoining foothills.

The whole series of mountains and hills is arranged as parallel ridges and valleys, trending about north 45 degrees west. Ten to 20 miles from the limestones the hills rise about 300 feet above the valleys, but nearer the limestones, this height increased to 1,000 to 2,000 feet. A stream is found in nearly every valley.

The entire region, except the parts underlain by the limestone, has been glaciated and many of the hills are rounded, those capped by heavy beds of sandstone showing a

gentle slope on the western and a more precipitous slope on the eastern side. The country, except a few spots that have been burned over, or where rock outcrops, is covered with a thick growth of timber.

The rivers that drain the area are of fair size. Hay river, to the south, has two large creeks entering it from the north. These, Moberly and Pinto creeks, are about 20 feet wide and average about 18 inches in depth. Proceeding northward, the next stream is Little Berland river, some 30 to 40 feet wide and about 18 inches deep where it joins Big Berland river. It has its source in the trough between the two limestone

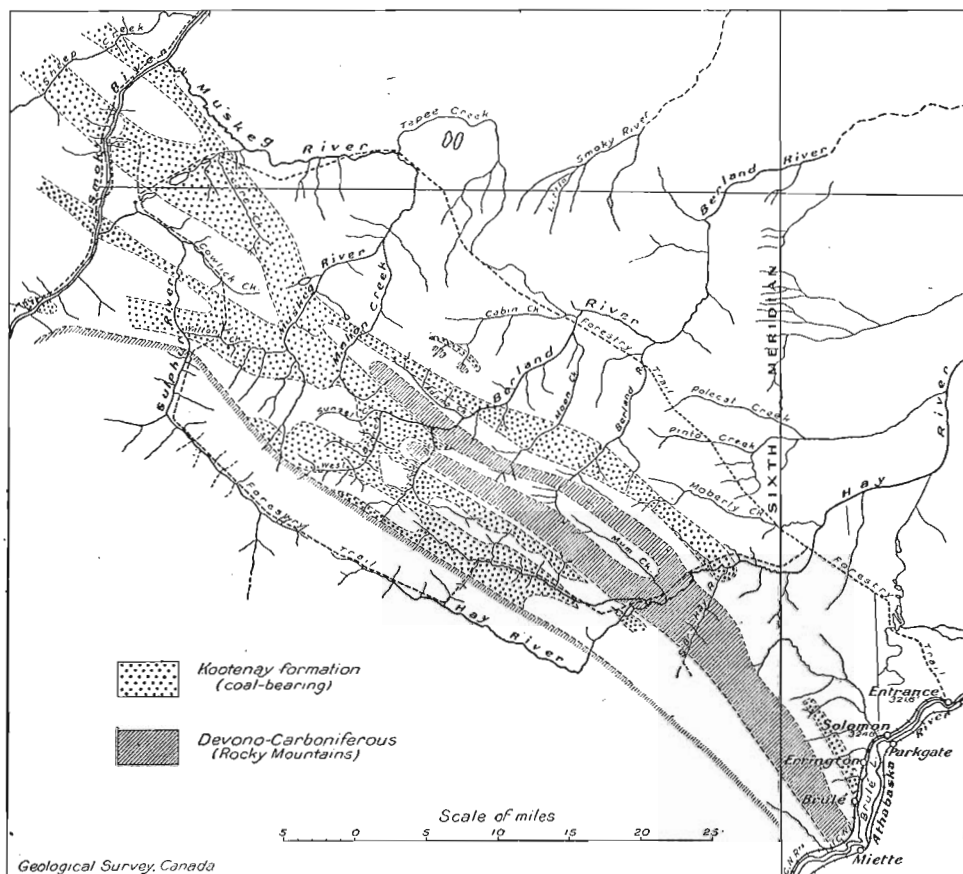


Figure 2. Areas of coal-bearing rocks, Kootenay formation, between Athabaska and Smoky rivers, Foothills, Alberta.

folds of the outer range of the Rockies. A short distance from the mountains, its valley is bounded by low, well-rounded hills. Moon creek, about the size of Little Berland, is the next stream to the north, followed by Big Berland which drains the central part of the area, and leaves it near the crossing of the 6th meridian and the 15th base-line. It is about 100 feet in width and 2 feet in depth. Low hills with gentle slopes border its valley which is about a mile wide. Much of the valley is timbered with spruce and jackpine, some of it is covered with small willow and alder, and occasionally an open grass meadow is met with. It is fed by a number of creeks, the more important being Cabin, Moon, and Adams.

The climate is similar to that of the foothills generally in Alberta. Ample rain and a good snowfall promote a rank growth of vegetation.

The forest growth in the country is, for the most part, very dense, except in a few places over which forest fires have swept or where rocks outcrop. The trees are banksian pine, spruce, balsam, tamarack, birch, and balsam poplar. Of these, banksian pine has the widest distribution and constitutes almost the entire forest except on the muskegs which, when trees are present, are covered with spruce and tamarack. The average diameter of the trees is from 4 to 6 inches, at the stump; the largest trees are from 15 to 18 inches in diameter and about 50 feet high.

Spruce forms an important part of the forest in the muskegs and on areas of poor drainage. The largest trees are found in swamps and river bottoms and attain sizes up to 18 inches diameter and 60 feet high. Birch and poplar grow with the pine and are particularly noticeable on burned areas. Along the streams alder and dwarf willow are abundant.

Moose, caribou, and deer, the most plentiful of the large game animals, are abundant throughout the region. Martens are the most common of the small animals and beavers are found on a number of streams where their dams flood large areas of the bottom lands. The grouse is the most widely distributed of the game birds.

#### MEANS OF ACCESS.

The area examined may best be reached over the Government pack trail, 175 miles in length, which runs from Entrance on the railway to Grande Cache, passing through about the centre of the region. The trail which is about 10 feet wide was cut by the Forestry Branch, for the use of fire rangers, who have cabins at intervals of about 20 miles along the trail. For a distance of 60 miles there is connexion by telephone with headquarters at Entrance.

The great resources in coal of this and the adjoining regions can be made available only by the construction of a railway and, therefore, while the field work was in progress, attention was given to the character of the topography that might affect the selection of a railway route. It was found that the country did not present great obstacles to railway building and that probably a satisfactory route could be selected roughly along the following line. Leaving the Canadian National railway at Solomon Creek the line would follow the creek for about 6 miles with a grade of 1.75 or less. Thence, turning to the right through a narrow gap, the lakes and creek valley would be followed to Hay river, following which the summit would be reached by way of Moberly and Pinto creeks whence a gently sloping hillside leads to Little Berland River flat. The line would follow this stream to its junction with Big Berland river, continue up Big Berland flats about 8 miles to the mouth of Cabin creek, and turning to the right, follow the right hand branch to Tepee Creek summit. Down Tepee creek about 20 miles it would reach the Muskeg River bottom and thence would follow that river to its junction with the Smoky.

