PROVINCE OF ALBERTA

Scientific and Industrial Research Council *Report No. 15*

University of Alberta, Edmonton. Alberta.

GEOLOGICAL SURVEY DIVISION

JOHN A. ALLAN, Director.

Geology of the Area

BETWEEN

Athabaska and Embarras Rivers

Alberta

BY

RALPH L. RUTHERFORD

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY

EDMONTON:

PRINTED BY W. D. McLEAN, ACTING KING'S PRINTER

1926

ORGANIZATION

The Scientific and Industrial Research Council of Alberta, formed in January, 1921, carries on its work in co-operation with the University of Alberta. The Geological reports are prepared under the direction of J. A. Allan, Professor of Geology, University of Alberta.

The personnel of the Council at the present time is as follows:

Hon. Alex. Ross, Minister of Public Works, Chairman.
H. M. Tory, President, University of Alberta.
J. T. Stirling, Chief Inspector of Mines, Province of Alberta.
J. A. Allan, Geologist.
N. C. Pitcher, Mining Engineer.
R. W. Boyle, Dean, Faculty of Applied Science, University of Alberta.
Edgar Stansfield, Honorary Secretary, Industrial Research Department, University of Alberta.

Requests for geological information and reports should be addressed to Department of Geology, University of Alberta, Edmonton, Alberta.

LETTER OF TRANSMITTAL

HONOURABLE ALEX. ROSS, M.L.A.,

Chairman, Scientific and Industrial Research Council of Alberta,

Edmonton, Alberta.

SIR:—I have the honour to transmit herewith a report of the Alberta Geological Survey Division, entitled "*Geology of the Area between Athabaska and Embarras Rivers, Alberta,*" prepared from field observations by Dr. Ralph L. Rutherford in 1925. This is Report No. 15 of the publications of the Scientific and Industrial Research Council of Alberta.

This report embodies the results from our fourth season of field work on the correlation of coal horizons within the foothills belt between North Saskatchewan and Athabaska rivers. The area mapped geologically and discussed in this report is approximately 800 square miles and extends from Bliss eastward to Edson. A geological map in three colours and on a scale of one inch to two miles accompanies this report.

Among the many important points in this report, mention might be made of two of these:—(1) An area of mineable coal occurs on McLeod river about 15 miles from the present line of railway at Hargwen; (2) Field investigations indicate that there is a probability that commercial seams of coal occur in the Athabaska valley along the Canadian National Railway under the thick deposits of lake terrace gravels. The coal seams should occur just east of Bliss station. The location of coal on this part of the Athabaska valley will have to be determined by drilling.

The last chapter of the report is an appendix and deals with additional information on the structure of the coal seams along the Alberta Coal Branch.

The correlation of the coal-bearing rock will be extended eastward to Evansburg and Wabamun during the season of 1926.

All of which is respectfully submitted.

Yours truly,

JOHN A. ALLAN,

Geologist.

Department of Geology,
University of Alberta,
Edmonton, Alberta, May 31, 1926.

TABLE OF CONTENTS

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

CHAPTER V.

MAPS AND SECTIONS

Geology of the Area Between Athabaska and Embarras Rivers, Alberta

By

RALPH L. RUTHERFORD

CHAPTER I.

INTRODUCTION.

General Statement.—The geological survey division of the Scientific and Industrial Research Council of Alberta has carried on geological surveys in the foothills belt of Alberta between North Saskatchewan and Athabaska rivers. These surveys were conducted during the field seasons of 1922, 1923 and 1924. An account of the information obtained on these surveys is given in reports numbers 6, 9 and 11[1] of the Council. During the field season of 1925, geological observations were extended eastwards from the northern end of this foothill belt, and the following report is based largely on the field work of 1925.

During the earlier part of the season the writer examined the exposures on the McLeod and Athabaska rivers near Whitecourt, Alberta, in order to get a general idea of the geology in that vicinity. In the latter part of the season the writer revisited the coal mines between Coalspur and Lovett to obtain further data which has been made available by recent mining developments. Notes on this district are included in the latter part of this report.

The chief purpose of the field work in 1925 was to investigate the coal districts that occur on McLeod river east of the area discussed in report number 11, and to extend observations eastwards from the foothill belt. The ultimate object is to determine the geological relations of the upper Cretaceous coal in the foothills belt to that in the districts around lake Wabamun and Edmonton.

Geographical position and accessibility.—The area discussed in this report and shown on the accompanying map (No. 11) borders a part of the foothill belt of Alberta. It lies between 116°45′ and 117°45′ west longitude and includes all or portions of townships 49 to 53, ranges 17 to 25, west of the fifth meridian. The thirteenth base line borders the area on the south and the fourteenth base line crosses the northern part.

---

[1]Allan, J. A., and Rutherford, R. L., "Saunders Creek and Nordegg Coal Basins," Rept. No. 6, Sci. and Ind. Res. Council of Alta., Edmonton, 1923.
Allan, J. A., and Rutherford, R. L., "Geology along the Blackstone, Brazeau and Pembina Rivers in the foothills belt, Alta.," Rept. No. 9, Sci. and Ind. Res. Council of Alta., Edmonton, 1924.
Rutherford, R. L., "Geology of the foothills belt between McLeod and Athabaska rivers, Alberta," Rept. No. 11, Sci. and Ind. Res. Council of Alta., Edmonton, 1925.
Hereafter referred to as reports Nos. 6, 9 and 11.

The Brazeau and Athabaska Forest Reserves include the south-western part of the area. The north-eastern boundary of these reserves is shown on the map. This area includes part of the Prairie Creek[2] coal area. The boundaries of the area are not marked by physiographical features excepting at the south-west where a relative high and continuous ridge occurs. This ridge is the first pronounced upland on the north-eastern side of the foothill belt in this region.

The main line of the Canadian National Railway crosses the northern part of the area, and a branch line from Bickerdike to Coalspur and points beyond passes along the south-east side of the area. A spur line approximately 9 miles long extends from Hargwen south to McLeod river and up the river to the McPherson and Quigley saw-mill. This mill has not operated during the past year, so that the spur line has not been in use.

The area lying between the railway lines is accessible in part by means of pack trails and wagon roads, but a large part of it can only be traversed on foot.