The steepest grade of the creek bottoms traversed would seem not to exceed 2 per cent, and with development this might be lowered. Excepting a short distance on Muskeg river this route would give earth work all the way. The stream crossings on this line being low would reduce the cost of bridging to a minimum and with the exception of a few trestles over ravines near the mouth of Muskeg river, no high bridges are necessary.

#### GEOLOGY.

Beneath the superficial drift covering the greater part of the area, the rock formations are sedimentary. In the western part of the field the rocks dip at a steep angle and exposures are frequent and easily studied. In the eastern part the dips are gentle—12 to 15 degrees—and exposures are few.

*Table of Formations.*

Pleistocene and Recent.....	Superficial deposits.
Upper Cretaceous.....	Montana to Dakota.
Lower Cretaceous.....	Kootenay.
"Juratrias".....	Fernie.
Devono-Carboniferous.....	

*Description of Formations.*

*Devono-Carboniferous.* These rocks consist, for the most part, of a compact, grey limestone, some of them massive and some evenly bedded. The top beds lie conformably under the "Juratrias." The base of the series is nowhere exposed. The upper part consists of a light grey quartzite that weathers to a reddish-brown colour. A few Carboniferous fossils were collected from the limestone beds in a locality just below the junction of the north and south branches of Berland river. The beds in which they were found appear to be well down in the series, since probably 2,000 feet of limestone lies above them in the fold of the mountain.

*Fernie.* Dark shales, siliceous shales, and thinly-bedded sandstones make up this series in the area.

*Kootenay.* This formation, which holds the bituminous coal of the district, is made up of sandstone and shale, in beds varying in thickness from a few inches to several feet. The dominant colour is grey; but black and brown are also common. At least two beds of conglomerate remarkably similar in appearance and colour to the conglomerates found in the adjoining coal areas occur in the measures at the western end of the field. The upper part of the measures is barren of coal or has only thin seams. From Hay river northward and westward to the main Berland only the upper part of the Kootenay was observed. The lower strata that are rich in coal seams both to the south at Brulé lake and to the north at Smoky river have not been exposed by erosion.

*Dakota.* Beds, probably of the same geological age as the Dakota, lie conformably upon the Kootenay. The formation is dominantly sandstone, but in places includes beds of grey shale 6 to 8 feet in thickness.

*Colorado.* A shale series, probably of the age of the St. John shales of Peace river, overlies the Dakota. The rocks are a brown and black shale, friable and apparently of great thickness, and divided some distance above the middle into an upper and lower section by a massive bed of sandstone from 75 to 100 feet thick.

A sandstone series about 250 feet thick overlies the shales. It is made up of banded shale and sandstone, the bands being from a fraction of an inch up to 15 or 18 inches in thickness. No fossils were found in these beds, but the occurrence in them of thin seams of coal up to 15 inches, and their stratigraphical position would seem to indicate that they are the time equivalent of the Dunvegan sandstones.

*Montana.* The lower formation which is a brownish-black shale probably 1,000 feet or more in thickness, is marine in origin and may represent a westward continuation of the Smoky River shales.

Shallow water sediments mostly of a light grey colour resting conformably upon the shales and lying comparatively flat or with gentle dips are made up of shales and sandstones with conglomerates and coal seams.

*Pleistocene.* The superficial deposits consist of glacial debris and river deposits. Some of these materials were carried in during the Glacial period and subsequently rearranged during the retreating stages of the ice. The most noticeable of these deposits are the gravel terraces along the main streams.

The pebbles in the gravel deposits are well rounded and vary in size from an inch up to about 9 inches in diameter. A great many of them are from the vicinity. One gravel deposit which extends along the summit between Tepee and Cabin creeks

appears to be of a different age from the rest; the pebbles in it, carried probably from the Rocky mountains by the ice, are of quartzite, milky in colour, smooth and round, and from 3 to 10 inches in diameter.

### *Structure.*

The most pronounced structural feature of the region is the precipitous limestones of the outer range. Intimately associated with this range is the fault zone in front of it which follows the mountains northwesterly across the country mapped. Great dissemblance in the sides of the fault is evidence that a vertical movement of considerable extent took place along this general line. Carboniferous rocks have been folded and pushed up on the newer Cretaceous. The rocks nearest the limestones show most disturbance. At a distance of from 10 to 15 miles east only gentle flexures are to be seen. In the disturbed area the upward bends in the rocks form ridges, capped by hard sandstone or conglomerate. The downward beds or synclines form low valleys and are occupied by soft, shaly rocks.

### MINERAL RESOURCES.

#### *Coal.*

The coal measures within the boundaries of the area mapped have not, so far as is known, been prospected, and in the hurried reconnaissance under review no attempt was made to prospect them in detail. But the following occurrences were observed and are of great importance as showing the presence of coal in the beds. The coal was found to occur at three horizons.

*Coals of the Montana Formation.* Coal occurs in these beds where they are exposed on the bank of a creek, to the right of the trail, 12½ miles from Entrance. The seams are 15 and 18 inches in thickness between beds of sandstone and shale. It occurs also on the bank of Hay river, at the trail-crossing, where two 18-inch seams are exposed. On Moberly creek considerable float is to be seen but no seams were found, the rocks being concealed by drift. On Pinto creek a number of thin seams are exposed in the banks, the thickest, which outcrops near the trail-crossing, having a thickness of 3 feet. Thin seams on one of which some prospecting was done are reported to occur on the Little Berland, and on the Big Berland two 15-inch seams outcrop in a cut bank about a mile below the trail.

*Coals of the Colorado Formation.* In the section of rocks exposed on the Little Berland a 15-inch seam was found which was assigned to this formation on lithological and stratigraphical grounds.

*Coals of the Kootenay Formation.* Outcrops of bituminous coal of Kootenay age are sparingly represented in the greater part of the area under examination. This is, probably, because the seams are covered by glacial drift, or because only the barren parts of the Kootenay are exposed. In the examination of the adjoining areas in 1916 it was found that about 600 to 700 feet of the top of the Kootenay and about 1,200 feet of the bottom is barren of coal or carries only thin seams. On Moberly and Hay rivers for example, no coal seams were seen in the Kootenay, but on Moberly considerable bituminous coal float was found where the formation crosses the creek. On the Little Berland two seams of coal occur enclosed in shales and sandstones. The upper seam is 3 feet in thickness with a 6-inch parting of grey shale. The lower seam has 3 feet of clean coal in a lower bench, then 1 foot of sandstone, and then 1 foot of coal. On Moon creek two seams were found and sampled. One, a 5-foot seam with a 6-inch parting of shale in the middle, contained the coal that was bright and clean but friable.

The other was a 3-foot seam of friable coal. A partial section, measured on the Big Berland, contains a coal seam, as follows:

	Ft.	In.
Conglomerate.. . . .	20	
Black shale.. . . .	10	
Coal.. . . .	1	10
Shale.. . . .	..	7
Coal.. . . .	1	3
Black shale.. . . .	21	
Grey sandstone.. . . .	15	
Black shale.. . . .	4	
Sandstone.. . . .	3	
Grey shale.. . . .	1	
Sandstone.. . . .	1	2
Black shale.. . . .	1	4
Grey sandstone.. . . .	2	
Black shale.. . . .	6	
Sandstone.. . . .	10	
Concealed.. . . .	8	4
Conglomerate.. . . .	200	
Concealed.. . . .		

One part of the measures containing a number of seams was exposed on the banks of a creek entering the north branch of the Berland about 8 miles from the junction of the two branches. A 3-foot 6-inch seam of hard coal with a 3-inch parting of shale near the top outcrops about a mile up from the mouth of this creek. Another seam which outcrops about 45 feet lower in the measures shows the following section:

	Ft.	In.
Coal, hard.. . . .	3	
Grey shale.. . . .	1	6
Coal, hard.. . . .	1	6
Black shale.. . . .	..	11
Coal.. . . .	..	8

Half a mile downstream from this outcrop are a 3-foot seam of soft coal and another of 2 feet with a 3-inch shale parting. A farther quarter of a mile downstream a large seam outcrops with the following section:

	Ft.	In.
Coal, soft.. . . .	3	
Grey shale.. . . .	..	6
Coal, soft.. . . .	2	
Coal, dirty.. . . .	2	
Shale.. . . .	..	3
Coal, clean and hard.. . . .	5	

The floor is sandstone and the roof is grey shale.

A few scattered exposures of Kootenay rocks were seen on Muskeg river, near A la Pace lake, but no coal was seen in them, though coal is reported to occur.

### LITTLE SMOKY RIVER, ALBERTA.

*By F. H. McLearn.*

The field season of 1919 was spent in a reconnaissance examination of a part of the valley of Little Smoky river, a tributary of Smoky river, Peace river, Alberta. It was studied from tp. 61, range 21, W. 5th mer., to the mouth of Tony creek and from tp. 69, range 21, W. 5th mer., to tp. 74, range 20, W. 5th mer., inclusive. Time did not admit of the completion of the section. Owing to the scarcity of outcrops the results of the expedition were unimportant. It is possible that exposures on the lower part of the river may be more frequent, but no geological data gathered there would add much to those already obtained from the nearby Smoky River section, studied in 1918. A. J. Childerhose gave efficient aid as assistant.

Intermittent exposures along the river in townships 72, 73, and 74 reveal massive, large scale crossbedded, yellow-weathering sandstones with large concretions and occasional fossil rootlets. Shale of subaerial origin also is exposed in a few places. A

bed of lignitic coal  $2\frac{1}{2}$  to 3 feet thick occurs in the river banks in the north end of township 72. These strata belong probably to the Wapiti formation. Shale outcropping on the river at the west boundary of range 20 contains a marine shell, *Nucula* sp.; this is perhaps the top of the Smoky River formation. No outcrops were seen from the river in townships 69, 70, and 71.

Massive sandstones and non-marine shales are exposed above and below the crossing of the Edson road and above the crossing are very thin lignitic coal seams. Below the base-line the river, in places, runs through steep-walled gorges of massive crossbedded sandstone with large concretions. Downstream toward the mouth of Tony creek the valley widens and there are no more exposures.

No details of structure can be deduced from the Little Smoky section. The disappearance upstream of the coal bed in township 72 and the marine shale with *Nucula* in range 20 indicate a southerly dip.

## HIGHWOOD COAL AREA, ALBERTA.

*By Bruce Rose.*

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### INTRODUCTION.

During the field season of 1919 the examination of the coal areas of the Rocky mountains, in which the writer has been engaged since 1915, was carried northward on the east slope of the Rocky mountains in Alberta, to cover the area drained by Highwood river. The area mapped extends from the Oldman-Highwood River divide, northward to  $50^{\circ} 30'$  north latitude and from the British Columbia-Alberta divide eastward to range 2, west of the 5th meridian, where it connects with the Foothills area mapped by J. S. Stewart.<sup>1</sup> Reconnaissance trips were made north of  $50^{\circ} 30'$  north latitude, along the valleys of Mist and Storm creeks (tributaries of Highwood river and, therefore, a part of the Highwood area) to look for connexions between the coal-bearing rocks of the Highwood area and those of Sheep river and Pocatererra creek.

The field work occupied a period of four months from June to September and one week in May was spent in the Bow valley near Banff in an examination of the known rock succession there, for the purpose of comparison with that to the south. J. R. Marshall of the Geological Survey was associated with the writer in this work and to him and the assistants R. L. Rutherford and M. R. Wells the progress made is in large part due.

### GENERAL GEOLOGY.

The rock succession and the structural features of the Highwood coal area are in general similar to those of the Crowsnest coal field to the south, which have been described in the summary reports on that area.<sup>2</sup> The table of formations summarizes the rock succession and in the paragraphs following it the special characteristics of the formations in the Highwood area are described.

<sup>1</sup> Geol. Surv., Can., Mem. 112.

<sup>2</sup> Geol. Surv., Can., Sum. Rept., 1916, pp. 107-114; 1918, pp. 13C-16C.

*Table of Formations.*

Pleistocene and Recent	Superficial deposits.
Tertiary (?)	
Upper Cretaceous	St. Mary River formations (?) Allison formation. Benton formation. Blairmore formation.
Lower Cretaceous	Kootenay formation.
Jurassic	Fernie formation.
Triassic	Upper Banff formation.
Devono-Carboniferous	

*Upper Banff and Fernie Formations.* The stratigraphic interval between the Devono-Carboniferous and the Cretaceous is occupied in the Crowsnest area to the south by the Fernie shale and in the Bow valley to the north by the Upper Banff shale and the Fernie shale. It was stated in the Summary Report for 1918 that in the northern part of the Crowsnest area quartzite underlain by shale occupies a position at the base of the Fernie formation and that this lower shale may represent the Upper Banff formation.<sup>1</sup> The examination of the Upper Banff shale in its typical development in the Bow valley seems to indicate from the similarity of the rock succession, that not only this lower shale but also the quartzite and probably some of the overlying shale belong to the Upper Banff formation. This succession is continuous across the Highwood area; but no fossils were found, so no sharp line can be drawn between the two formations. The age of the Upper Banff formation is placed as Triassic following a statement made by E. M. Kindle.<sup>2</sup>

*Kootenay and Blairmore Formations.* These formations hold their typical southern Alberta development across the Highwood area. It is to be expected that the nature of the sediments changes, probably, in a northward direction since the section in the Bow valley shows 1,000 feet of thin-bedded sandstones and shales between the Kootenay coal measures and the underlying Fernie formation and shows no conglomerate between the Kootenay coal measures and the overlying sandstones and shales.<sup>3</sup> But no change of a similar kind was noted in the rock succession of the Highwood area. The Fernie-Kootenay contact is marked by 50 to 100 feet of thin-bedded sandstones and shales, as in the areas to the south, and the conglomerate at the base of the Blairmore formation is continuous across the area.