Two railways grades are shown to cross the northern part of the area. These were formerly the grades of the Grand Trunk Pacific and the Canadian Northern Railways. Since the consolidation of the two systems into the Canadian National Railway, parts of both grades have been abandoned. At present the Canadian National Railway is using the Grand Trunk grade from Edson west to Obed and the Canadian Northern grade from Obed west beyond the boundary of this area. About a mile of Canadian Northern grade is used near the "Big Eddy" in sections 3, township 53, range 18, where the railway leaves Grand Trunk grade to follow a lower crossing over Sundance creek.

The railway ties have been removed from portions of the abandoned grade, which are being used as an auto or wagon road. These used portions form part of the proposed Jasper Highway. At present this Highway follows the Canadian Northern grade from Sundance station site in section 18, township 53, range 18, west to Marlboro. About 2 miles south-west of Marlboro the highway comes on to the grade again and uses it as far as Hargwen in section 36, township 52, range 22. The grade may, however, be followed west to Obed. From Obed west the railway ties have not been removed from the abandoned Grand Trunk grade so that it is difficult for automobiles or wagons to make use of it. A wagon road extends west from Hargwen through Dalehurst to Bliss. This road follows the old railway construction route and has been maintained to some extent by companies that have carried on lumbering operations in the vicinity of Dalehurst.

The road between Hargwen and Bliss is the only poor part of the Highway between Edson and the east boundary of Jasper Park. A few small bridges and some road grading would make this part passable the year round for automobile or wagon traffic.

2"Coal Areas Map of Alberta," Map No. 6, Rept. No. 10, Sci. and Ind. Res. Council of Alta.

Culture.—The chief industries carried on in the area are coal mining in the southern part, lumbering on a small scale at different places, and farming in the eastern part around Edson. A cement plant operates at Marlboro, but the raw materials come from outside this area. A large part of the interstream areas is covered with muskeg.

Field Work and Preparation of Map.—This report is based on information obtained in the field between June 1st and September 13th, 1925. The country was traversed by means of pack horses. L. S. Russell gave very satisfactory service as assistant; C. H. Mealing did the instrument work during the first part of the season when the party was working in unsurveyed territory; Geo. C. Haworth, assisted by C. H. McKenzie, had charge of the pack train and cooking. Their work was performed very satisfactorily. Most of the information was obtained by traversing the major streams, since almost all rock exposures are confined to the stream channels. Considerable time was spent in traversing the interstream areas in order to sketch the topography.

The base for the accompanying map has been compiled from several sources and an attempt has been made to incorporate all available geographical data. A large part of the area, as indicated on the map, has been surveyed and the township plans issued by the Topographical Survey of Canada were used as the base in these surveyed areas. In the unsurveyed areas our party ran traverses along the main streams and larger creeks as well as determined the position of some of the higher points by triangulation. A stadia traverse was carried up McLeod river from section 16, township 51, range 22, to the south-west boundary of this map-area. Telemeter traverses were carried up the tributary creeks to distances from 2 to 5 miles. Levels were carried up McLeod river and stadia levels on the telemeter traverses. On the accompanying map the portion of the McLeod in the unsurveyed territory is shown with more accuracy than on any previous map, and the position of several large creeks is also shown. The headwater creeks have been sketched, and their position as shown is thus only approximately correct.

The contour lines shown on the map have been sketched and are only approximate. Control elevations were taken from railway bench marks and the levels carried up McLeod river. In the areas between the railways and McLeod river only relative elevations were determined by barometric reading, thus the accuracy is only approximate.

In many of the muskeg covered areas the determining of the elevations by barometer is difficult since traversing is difficult and slow and the diurnal change in barometer is frequently too rapid to permit obtaining even fair results by this method. This approximate accuracy must be considered by those who make use of the map in the field.

Names have been given to some of the larger creeks. These names are not final unless adopted by the Geographic Board of Canada.

The rock outcrops are shown in color, and the positions of fossil localities and coal prospects are indicated by symbols.

Previous work.—In 1898 McEvoy[3] crossed the northern part of this area while he was making a reconnaissance survey of the "Yellowhead Pass Route". The geology at various points along this route are discussed in his report.

In 1922, Dowling[4], reporting on the coal area to the southwest of this area, gives some general notes on the structure along the southern part of this map-area.

It is of interest to note that the Earl of Southesk[5] followed up the Embarras river while making his journey through the west in 1859.

The above references only give scattered information on this area, and to date very little detailed geological information has been published on it.

Acknowledgments.—The writer wishes to acknowledge the assistance and favours given the party during the field season by various persons. Mr. Chas. White, of the Forestry Station at Coalspur, supplied geographical data for parts of the unsurveyed area in townships 49 and 50, range 22. The officials at the Balkan and Bryan mines gave assistance and information concerning their properties. The party received courteous treatment from the settlers and railway agents at various points throughout the area.

Dr. J. A. Allan has given considerable of his time to the revision of this report and assisted in the preparation of the accompanying map. Dr. P. S. Warren has kindly determined the fossils collected in the field, and the results of his examination of these are included in this report.

[3]McEvoy, J., Geol. Surv., Can., Ann. Rept., 1898, Pt. D, pp. 1-44.
[4]Dowling, D. B., Geol. Surv., Can., Sum. Rept., 1922, Pt. B, p. 102.
[5]Wallace, J. N., "Southesk's Journey through the West," Geographical Journal, Vol. LXVI, 1925, p. 246.

CHAPTER II.

GENERAL CHARACTER OF THE AREA.

Physiography.—The area shown on the accompanying map borders the foothills and does not exhibit any pronounced uplands within it. Almost all the interstream areas have gentle slopes. There is a gradual increase in average elevation from east to west across the area. Edson at the eastern edge of the area has an elevation of 2,885 feet above sea level, and the highest part of the area at the western side has an elevation of approximately 4,700 feet. The underlying strata are flat-lying or have low dips excepting along the south-west part of the area. Here the dip is from 25 to 40 degrees to the north-east with the strike of the beds averaging north 45 to 60 degrees west. Consequently there is an alignment of higher and somewhat parallel ridges across the south-west part of the area. The high area shown in the southern part of township 49, range 22, is one of these ridges. It is the northern end of a long ridge[6] that extends south-west beyond this area. This ridge extends about 9 miles north-west from Embarras river. The crest is not well defined, but is broad and irregular with an average elevation of 4,700 feet. The slopes from it are gentle, especially to the north-west towards McLeod river.

The divide between McLeod and Athabaska rivers is represented by an upland which extends across the north-west part of the area as shown by the sketch contours. The slope from this upland to Athabaska river is steeper than that to the McLeod. The upland is more dissected on the McLeod slope, where several long creeks flow to McLeod river.