The Kootenay formation consists of grey sandstones, dark shales, and intercalated coal seams, the Blairmore formation of grey sandstones and dark shales showing red and green colours with conglomerate bands in places. The outcrops of the Kootenay formation are shown on Figure 3.

<sup>1</sup> Geol. Surv., Can., Sum. Rept., 1918, p. 14C.

<sup>2</sup> Trans. Roy. Soc. Can., Ser. III, vol. X, sec. 4, 1916, pp. 37-38.

<sup>3</sup> Dowling, D. B., Geol. Surv., Can., Pub. No. 949, p. 8.

*Crowsnest Volcanics.* This formation lies between the Blairmore and Benton formations in the Crowsnest area, but in the Highwood area no outcrops of it were found and the Benton lies conformably on the Blairmore. The most northerly out-

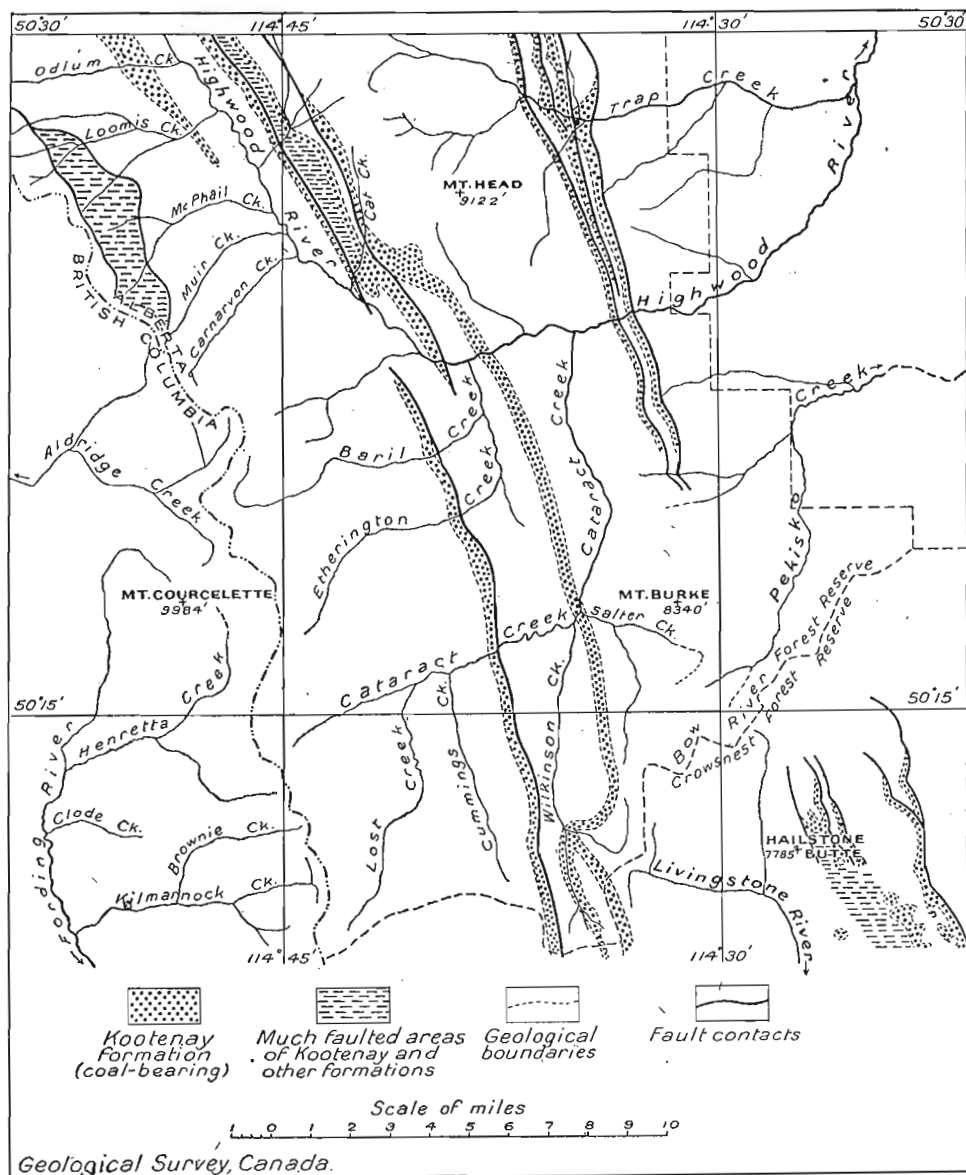


Figure 3. Areas of coal-bearing rocks, Kootenay formation, Upper Highwood river, Alberta.

crop of the Crowsnest Volcanics known is that first reported by G. M. Dawson as occurring at the mouth of a creek 3 miles north of a fall on Oldman river.<sup>1</sup> As the writer had not been able to find this outcrop when working in that area,<sup>2</sup> a search for

<sup>1</sup> Geol. Surv., Can., Ann. Rept., 1885, p. 88B.

<sup>2</sup> Geol. Surv., Can., Sum. Rept., 1918, p. 15C.

it was made along the Benton-Blairmore contact which parallels the valley, and a small outcrop of the volcanic rock was found at the trail crossing, on a creek joining Oldman river from the east, 2 miles north of the fall. This is doubtless the outcrop seen by Dr. Dawson, for the mouth of the creek, which joins Oldman river 3 miles north of the fall, lies wholly in Benton shale. This outcrop is in the southern part of sec. 15, tp. 13, range 5, W. 5th mer.

**Benton Formation.** The Benton in this area, as in areas to the south, is in general a dark shale formation but contains more sandstone beds than in the southern areas. The two sandstone members near the base are continuous across this area, and, in places, are followed upwards by platy sandstone containing fossils. *Ostrea legumbrarius sannionis* was found in this platy sandstone in sec. 34, tp. 16, range 6, W. 5th mer. This species has not been reported from any other locality in Canada. It is common in the Frontier formation of Wyoming.<sup>1</sup> Above these beds, arenaceous shale and sandstone beds occur at irregular intervals. The Cardium sandstone, a series characterized by interstratified sandstone and shale with bands of fine conglomerate, similar to beds described by Cairnes in the foothills area to the north,<sup>2</sup> was seen as far south as township 14 in the foothills and township 17 in the mountains. The Cardium sandstone, however, does not lie at the top of the Benton shale nor is it to be correlated with the Eagle sandstone as suggested by Cairnes of the formations to the north. A heavy sandstone at the base of the Allison formation corresponds stratigraphically to the Eagle formation, and the shales between the Cardium sandstone and the base of the Allison formation, which Cairnes designated as belonging to the Claggett formation, are here included with the Cardium sandstone and the lower shales and sandstones, in the Benton formation.