Most of the country between Embarras and McLeod rivers has relatively low relief and much of it is covered with muskeg. The slopes are gentle. This description applies also to the country adjacent to the railway from Hargwen to Edson.

There are extensive gravel and sand deposits along the Athabaska valley from about Pedley station south-west beyond this map-area. These deposits are believed to represent higher levels and laking of Athabaska river in the past. As the valley has been deepened, these deposits have been re-sorted and occur now as river terraces. Hinton and Bliss railway stations are situated on two of these well-defined terraces.

Drainage.—The streams draining this area belong to the Athabaska river system. Athabaska river forming the north-west boundary is a relatively swift flowing stream. The immediate tributaries within this area do not carry much water to the main part of the Athabaska, which has its source in the Rocky mountains to the west. McLeod river, a tributary to the Athabaska,

[6]Rept. No. 11, 1924, p. 23; and No. 9, 1923, p. 17.

drains most of the area, and the Embarras is the main tributary of McLeod river in this area. Thus, Athabaska, McLeod and Embarras rivers are the major streams of the area.

Athabaska river, the largest of the three, has eroded a deeper valley than the others, but there are very few exposures of the strata in its valley owing to the thick mantle of recent deposits. A large part of its water comes from melting snow and ice in the mountains.

McLeod river, the second largest stream, drains most of the central part of the area. Its water level varies appreciably with local rainfall. It has an average width of 100-200 feet, and is a shallow stream except during flood periods.

Embarras river joins the McLeod in township 52, range 18, and carries about one-half as much water as does the McLeod above this confluence. Embarras river branches into two streams of about equal size in section 12, township 51, range 19. The west branch is shown on some maps as the "West Embarras". This branch divides again into two streams of about equal size in section 14, township 50, range 20, west of the 5th meridian.

The outcrops of rock as indicated on the map occur mainly along the channel of the three major streams. The tributary creeks show outcrops near their mouths. The distribution of the rock outcrops with reference to the streams, indicate that the major streams are eroding more rapidly than the tributary creeks. This is largely due to the fact that the major streams carry a large volume of water from areas to the west and their volume is not so closely related to local precipitation as is the case with the tributary creeks.

The course of McLeod river in township 52, ranges 19 and 20, has changed considerably since these townships were surveyed and mapped in 1907. The new channel is shown on the accompanying map and the old course is indicated by broken lines. In the south-east half of section 31, township 52, range 20, the stream channel has moved north, and is now undermining the railway grade in section 32. A diversion wing in section 31 would easily remedy this by making the stream resume its old course to the south.

The major streams have a general north-east trend across the area, and this trend is apparently not affected much by the structure of the underlying rocks. The course of McLeod river in township 52, range 19, appears to be the only exception, and is here believed to follow the structure of the underlying strata.

There are several relatively large creeks within the area that are tributary to the major streams mentioned above. Hardisty creek is the largest one tributary to the Athabaska.

Some of the larger creeks tributary to the McLeod in the unsurveyed area have not been shown on previous maps. High-Divide, Quigley and McPherson creeks were shown on Map No. 9, accompanying Report No. 11. Their position as shown on Map No. 11 accompanying this report is more accurate.

Felton and White creeks are the two main tributaries joining the McLeod from the south. Lambert and Prest creeks are the two largest tributaries to the Embarras within this area.

The names of McPherson and Quigley creeks have been officially adopted by the Geographic Board of Canada. High-Divide has not been adopted by this Board as the name for the creek thus indicated on the map. For want of a more suitable name the writer has continued to use this same designation.

The name Felton has been suggested by Mr. Charles White, of the Forestry Branch at Coalspur. This name occurs on an old map of a timber berth on this creek. White creek has been suggested by the writer for the creek thus indicated, since the first mapping on it was done by Mr. Charles White.

There are several other large creeks within the area that have no names. It seems advisable to leave them without names until such time as local development takes place and appropriate names can be given to them.

Forests.—Most of the western part of the area has been forested with spruce, pine, and tamarack, but fires and timbering operations have removed the best of the merchantable timber from the area.

The McPherson and Quigley Lumber Company operated along the McLeod and its tributaries from the position of the sawmill up to Quigley creek. This company has not operated during the last year. Another company operated for several years at the mouth of Lambert creek near Weald. This company has moved its mill to the confluence of the two branches of Embarras river in section 12, township 51, range 19. Its raw material, however, will be obtained from areas to the south on the east branch of the Embarras. A lot of mine timber and lumber material has been taken out of the district around Dalehurst.

In the large areas that are covered with muskeg there are good stands of young tamarack that in future may become of merchantable size, and are worthy of protection from forest fires.

CHAPTER III.

DESCRIPTIVE GEOLOGY.

Structural Geology.—It has been stated above that the north-eastern edge of the foothills borders this area along the south-west and that the rocks are very little deformed in this area, with the exception of those in the south-western part. Here the strata dip to the north-east at angles from 20 to 40 degrees and strike north 45 to 60 degrees west. The steepest dips occur along Embarras river in the vicinity of Balkan and Bryan mines. The dip angle is seldom over 25 degrees on McLeod river at the locality in strike alignment with Balkan and Bryan mines. In Athabaska valley the dips are about the same as on the McLeod in the corresponding strike position.

A fault is shown along the south-west boundary of the area. This represents a broken anticlinal structure that has been described in earlier reports[7] which deal with the areas to the west.

It is difficult to determine the exact position of this fault since in most places the surface evidence of displacement is not very definite. Consequently the position of this fault as shown in the Embarras valley is only approximate, as the evidence of displacement there is poor. On Gregg river there is good surface evidence of faulting. The beds in the west limb are practically flat-lying, and those in the east limb almost vertical at the fault. These vertical beds flatten out very rapidly to the east, and at the mouth of Gregg river they dip 20 degrees to the north-east. In Athabaska valley the fault is concealed, but the structure of the beds in the vicinity of the position of the fault as mapped indicates considerable displacement by faulting.

Embarras river exposes a more continuous section than the other streams, and the structure is more easily worked out in this stream valley than in that of the McLeod or Athabaska.

From the fault eastward to Bryan and Balkan mines the strata dip from 30 to 40 degrees to the north-east. At the mines the dip is 38 degrees. From the mines north-eastward the dip decreases very rapidly, and within a mile in this direction it is less than 15 degrees. It continues to decrease, and averages about two degrees across township 50, range 20. At Weald the beds are flat-lying and a flexure axis is mapped west of Weald. This is believed to be the approximate position of the change from flat-lying to dipping beds, but the change is so gradual that it is difficult to locate its exact position.

Flat-lying beds extend from Weald east beyond Erith almost across township 51, range 19. A second flexure axis is shown to cross the Embarras in section 30, township 51, range 18. The beds

[7]Rept. No. 9, 1923, p. 9; and Rept. No. 11, 1924, p. 11.

to the north-east of this axis show a small, yet definite dip to the north-east. This north-east dip, which is about two degrees, continues to the eastern boundary of the area.

On McLeod river at the mouth of Gregg river the beds dip 20 degrees north-east. This dip decreases to the north-east and near the mouth of McPherson creek it is 10 degrees. From this point eastwards the dip decreases rapidly, and the beds are flat-lying in the southern part of township 51, range 22. The exposures on McLeod river in townships 51 and 52, range 22, show almost flat-lying beds, although local undulations and initial inclinations of the strata are indicated in several places by dips as much as 5 degrees. In the western half of township 52, range 21, the beds have an average dip of 2 degrees to the north-east. The flexure axis shown on the Embarras west of Weald is believed to cross the McLeod approximately in the position as mapped. East of this flexure the beds are flat-lying as far as the east side of range 20, where a second flexure is mapped. This is thought to be the same structural bend as occurs on the Embarras east of Erith. East of this second flexure the dip averages two degrees north-east, and the structure corresponds to that on the lower part of Embarras river. The south-east direction of the McLeod through Township 52, range 19, is believed to be following approximately along the strike of the underlying strata.

In the Athabaska valley exposures of rock are very few, but those that occur show a north-east dip, decreasing gradually from about 15 degrees at the west side of the area to small dips of one or two degrees at the east side.

In general, the strata within this area form the broad north-east limb of a faulted anticline which borders the area along the south-west. There are several minor structures within this general structure as indicated on the map by local changes in the dip angles and flexure axes. Some of these minor structures may be due to local conditions such as unequal settling of the sediments during consolidation or initial dips in the strata due to the slope of the surface of deposition, rather than to mountain building forces which produced the foothills.

The strike of the strata is north-west. Between Embarras and McLeod rivers it averages north 45 to 60 degrees west. Between McLeod and Athabaska rivers it averages north 60 to 70 degrees west. These different strikes of the strata correspond to the structure in the foothills immediately west of the area. It is difficult to determine the strike direction in the eastern parts of the area where dip angles are small.

The flexure axis east of Erith is perhaps the most significant structural feature in the eastern part of the area. Although the folding at this point is not marked, it is the most easterly indication of deformation in the area. Beds lower stratigraphically than any to the east are brought to the surface at this point.

Three structure sections across the area are shown on Plate I. These illustrate the slight amount of folding of the strata within most of the area.

Stratigraphy.—Lithologically, the entire sequence of rocks in this area belong to one formation and were deposited in fresh waters either in streams or lakes. The strata consist chiefly of shales, sandstone, conglomerates with all graduations between these three types of sediments. Arenaceous beds are most prevalent. Lithological units are lenticular and show rapid variations in thickness and texture both vertically and laterally. In general the younger beds are softer or more poorly consolidated than the older or lower ones. This appears to be largely due to the greater weight of cover on the older beds rather than any differences in materials forming the different strata. In addition to these sediments there are thick coal seams at different horizons in the series.

In Reports Nos. 6, 9 and 11 the name "*Saunders formation*" was given to the uppermost Cretaceous strata which overlaid the Colorado marine strata of upper Cretaceous age in the foothills. In the areas dealt with in these reports the *Saunders formation* included all the strata above the Colorado, and thus possibly some beds younger than Cretaceous were included. The lower strata in this area are undoubtedly the equivalent of some of the Saunders beds in the foothills belt, but the uppermost strata in this area occurring in the eastern part, are thought to be younger than any of the Saunders beds occurring in the foothills to the west.

Columnar sections representing the strata in different parts of the area are shown on Plate I. These have been constructed from exposures along the rivers. These sections are shown to overlap between lines indicated as X—X, and Y—Y. This is due to the fact that the beds are flat-lying in the area between the two flexure axes and the streams flowing from west to east cut down through the stratigraphical succession in this part of the area. In the greater part of the area the beds dip to the north-east, and the stream exposures show successively higher strata from west to east.

Columnar sections A and B (Plate I) together represent the strata exposed from Edson west to the Balkan mine, and is constructed from exposures on Embarras and McLeod rivers. This section shows that at least 5,300 feet of beds are represented between these two points. Since an appreciable part of the succession is concealed the exact section cannot be obtained, but it is thought that the above is a minimum thickness of the section in this part of the area. Sections A and D represent beds on McLeod river up as far as McPherson creek. Section D is subject to greater error than A or B, since the beds on McLeod river in townships 51 and 52, range 22, show several undulations, and it is difficult to determine the stratigraphical succession. Section D is included mainly to show the relative position of the coal on McPherson creek to that at the Balkan and Bryan mines.

Section C represents beds exposed on McLeod river between the two flexure axes and is given particularly to show the stratigraphical position of beds carrying fossils at localities numbers 16 and 17. The corresponding beds on Embarras river are not shown in columnar section as they are essentially the same as those shown on lower part of Section A or upper part of Section B, and no fossils were found in them.

Palaeontology.—The localities from which fossils were collected are indicated by numbers on the map which correspond to the numbers in the columnar sections. Fossil animal remains are not abundant in the strata, and occur in lenses or pockets. They do not occur in beds with wide lateral distribution which would form good key beds for correlation purposes. Plant remains also occur in pockets and lenses, and frequently the plant and animal remains are found together.

In studying the Saunders formation in the foothills, no fossil invertebrates were found in the western belts of this formation. Fresh water invertebrates were found at a few localities along the eastern edge of the foothills, but these occurrences were in beds high up in the Saunders formation, which were in all probability the stratigraphical equivalent of some of the strata in this area.

Dr. P. S. Warren has identified the fossils collected from this area and written the notes accompanying them. The only previous mention of fossils from this area is contained in McEvoy's report. He collected fossils from a creek then called Sandstone creek, which, from his description, appears to be the creek that joins the Athabaska in section 4, township 52, range 24. From this locality he lists *Physa copei*: *Patula* sp., *Zonites* or *Conulus*, and a fossil plant *Taxites?* We were unable to locate fossil invertebrates in the exposures along this creek, but found plant remains at locality 2 shown on the map.