**Allison and Later Formations.** The Allison formation has a development similar to that typical of it in southern Alberta. It is characterized by a thick sandstone member at the base, the equivalent of the Eagle (Milk River), followed by alternating grey sandstone and shale carrying brackish and freshwater fossils. The fossil bones of a large vertebrate were found in sandstone of this formation on the north branch of Sullivan creek in the foothills. The Allison is practically all non-marine. No shale series in any way comparable to the Claggett has been found.

In the mountains the typical Allison passes up into a thick series, predominantly made up of soft grey sandstone and shale. In the Summary Report for 1918, 10,000 feet of this series was reported in the region of the headwaters of Oldman river. It is now known that this higher series extends northward for a distance of 31 miles into the Highwood area. In the 1918 Summary Report this series was correlated with the St. Mary and possibly higher formations of the foothills and southern plains. This correlation was made largely on the presence of an oyster bed, in Oyster creek, near the base of the series; a similar oyster bed is found near the base of the St. Mary formation. Additional evidence somewhat modified this correlation. Fossils collected from the base of the series in Oyster creek are identified by T. W. Stanton as follows: *Ostrea glabra*, *Unio consuetus*, *Goniobasis* sp., and *Goniobasis judithensis*. Stanton states that this fauna "strongly suggests" Judith River (i.e. Belly River). It is still possible, however, that the higher part of the series may be of St. Mary or even later age. Reddish shales and sandstones on some of the tributary creeks at the head of Cataract river are lithologically like the rocks of the Willow Creek formation. Soft, grey sandstones at the top of the series may be equivalent to the Porcupine Hills formation.

In the mountains there is evidently a continuous section of non-marine beds from the end of the Benton, but how far up they extend in the stratigraphic column is not known. The problem is not an easy one; fossils are rare in the higher rocks and outcrops are few in the areas where they occur.

<sup>1</sup> Personal communication, T. W. Stanton.

<sup>2</sup> Cairnes, D. D., Geol. Surv., Can., Mem. 61, pp. 26-28.

## ECONOMIC GEOLOGY.

There are no working coal mines in the Highwood area and the coal measures have been well prospected at only one locality—on the property locally known as the Ford mine on Cat creek.

Coal of economic importance is found in the Kootenay formation only. The coal is high carbon bituminous as may be seen from the analyses below.

For convenience in summarizing, the local areas are described under the following names: (1) Mountain area; (2) Foothills area; (3) Mist and Storm Creeks area.

*Mountain Area.*

The term Mountain area as applied to the Highwood coal field includes the part of the area lying west of the Highwood range which is here the most easterly range of the Rocky mountains.

Two main bands of the Kootenay coal-bearing formation cross this area in a general north-northwest direction parallel to the trend of the mountains. In the summary report on the northern part of the Crowsnest coal field it was noted that three bands pass northward across the Oldman-Highwood River divide.<sup>1</sup> The middle band plays out by faulting and folding about 3 miles north of the divide, leaving only the above-mentioned two bands of importance.

The western band crosses the divide in sec. 10, tp. 14, range 5, W. 5th mer., and is continuous for 15 miles to sec. 19, tp. 16, range 5, W. 5th mer., where it plunges under the overlying rocks by folding. Seven miles farther on, and in line with this band, the coal formation comes to the surface again in an anticlinal fold and continues northward beyond 50° 30' north latitude; to the north this fold broadens exposing the formations beneath the coal formation. The western arm of the coal passes west of Misty range, along Storm Creek valley, and the eastern arm passes east of Misty range along Mist Creek valley. This band lies wholly on the west side of Highwood river and crosses a number of its eastward-flowing tributaries. Prospecting has been done on it only in sec. 19, tp. 14, range 5, W. 5th mer., where a 22-foot seam has been opened.

The eastern band crosses the Oldman-Highwood divide in sec. 13, tp. 14, range 5, W. 5th mer., runs northward on the west slope of the Highwood range, crosses Highwood river about the northwest corner of sec. 28, tp. 16, range 5, W. 5th mer., and thence follows a more nearly north-northwesterly course, parallel to Highwood river, across tp. 17, range 16, W. 5th mer. This band is joined by two others which are brought in by faulting and first appear at the surface in sec. 20, tp. 16, range 5, W. 5th mer., and in sec. 1, tp. 17, range 6, W. 5th mer., so that from Cat creek northward what is here called the eastern band consists of three outcroppings of the formation and connects with the coal on Sheep river in tp. 19, range 7, W. 5th mer. The band has been well prospected on Cat creek on the H. A. Ford holdings, where fourteen seams of coal are exposed in a distance of approximately three-quarters of a mile across the measures. The thicknesses of the seams are as follows from east to west along Cat creek:

Seam.	Feet.	Seam.	Feet.	Seam.	Feet.
1	5	6	4	11	4
2	14	7	5	12	7
3	8'	8	33 <sup>2</sup>	13	7
4	10	9	10	14	22 (with pinch and swell).
5	17	10	12		

The formation is repeated by faulting between Nos. 7 and 8, between Nos. 12 and 13, and, probably, between Nos. 11 and 12. Seams Nos. 7 and 6 may be repetition

<sup>1</sup> Geol. Surv., Can., Sum. Rept., 1918, p. 16C.

<sup>2</sup> 22 feet coal, 2 feet shale, 16 feet coal.

of seams Nos. 4 and 5 which have been folded and dragged on the fault plane that passes between Nos. 7 and 8.

The seams have been prospected by tunnelling. The following analyses made in the laboratory of the Fuel Testing Station, Mines Branch, Ottawa, indicate the character of the coal.

*Analyses of Coal from Cat Creek.*

Seam No.		2	2*	5	8	9	12
Proximate analysis							
Moisture	%	0.6	0.9	0.5	0.6	0.6	0.7
Ash	%	23.6	8.1	8.7	7.6	23.9	6.8
Volatile matter	%	14.3	16.0	15.1	16.0	16.2	18.8
Fixed carbon	%	61.5	75.0	75.7	75.8	59.3	73.7
Ultimate analysis							
Sulphur	%	0.6	0.6	0.5	0.5	0.3	0.7
Calorific value in B.T.U. per lb.		11620	14110	14150	14300	11370	14370

- 2 Sample across upper 7 feet—forms poor coke.  
 2\* Single piece sample—agglomerates.  
 5 Single piece sample—forms fair coke.  
 8 Single piece sample from bottom—agglomerates.  
 9 Sample across seam—forms poor coke.  
 12 Single piece sample—forms good coke not much swollen.