The following is a list of the fossils collected during the past season in this area:—

INVERTEBRATES

Field Number		Locality
3-5	*Sphaerium formosum* M. & H. *Vivipara* sp. undet	Sec. 30, Tp. 52, Rg. 23.
4-8	*Sphaerium* sp. undet *Bulinus longiusculus* M. & H.	Sec. 35, Tp. 52, Rg. 23.
7-12	*Hydrobia subcylindracea* Whiteaves *Helix* sp. nov. *Helix* (*Patula?*) *obtusata* Whiteaves *Helix* sp. undet	Sec. 3, Tp. 52, Rg. 22.
8-15	*Vivipara* sp. undet *Sphaerium subellipticum* M. & H.	Sec. 9, Tp. 51, Rg. 22.
9-21	*Hypdrobia subcylindracea* Whiteaves *Helix* sp. undet	McLeod river at McPherson creek.
10-21	*Sphaerium subellipticum* M. & H.?	McLeod river at McPherson creek.
11-21	*Vivipara* sp. undet	White creek.
15-37	*Bulinus longiusculus* M. & H.	Sec. 28, Tp. 52, Rg. 21.
16-41	*Bulinus longiusculus* M. & H. *Vivipara* sp. undet *Sphaerium subellipticum* M. & H. *Helix* sp. undet	Sec. 31, Tp. 52, Rg. 20.
17-41	*Helix* sp. nov. *Helix* (*Patula?*) *obtusata* Whiteaves *Helix* (*Patula?*) *angulifera* Whiteaves	Sec. 8, Tp. 52, Rg. 20.
18-43	*Bulinus longiusculus* M. & H. *Vivipara leai* M. & H.?	Sec. 6, Tp. 52, Rg. 18.

FIELD NUMBER		LOCALITY
19-44	*Micropyrgus minutulus* M. & H.	Sec. 8, Tp. 52, Rg. 18.
	Helix (Patula?) angulifera Whiteaves	
	Physa canadensis Whiteaves	
	Vivipara leai M. & H	
	Helix (Patula?) obtusata Whiteaves	
	Valvata bicincta Whiteaves=*V. parvula* M. & H.	
	Sphaerium formosum M. & H.	
	Vivipara sp. nov.	
	Goniabasis sp. undet	
	Bulinus longiusculus M. & H.	
	Vivipara retusa M. & H.?	
	Helix (Patula?) sp. nov.	
	Valvata subumbilicata M. & H.=*V. filosa* Whiteaves	
	Lymnaea tenuicostata M. & H.	
20-47	*Physa canadensis* Whiteaves	Sec. 10, Tp. 51, Rg. 19.
21-47	*Unio priscus* M. & H.	Sec. 23, Tp. 49, Rg. 21.
	Goniabasis? sp. undet	
	Vivipara retusa M. & H.	
	Vivipara leai M. & H.	
	Valvata subumbilicata M. & H.	
	Sphaerium sp. undet	
	Micropyrgus minutulus M. & H.	

NOTES BY P. S. WARREN.*

"The fossils listed above were identified from material far from satisfactory for definite determinations. Identifications were possible in many cases only after the study of a great number of specimens which the size of the collections permitted. Several forms were too sparsely represented and too poorly preserved to admit of definite identification and were omitted from the lists.

"The fauna is typically of fresh-water origin. The various forms listed are characteristic of the uppermost Cretaceous and basal Eocene fresh-water beds of Alberta, and Montana. Of the fourteen forms which have been definitely identified nine were originally described from the Paskapoo or Fort Union beds, which are generally considered to be equivalent in age. Of these nine forms, one, *Sphaerium formosum*, has been listed from a lower horizon, viz.: Belly river and Judith river formations.

"Of the remaining five forms, two, *Unio priscus* and *Hydrobia subcylindracea*, were originally described from the Judith river and Belly river beds. *Unio priscus* is now known to occur in beds as high as the Paskapoo. The other three specimens, *Physa canadensis*, *Helix (Patula?) angulifera* and *Helix (Patula?) obtusata* were described from the St. Mary river formation. *Physa canadensis* has since been identified from the Belly river and Paskapoo formations.

"The preponderance of evidence, therefore, points to a Paskapoo or Fort Union age for this fauna as eleven of the fourteen forms listed occur in these formations. It is well to consider, however, that the fauna from the fresh-water Cretaceous beds in Alberta is

*Associate Professor of Geology, University of Alberta.

not well known. A careful study of the fauna of these beds may demonstrate that a considerable number of the Paskapoo species may extend to a lower horizon and that the beds from which these collections were made are older than the fauna at present would seem to indicate."

FOSSIL LEAVES

Field Number		Locality
2-3	*Taxodium dubium* (Sternb.) Heer Cone unidentifiable *Populus speciosa* Ward *Populus richardsoni* Heer Fruit unidentifiable	Sec. 3, Tp. 52, Rg. 24.
3-3	*Populus speciosa* Ward *Populus* sp. undet	Sec. 30, Tp. 52, Rg. 23.
4-8	*Equisetum* sp. undet *Populus* sp. undet	Sec. 35, Tp. 52, Rg. 23.
5-9	*Equisetum* sp. undet *Onoclea sensibilis fossilis*, Newberry *Taxodium dubium* (Sternb.) Heer *Viburnum newberryanum* Ward	Sec. 32, Tp. 53, Rg. 22.
6-10	*Equisetum* sp. undet	Sec. 24, Tp. 52, Rg. 22.
12-40	*Trapa? microphylla* Lesq.	Mouth of High Divide creek.
14-32	*Taxodium dubium* (Sternb.) Heer	Sec. 29, Tp. 52, Rg. 21.
17-41	*Taxodium dubium* (Sternb.) Heer	Sec. 36, Tp. 52, Rg. 21.
18-43	*Viburnum asperum*, Newberry *Viburnum newberryanum* Ward *Carpolithes*, sp. undet	Sec. 6, Tp. 52, Rg. 18.
22-47	*Onoclea sensibilis fossilis* Newberry *Taxodium dubium* (Sternb.) Heer *Glyptostrobus europaeus* (Brong.) Heer *Cornus*, sp. undet *Populus speciosa* Ward? *Platanus* sp. undet	
21-47	Chara "fruit"	Sec. 23, Tp. 49, Rg. 21.