It should be mentioned that in taking the cross-seam samples, some of the roof and foot-wall shale was included and that in the sample from seam No. 9 a 2-inch shale parting was included. The ash contents, therefore, of 23.6 per cent and 23.9 per cent do not represent fairly the quality of the coal. It is necessary, in mining, as shown by these analyses, to take care that the shale be kept apart from the coal. The samples were stored in canvas bags for several weeks before the analyses were made and some of the moisture content was doubtless lost by evaporation. Allowing 1 per cent for the moisture content an average analysis of the Highwood coal is approximately as follows:

	Per cent.
Moisture	1
Ash	8
Volatile matter	16
Fixed carbon	75

As most of the seams appear to be clean coal, it should be practicable to mine coal with a carbon content of 70 per cent and an ash content of less than 15 per cent.

Coal occurs at one other locality in the Mountain area. From sec. 6, tp. 17, range 6, W. 5th mer., to sec. 27, tp. 17, range 7, W. 5th mer., rocks of the Kootenay formation occupy a broken area at the foot of the high limestone mountains of the British Columbia-Alberta divide; but it is doubtful if coal of economic importance can be obtained there.

*Foothills Area.*

Kootenay coal-bearing rocks occur in the foothills east of Highwood range, in the area tributary to Highwood river, but so broken by faulting that it is doubtful if any of the coal is suitable for mining on a large scale, although favourable locations for mining coal for local use can be found along some of the creeks. These rocks run from the south of tp. 16, range 4, W. 5th mer., to the north of tp. 17, range 5, W. 5th mer., but were not examined further.

*Mist and Storm Creeks.*

One mile north of 50° 30' north latitude at the south end of Misty range, Highwood river divides into Mist creek and Storm creek. Mist creek drains the area between Misty range and Highwood range to the east and Storm creek the area between Misty range and the Elk mountains of the British Columbia-Alberta divide to the west. Reconnaissance trips along the valleys of these creeks showed that the coal formation is present there.

The western band of the coal formation in the Mountain area bifurcates, one branch passing along Mist Creek valley and the other along Storm Creek valley. To the south these bands join in an anticlinal fold, but northward the centre of the anticline is broken by an overthrust fault that passes east of Misty range so that the band which follows Mist Creek valley lies to the east of this overthrust fault, with the Devonian-Carboniferous limestone of Misty range thrust against it, and the band which follows Storm Creek valley lies in its natural succession on the west slope of Misty range.

In Mist Creek valley the band running east of Misty range lies to the west of the creek course, crosses a number of ridges running from the range, and finally crosses the head of Mist creek to Sheep River divide, beyond which it was not followed. East of the creek course and lying on the west slope of Highwood range, is another band of the coal formation. This is the northward extension of what was called the eastern band in the Mountain area. It crosses the divide at the head of Mist creek and connects with the coal at the Burns mine on Sheep river. Other outcrops of the coal formation were seen in the broken area between these two bands at the head of Mist creek, but are, probably, of small extent. No prospecting has been done in this valley and the formation was not traced in detail, but it is likely that much of it will yield good coal. This likelihood applies particularly to the eastern band which is continuous from the Ford mine on Cat creek to the Burns mine on Sheep river.

In Storm Creek valley the band west of Misty range crosses the creek twice and at its head lies on the west side of the pass to Pocaterra creek, which flows north to Kananaskis river. No prospecting has been done along Storm creek, but on the same band along Pocaterra creek a number of good coal seams were opened a few years ago and it is reported that analyses of picked samples gave a carbon content of 80 per cent. This band was not followed northward, but seems to pinch out a few miles farther on, for a view from the pass at the head of Pocaterra creek shows that the limestones of the ranges to the east and west come together in a distance of approximately 10 miles.

## OIL POSSIBILITIES AND DEVELOPMENTS IN THE GREAT PLAINS.

*By D. B. Dowling.*

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## THE EDMONTON OFFICE.

It was found advisable to keep an officer in the province of Alberta throughout the season during the oil boom of 1913-14. His usefulness in collecting data regarding the formations met with in the course of drilling operations and the importance

to the country of his advice and counsel led to the establishment of a temporary office in Calgary. On the discovery of oil in the Peace River area and the consequent interest that was aroused in the prospective oil fields of the Mackenzie and Athabaska valleys, the office was moved to Edmonton and to it was added as the nucleus of a geological reference library, many of the publications of the Department of Mines, the Conservation Commission, and the Surveyor General. During the winter of 1918-19, the office was closed owing to the resignation of S. E. Slipper who had been in charge since 1914. It was opened again in the spring of 1919 under the charge of J. S. Stewart who had previously made a study of the structure of the foothill region north of Highwood river and of the Wyoming and other oil fields of the United States. His experience was found to be of great benefit to the oil prospectors and the office became a centre for inquiry and consultation. The offices are now conveniently located in the Federal Building in which is also the city post office.

A supply of reports and maps dealing with the central provinces is kept in the office for distribution and is in constant demand. Specimens of local minerals, and products of their manufacture such as building materials have been added by private contribution and it is hoped their display will help to encourage the development of these resources and stimulate new industries. In appreciation of the efforts of the Survey in this work, it may be noted that the Board of Trade at this centre forwarded to the Minister of Mines the following resolution on December 8, 1919.

"That the Edmonton Board of Trade wish to express their appreciation of the valuable work being performed by the new office of the Geological Survey and Mines Branch of the Dominion Government opened in this city. In view of the increasing mining activities which may be confidently anticipated, it is hoped that this office may be made a permanent one and the work of the Geological Survey and Mines Branch be extended into northern undeveloped portions of the province."

For a period of about three months during the summer, the writer was in attendance at the Edmonton office in order to allow Mr. Stewart to devote a portion of his time to exploration of the foothill area south of Peace river. Considerable interest was manifested in this district by the government of British Columbia as it represented their share in the possible oil fields of the northern plains area. A study of the structure is briefly reported by Mr. Stewart and to this it is hoped will be added the general outlines of the structure studies made by the geologist employed by the Imperial Oil Company.

The interest in the foothill structures has been due largely to the installation at the wells on Sheep river, of an absorption plant for the extraction of gasoline from natural gas, and to the presence in the wells of oil that is of a very light specific gravity. The report of Mr. Stewart on the foothills of southern Alberta, Memoir No. 112, indicates several rather favourable localities and the Imperial Oil Company is erecting rigs at two of these points. To the north, an outer anticline in which the gas and oil horizons lie at great depth has been traced south from the Grand Trunk Pacific railway toward Brazeau river. At a few points, gas springs are reported. From one of these near Coalspur a sample of the gas emitted from the surface rocks was obtained, but the result of a laboratory absorption test with mineral seal oil gave only a trace of gasoline. This is not considered as an altogether satisfactory proof that there is not at depth a wet gas.