Notes by P. S. Warren.

"This flora is undoubtedly Eocene in aspect and all the forms listed above with the exception of the Chara "fruits" are known to occur in the Paskapoo formation in Alberta. Most of the species, however, are known to occur in slightly lower horizons having been listed from the Lance formation and one, *Trapa? microphylla*, has been listed from the Belly river.[8] From our knowledge of the flora of the Cretaceous and Eocene this flora cannot be considered to be older than Lance. Our knowledge of the Edmonton flora is, as yet, meagre, but some species that are known seem to show Tertiary affinities. It is quite possible, therefore, that the beds containing this flora may be as old as the Edmonton formation."

Vertebrate remains occur at localities 9, 17, 19, 20 and 21, where they are mixed in with the invertebrates. They are fragmentary and appear to consist entirely of fish remains. These remains are quite abundant at localities 19 and 21, but are too fragmentary for identification. Two vertebrae from locality 19 belong to the genus *Pappichthys* Cope.

[8]U.S.G.S. Bull. No. 696.

Correlation.—Beds carrying fossils at localities 14, 15, 16, 17, 18, 19 and 20 all appear to lie within 200 feet of strata as shown in the columnar sections. These localities are also richest in species and in numbers of specimens with the possible exception of locality 21. These 200 feet of strata may later prove a good horizon in correlating to the east and south-east, but unfortunately no evidence of a similar horizon was found in the Saunders beds to the west. This may be due to the fact that the stratigraphical equivalent of these beds may be eroded from the areas to the west, or if the equivalent strata are present they may be barren of fossils. It is difficult to determine which strata in the thick Saunders series to the west are the equivalent of any of the fossil-bearing strata in this area.

In the area immediately west the Saunders formation was estimated[9] to be at least 12,000 feet thick and in two other foothill areas 11,000 and 13,000 feet. Coal seams were the only key horizons that could be used in tracing stratigraphical relations through the foothills. Such horizons served best when working parallel to the foothill structure, but failed when working transverse to the structure since the seams showed rapid lensing in an east-west direction and the coal was not present in the belts of Saunders beds nearest the front ranges.

The bottom of the massive sandstone beds exposed on Pembina river at Evansburg have been taken as the base[10] of the Paskapoo formation. The underlying rocks at this locality which carry coal seams are assigned to the Edmonton formation.[11] A seam 25 feet thick occurring on Saskatchewan river south-east of Evansburg is placed[12] in the Edmonton formation, although another seam 15 feet thick occurring 400 to 500 feet above it, is placed in the Paskapoo formation by Tyrrell.[13]

McEvoy[14], from surface evidence, believed that the massive sandstone exposed on the Pembina at Evansburg did not extend west to Edson, so that the beds to the west of Edson which dip to the north-east should be older than what has been called the Paskapoo in the area east of Edson. Consequently, all the beds in the area discussed in this report should be older than the beds so far assigned to the Paskapoo in the area to the east. McEvoy's map shows this, as well as all maps published subsequently by the Geological Survey of Canada. If palaeontological or palaeobotanical evidence in future shows the beds in this area to be definitely Paskapoo in age, then the Paskapoo formation would include beds lower than those exposed at Evansburg and the contact with the Edmonton formation would have to be extended eastwards from Evansburg.

It is the intention to continue our survey eastwards from Edson during the coming season, and it is hoped that data will be obtained which will warrant more definite conclusions regarding the age of the rocks in this and adjacent areas.

9Rept. No. 11, 1924, p. 47.
10McEvoy, J., G.S.C., Sum. Rept., 1898, Pt. D, p. 24.
11Dowling, D. B., Geol. Surv., Can., Mem. 53, 1914, p. 57.
12Dowling, D. B., Op. cit., p. 55.
13Quoted by Dowling, Op. cit., p. 54.
14Op. cit. See Map accompanying.

In this area the only beds that have been used to correlate with the area to the west are the coal seams which are worked at the Balkan and Bryan mines. These have been correlated[15] westwards to Coalspur and Mercoal. At Mercoal this coal is estimated to be between 6,000 and 7,000 feet above the base of the Saunders formation. The fresh-water formations in the foothills show a thinning to the east and possibly the coal at the Balkan and Bryan mines is much closer to the base of the Saunders formation than it is at Mercoal. Similarly, the beds above the coal, with an estimated thickness of 5,300 feet between Edson and the Balkan mine, may be represented by a much greater thickness of beds in areas to the west. This would permit much younger strata to occupy positions stratigraphically closer to the coal than beds of the same age would occupy in areas to the west.

Fossil locality 21 is significant in that it carries a Paskapoo fauna and has been estimated to be about 1,700 feet above the coal at Balkan mine. This coal has previously[16] been correlated with coal seams to the west which were thought to be in beds older than the Edmonton formation, and as yet no evidence is at hand which would definitely indicate their being younger than the age assigned to them. Fossil locality No. 21 is further significant in that the beds here are stratigraphically lower than the coal seams on McPherson creek. These seams which are of commercial thickness would lie in Paskapoo rocks, from conclusions based on fossil evidence alone. At Evansburg the Paskapoo and Edmonton formations are separated on lithological differences rather than on fossil evidence, the base of the Paskapoo being placed at the bottom of a thick massive sandstone which occurs here. Both the formations are of fresh-water deposition and consequently the beds are lenticular. Thus, it is difficult to determine the division between these formations in areas to the west of Evansburg since the lithological character of any particular stratum varies rapidly in a lateral direction.

Recent deposits.—The unconsolidated rocks in this area consist of boulders, gravel, sand and clay of glacial and fluviatile deposition. Most of the area is covered with a mantle of soil and unconsolidated material which has been formed by the erosion of the underlying rock. Gravel and silt deposits of comparatively recent deposition occur as flood plain deposits in the valleys of the major streams. These deposits are common along McLeod river above the mouth of Embarras river, especially in ranges 20 and 21 where McLeod river changes its course during flooding. Thick deposits of recent material occur along the valley of the Athabaska. These are especially noticeable in the vicinity of Bliss and Hinton stations and to the west beyond this area.[17] These terraces do not appear to be related very closely to the present stream channel, but were formed in the earlier stages of the development of Athabaska valley. It seems probable that during development of Athabaska valley there was considerable laking of this stream in the vicinity of Bliss and Hinton, and during this laking large quantities of sand

15Reports No. 9 and 11.
16Reports Nos. 9 and 11.
17Rept. No. 11, p. 49.

and gravel accumulated. These deposits were re-sorted as the river deepened its valley, and today remain as extensive river terraces. At Bliss and Hinton these terraces are made up chiefly of unconsolidated gravel, while to the east in sections 3 and 10, township 52, range 23, there are thick accumulations of sand. These sand deposits are well exposed along the railway grades and are about 200 feet above the present river level. The old river terraces do not appear to extend east of Pedley station in section 11, township 52, range 24. There are large river flats along the Athabaska from Dalehurst east to beyond the area on the map, but these are related to the present cycle of river erosion, and in most places are from 10 to 50 feet above the present level of the river. These are developing at the present time and do not appear to be related to the high terraces in the western part of the area which are all from 75 to 200 feet above the river level.

In addition to the recent deposits already mentioned there are deposits of white marl underlying several of the muskegs and small bodies of water. These are most prevalent in the eastern part of the area in the district between Hargwen and Edson. The cement plant at Marlboro made use of this marl in their earlier operations, but at present a process is followed in making the cement which does not utilize this marl.

The muskeg growth over a large part of the area is in places compacted into a form of peat, and in some places this plant material has been intermixed with the decomposed underlying rocks. The railway cut through the recent deposits at a point about a half-mile west of Marlboro station, exposes a series of silts which are well cross-bedded, and many of the lamellae in these silts are composed of coal fragments. This is thought to represent the remains of an eroded coal seam that belonged to higher strata than those at present underlying this part of the area.

Glacial boulders of different sizes occur at various places mixed in with other recent deposits. These are very noticeable along the spur line between Hargwen and the McLeod. A noticeable glacial boulder of large dimensions occurs in the Embarras valley in section 14, township 50, range 20. This boulder is over 15 feet high and has been brought from a locality to the west of this area.

The extensive gravel terraces at Bliss and Hinton stations have been used to a considerable extent for railway ballast. With the exception of the marls, the rest of the recent deposits do not appear to be of any economic importance.

CHAPTER IV.

ECONOMIC GEOLOGY.

Areas Partly Developed.—The presence of coal in commercial quantities in the southern part of this area forms the chief basis of industry. The chief object of investigation from the economic standpoint was to determine the relationship of this coal to that occurring in McPherson creek valley and to determine the most probable locality at which these seams might occur in the valley of Athabaska river. Coal is being mined at present by two companies, namely, the Balkan Coal Company and the Bryan Coal Company. The Balkan mine, situated in section 14, township 49, range 21, started operating in 1918, and the Bryan mine, situated in section 15, township 49, range 21, began operations in the summer of 1924.

The Balkan and the Bryan mines are both operating in the same coal seam. At these mines the seam and the associated strata have a dip of 35 to 38 degrees to the north-east and strike north 55 degrees west. Sections of the seams at these mines were given in report No. 11 and are repeated here for convenience to the readers.

SECTION AT THE BALKAN MINE.

	Ft.	*Ins.*	
Coal	2	5	No. 1 seam.
Clay and hard shale	0	1	
Coal	2	5	
Shale and sandstone, about	10	0	
Coal	3	7	No. 2 seam.
Clay and hard shale	0	8	
Coal	4	6	

SECTION AT THE BRYAN MINE

	Ft.	*Ins.*	
Coal	6	0	No. 1 seam.
Shale and sandstone	8	0	
Coal	5	3	No. 2 seam.
Clay and shale	0	11	
Coal	5	0	

The coal from these mines is classed as sub-bituminous. The following general analyses are given[18] for a district that includes these mines:—

	Typical.	Max.	Min.
Proximate Analyses:—			
Moisture ..... %	9.8	11.8	7.7
Ash ..... %	10.2	12.8	7.8
Volatile matter ..... %	35.4	37.2	33.6
Fixed carbon ..... %	44.6	47.5	42.5
Calorific value, gross B.T.U. per lb.	10,720	11,350	10,140
Moisture in air dried coal ..... %	6.7	7.4	6.0
Sulphur ..... %	.2	.4	.2
Fuel ratio	1.25	1.35	1.20

Non-coking.

The thickness of coal varies within the mines, but the above sections represent the average thickness. Practically all the mining is done in the lower part of the seam, which is called No. 2 seam, but at times some coal has been mined from the upper part, or No. 1 seam. Nos. 1 and 2 seams when considered together as one seam are correlated[19] with that mined at Mercoal to the west at mile 5 on the railway line to Mountain Park, and also with the seam mined at Foothills on the branch line to Lovett. This seam is locally known as the "*Val d'Or*". Its stratigraphical position with respect to the base of the Saunders formation has already been discussed in this report and from all the data thus far obtained the writer is of the opinion that it is an older seam than those mined in the Edmonton formation at Evansburg to the east of this area.

At Balkan mine a thick seam is exposed in the railway cut just west of the tipple. This seam is about 650 feet stratigraphically below the one that is being mined. It is correlated with the thick seam mined along the Alberta Coal Branch at Sterco (mile 47) and Coal Valley (mile 48) where it is known as the *Mynheer* seam. This seam is also present at Coalspur where prospecting showed it to be about 40 feet thick. It is not mined at Balkan and Bryan mines on account of its inferior quality due to clay partings and bands of dirty coal. Another seam about 8 feet thick with partings occur at the Balkan mine between the *Val d'Or* and the *Mynheer seams*.

The strata flatten out rapidly to the north-east from the Balkan and the Bryan mines, but the coal seams do not outcrop again at the surface to the east within this area. This statement seems necessary since many of those interested in coal properties in this

18"Analyses of Alberta Coal". Sci. & Ind. Res. Coun., Rept. No. 14, 1925, p. 33.
19Rept. No. 11, 1924, p. 55.

district have thought it possible for the coal to outcrop to the east as the land is lower and the beds flatten out rapidly in this direction.

Undeveloped Areas.—Various persons associated with the coal mining industry have been particularly interested in the probability of coal seams occurring in Athabaska valley and considerable time was spent in the field in attempting to solve this problem. Obviously this is an important problem, since the main line of the Canadian National Railway follows this valley and coal occurring here would be readily accessible to railway service. Some preliminary remarks on this question were made in Report No. 11, and new data obtained during 1925 permit the making of more definite statements.

The general structure at the Balkan mine, that is, beds dipping to the north-east, continues north-west across the area to the Athabaska valley although the dip angles are smaller in McLeod and Athabaska valleys than at the corresponding strike positions in Embarras valley. The average strike of the strata is parallel to the fault line shown along the south-west boundary of the map.