#### *Absorption Plant.*

The absorption plant at Sheep river which began operation during the past summer is expected to make an output of somewhere between 20 and 30 barrels of gasoline per day. The original installation of three upright absorbers was found to be short of the requirements and two horizontal spray absorbers were added. The installation at present consists of two horizontal spray absorbers made of steel pipe 19 inches outside diameter and each 75 feet long, and in addition three vertical

absorbers filled with a grill of shingles moistened by a stream of oil pumped to the top. The gas from each of the two gas wells is passed through a spray absorber and then through vertical absorbers. From one spray absorber the gas passes through a vertical absorber 3 feet in diameter and 24 feet high. From the other horizontal absorber the gas passes through two smaller vertical absorbers 30 inches in diameter and each 22 feet high. The oil which has circulated through the two absorbing units, is then passed to a steam still 8 by 20 feet, where the light oil is driven off by the introduction of live steam at 175 pounds pressure. Cooling and condensing coils are provided for the oil passed back to the absorbers and for the gasoline vapour. The vapour that is being condensed is held through the later part of the operation at 100 pounds pressure by auxiliary pumps. The cooling coils for the heated oil transfer most of the heat to the oil coming from the absorbers.

Details of tests of the gas from these wells were given in the Summary Report for 1918.<sup>1</sup>

#### EXPLORATIONS AND DEVELOPMENTS ON THE PLAINS.

Drilling for gas in order to increase the supply for Calgary requirements was continued. A well to the south of Bow Island in Fortymile cou  e gave great promise, but through accidents seems to have been abandoned. This location is, probably, well within the Bow Island anticline and success might reasonably have been anticipated. Near Barnwell, at the extreme western edge of the probable gas field, a small flow of gas was obtained. A well is being bored at Monarch, west of Lethbridge, to test a possible new field on the eastern edge of the Alberta syncline. A slight disturbance in the outcropping beds of the base of the St. Mary series is supposed to extend downwards and either by a dislocation impound natural gas in the sands or be an avenue for the ascent of gas from lower beds. The result of this boring will be interesting, the beds likely to provide gas and to be within reach of the drill being later in age than those of the Bow Island field and providing, apparently, only a small area of closed structure.

In the Viking field east of Edmonton, well No. 9 when completed produced a small flow.

The Great West Gas Company is reported to have obtained franchises from the cities of Moosejaw and Regina. The firm of Johnston and Huntley of Pittsburgh have been retained to locate the nearest possible structural area indicating a possible gas field. Their party was located on the South Saskatchewan north of Chaplin and it is probable that a well may be bored in that vicinity. Boring for oil on the plains has proceeded very slowly owing to lack of supplies and the use of inferior material. In the Peace River area trouble with water may be attributed mainly to the lack of sufficient casing and the means to shut off or mud the wells. The popular impression that the oil in the Lower Cretaceous is underlain by great reservoirs of oil in the Devonian has led to a certain laxness in trying to recover what has already been encountered. Southeastward from the Viking area, attention is being called to the continuation of the terrace underlain here by rocks of Belly River age. Westward of this terrace the rocks dip to the southwest at right angles. The change in dip in that direction introduces a band of marine shales to the west and above the Belly River rocks, followed farther west by the beds exposed at Edmonton. Eastward, the beds are nearly flat. In the vicinity of the edge of the terrace or of the line indicating a change of dip and southward along it to near the Saskatchewan boundary where a change of strike occurs, many minor folds and slight faults are observed. Of these, the following observations by S. E. Slipper are quoted.<sup>2</sup>

"In the Neutral hills and Tit hills north of Coronation and in the Mud buttes and Misty hills south of Monitor, many minor folds were observed and mapped.

<sup>1</sup> Geol. Surv., Can., Sum. Rept., 1918, pt. C, pp. 17-32.

<sup>2</sup> Geol. Surv., Can., Sum. Rept., 1917, p. 7C.

# Canada Department of Mines

HON. ARTHUR MEIGHEN, MINISTER; R. G. McCONNELL, DEPUTY MINISTER.

## GEOLOGICAL SURVEY

WILLIAM McINNES, DIRECTING GEOLOGIST

Issued 1920

### LEGEND

K2  
Bearpaw shale

Bulwark sandstone  
(in Bearpaw shale)

K1  
Pale beds

Crown of anticline

Lines of dislocation  
on crown of anticline

Upper Pierre

Belly River

### LEGEND

Roads  
(well travelled)

Roads  
(not well travelled)

Churches

Schools

Post Offices

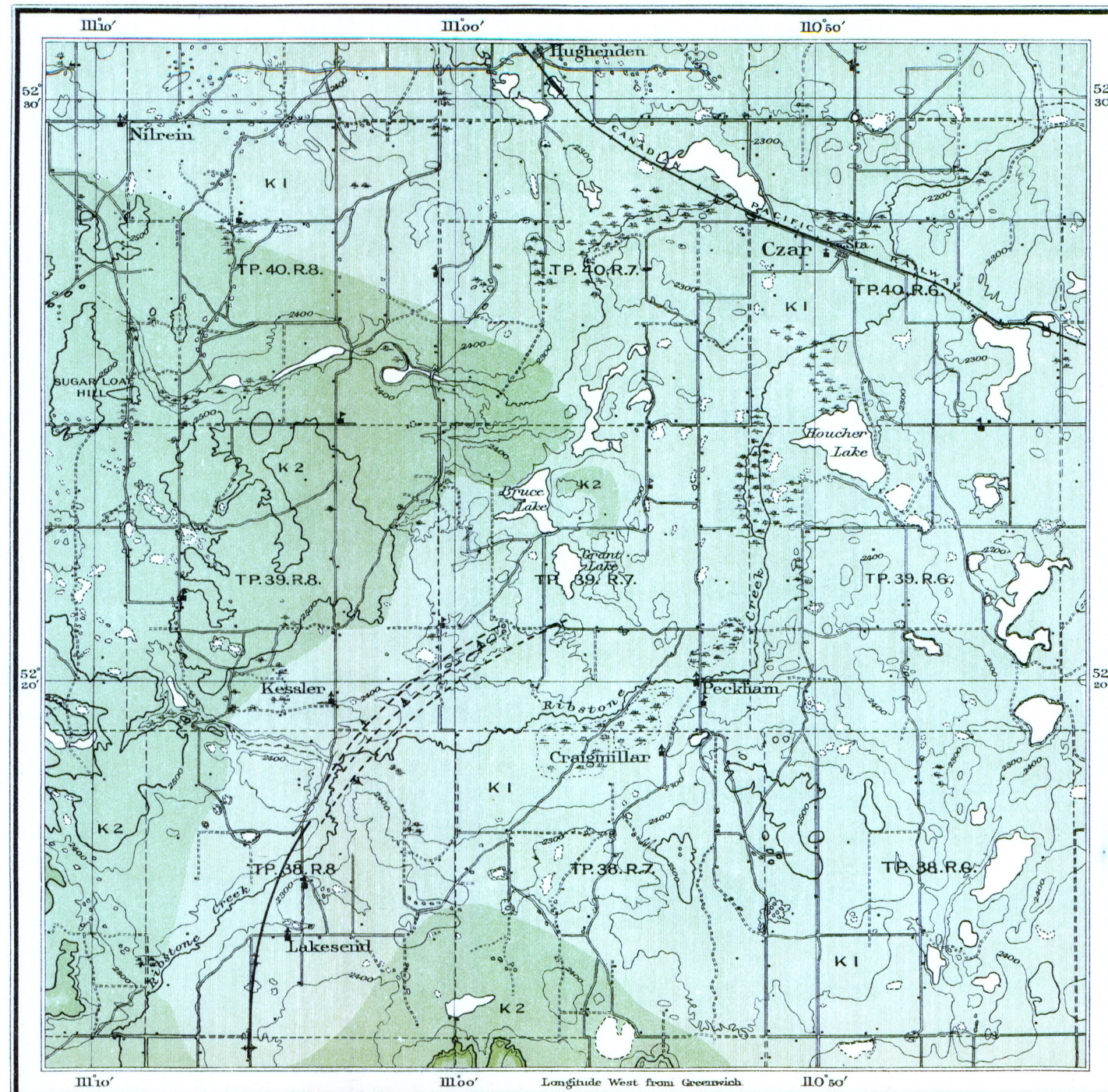
Watercourses  
(with intermittent flow)

Intermittent lakes

Contours  
(showing land forms and  
elevations above sea-level)  
Interval 100 feet

Depression contours

Approximate magnetic declination, 23° East.



C. O. Senécal, Geographer and Chief Draughtsman.  
A. Joanes, Draughtsman.

Publication No. 1803

## RIBSTONE VALLEY ANTICLINE TPS. 38, 39, 40, RS. 6, 7, 8. W. OF 4<sup>TH</sup> MER., ALBERTA.

To accompany Summary Report, Part C, 1919, by D. B. Dowling.

Scale of Miles  
1 1/2 0 1 2 3 4 5

Sources of Information  
Geology by S. E. Slipper, 1917.  
Topography by A. C. T. Sheppard, 1917.

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These minor folds may contain oil and gas, but no drilling has been done to test them. The lowest beds exposed are the Pale beds of the Belly River formation and hence depths to the gas and petrolific horizons would be considerable. It should be pointed out that nowhere else on the Canadian prairies have such sharp upwarps been observed; but south of the boundary, in Wyoming, all the productive oil fields are located on minor uplifts of the Cretaceous basin."

One of the minor folds noted by Mr. Slipper crosses the general structure at right angles and is followed through the Neutral hills by Ribstone creek. Slight faults are observed along the crest of this anticline and structure ridges seem to be in evidence in such features as the Tit hills south of Czar. A copy (Map 1803) of a small part of the forthcoming Wainwright sheet illustrating the surface features of the locality near the Ribstone Creek anticline accompanies the present report. On the line of this disturbance, the Imperial Oil Company has erected a derrick, and boring will be proceeded with during the summer of 1920.

#### DEVONIAN OF THE CENTRAL BASIN.

The presence of Devonian rocks beneath the plains is indicated in outcrops along the eastern margin in Manitoba, exposures in northern Saskatchewan, and also on Peace and Athabaska rivers in Alberta. Bore-holes in Manitoba and on Athabaska and Peace rivers near the edge of the basin give, so far, negative results in the search for oil. In other regions the beds of the middle Devonian are classed as oil bearing, but it is noticed that in all these oil fields there is a reasonable supposition that the Devonian sediments form only a part of a greater series of sediments that indicate a long period of submergence. It may be that in this area where the transgression of the sea on the continent reached its maximum proportions the shore-line fluctuated throughout the period of submergence to a greater extent than elsewhere due mainly to the gentle surface dip of the underlying Archæan rocks constituting the Canadian shield. This fluctuation is evident in the deposits laid down through the early Palæozoic and to the end of Devonian time and may account for the absence of Carboniferous rocks above the Devonian near the eastern edge of the basin. A strip of this edge—that is, the part which has been pierced by the drill—has been, probably, unprotected through long periods. If for these periods there occurred much differential elevation, and this is suggested in the Winnipegosis area by many fractures through the formations, the retaining of oil in the beds would be very uncertain and even the present elevation of the margin would suggest a draining back from the edge toward the basin.

This supposition might apply to the beds in the Manitoba portion where the section of the Devonian contains the deposits which are elsewhere oil-bearing. The elevation is there over 800 feet above sea-level. The same beds at Moosejaw are 1,000 feet or more below sea-level, so that provided there was no wastage before Cretaceous times the cover of Cretaceous sediments might retain in the Devonian some of the westward-drained oil. In the absence of indications of undulations in the westward dip the supposition is that the remaining oil would be located somewhere near and above the water-level that would be found in the beds of the basin. Assuming it to be about sea-level—or as deep as prospecting could be carried through the Cretaceous sediments—prospecting would be confined to a strip of country the western edge of which would be about 60 miles from the edge of the Cretaceous escarpment.

Along the northern border the problem is different in one particular. The fluctuation of the sea margin already noted is very marked. Resting on the granites of the old continent are found Devonian, Silurian, and, in Manitoba, Ordovician. This overlapping of sediments is also found in the individual members of the formations. The middle Devonian is absent in the exposures on Peace river below the Cascades. Southward and westward it is probably present. Where it comes in again is very problematical and on its location hinges the problem of whether oil will be found in the Devonian of this area. Borings at Pelican rapids on the Athabaska are

not conclusive, a little gas being reported in the limestones. At Peace River town, farther from the outcrop, it is proposed to penetrate the Devonian. There is no certainty that even here oil-shales and porous dolomites are present, but the experiment is worthy of a trial in at least one locality.

Northward of the granite spur extending westward between Athabaska and Great Slave lakes another embayment of the ancient sea is encountered. The deposits in this embayment show a sedimentation somewhat similar to that in Manitoba, but as they are not masked by great thicknesses of Cretaceous shales and as the basin was not so greatly deepened by the continental stresses, exposures farther from the fluctuating margin are found and the Devonian section includes the petroliferous beds that are absent from the exposures in Alberta and Saskatchewan.

These beds can be reached by the drill over a large area and the probing for oil pools presents consequently many more chances of success than is expected of the Devonian basin lying beneath the Cretaceous rocks to the south.

Preparations are being made by the Imperial Oil Company to sink two drill holes during the coming summer. The machinery for the two rigs was transported north last season and erected at the two selected sites, namely, one on the north shore of Great Slave lake and one near Norman, west of the mouth of Great Bear river.

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