The seam at Balkan and Bryan mines continues regularly to the north-west of the Bryan mine for two or three miles, as shown by prospecting. A projection of this strike direction to McLeod river would indicate that the seams should cross McLeod river at a point near the mouth of Quigley creek, if the angle of dip remains the same throughout this distance.

The exposures on McLeod river between McPherson and High Divide creeks all show a dip of 15 degrees or less to the north-east. This would tend to place the coal seams further west than the mouth of Quigley creek. Furthermore, the strike of the formation is more to the west or north on the McLeod than on the Embarras. This also would tend to place the coal seams still further west on McLeod river. Unfortunately there are very few exposures of rock along the McLeod between McPherson and High Divide creeks. Coal fragments are common in Quigley creek, but these may be derived from a thin seam. Good exposures of rock occur along the McLeod between the mouth of Gregg river and High Divide creek. These strata carry several thin coal seams. Some have a thickness of about three feet, but on the average they are less than two feet thick. These rocks are very similar lithologically to those exposed on Embarras river between Balkan mine and Robb station where the strata carry several thin seams, but the lenticular character of the sediments and the distance between these exposures will not permit a definite correlation.

A coal seam is exposed in Athabaska valley on Happy creek at the old Grand Trunk bridge in section 15, township 51, range 25. The occurrence of this has been known ever since the Grand Trunk Pacific railway was built through here. It has been prospected several times, and prospecting in 1924 showed a seam less than 5 feet thick with several clay partings. The position of this seam is approximately in strike alignment with those at Balkan and Bryan mines, but the distance between them is too great to permit a

correlation. This seam, however, represents a possible coal horizon and it is very probable that commercial seams occur in this locality. The strata at Happy creek have an average dip of 15 degrees to the north-east, and it would not be necessary to drill very deep to prove whether commercial seams are present or absent at this locality.

The prospecting work carried out in McPherson creek valley during the spring of 1925 by Mr. Thomas Box and Mr. J. Gallo has given the most important data regarding the possible occurrence of commercial seams in Athabaska valley. The occurrence of this coal on McPherson creek was mentioned in Report No. 11, but when that report was written the coal had not been prospected, and as it occurs in unsurveyed territory only general remarks were made on it. During 1926, our party carried a transit-stadia up McLeod river, south from the surveyed territory, and tied in the prospects in McPherson creek valley. The position of the prospects are shown on the map.

Unfortunately the prospect pits were filled with water when we visited them and we were unable to measure the seams. Prospects numbers 1 and 2 are situated on a small creek tributary to McPherson creek about two miles from McLeod river. Number 1 which is nearest McPherson creek showed a 14-foot seam of coal with a clay parting in the middle of it. Six feet of coal with several clay partings lie above the 14-foot seam. A seam over eleven feet thick with a thin parting was exposed in prospect number 2. Here also 10 feet of coal with many clay partings overlie the seam. The strata at these prospects dip from 10 to 12 degrees to the north-east and the two prospects are believed to be in different seams. The calculated stratigraphical distance between these seams is 250 to 300 feet. A massive sandstone over 20 feet thick is the only part of the strata between these seams that is exposed, so that there may be other coal seams between these shown in the prospect pits.

Prospect number 3 is situated about two and a half miles to the north-west of number 1. This prospect showed a seam similar to that exposed in number 1, and it is thought that prospects numbers 1 and 3 are in the same seam. This would mean that the coal and associated strata have a strike of north 70 degrees west in this district. The exposure of rock on the divide at the headwaters of McPherson creek have a strike direction the same as these coal prospects indicate.

A fourth prospect has been made to the north-east of number 3, and although it was not carried deep enough to get the thickness of the seam its position with respect to number 3 is the same as the position of number 2 is with respect to number 1, thus indicating a second seam above and parallel to the one exposed by prospects 1 and 3.

The thicknesses of the coal seams stated above were given verbally by the prospectors in the field, and may be only approximately correct. There was, however, sufficient coal exposed at these prospects when we visited them to warrant the statement that there are undoubtedly seams of commercial thickness in this district.

These seams and associated sediments extend to the south-east, and prospecting along McLeod river would undoubtedly reveal the presence of coal seams. These seams should cross McLeod river near the mouth of McPherson creek, and to the west of the exposures of rock which occur about one half-mile below the mouth of the creek. It would not be difficult to locate them on the north side of the river at this locality, since the valley side is steep and the mantle of recent deposits is thin. On the south side of the stream the seams would be eroded and covered by a broad river flat. These seams should continue to the south-east beyond McLeod river. Coal wash on White creek about two miles from its mouth indicates the presence of coal, but this may come from a very thin seam.

Further to the south-east on Embarras river there is a possibility of the occurrence of these McPherson creek seams. From structural data obtained it appears that if they occur in this valley they should be situated west of Embarras station. A seam about two feet thick occurs near the surface on Embarras river in legal subdivision 3, section 17, township 50, range 20. Some drilling has been done on the river flat in legal subdivision 2, section 17, township 50, range 20. This was done several years ago, and the writer has not been able to obtain the drill records from this well. When we visited this well, water and combustible gas were flowing from the top of the casing. This well was presumably drilled in search for coal.

Prospectors and mining men acquainted with the area have been inclined to correlate the coal on McPherson creek with that at the Balkan and Bryan mines. This correlation at first seemed possible to the writer, but after examining the area in more detail, the data obtained indicated that the seams at the two localities are not the same, and that those on McPherson creek occupy a higher stratigraphical position as is shown in the columnar sections on Plate I. Drilling is the most satisfactory method to prove the presence or absence of the McPherson creek coal in the valley of Embarras river since rock exposurse are few and most of the district is covered with muskeg.

The more important question is the probability of the McPherson creek coal extending into Athabaska valley. The short distance between the Athabaska and the prospects on McPherson creek make it almost certain that these seams do occur in Athabaska valley. The structure is regular as shown by the outcrops of harder strata which occur in the intervening area.

Making allowances for differences in elevation, the projection to the north-west of the strike of the coal seams in McPherson creek valley indicates that they should cross the Canadian National Railway just east of Bliss and about in the centre of section 30, township 51, range 24. The line joining this point with prospects numbers 1 and 3 on McPherson creek would be the strike line. The north-east dip of the strata would place the outcrop about a half-mile to the west of this line on the higher points at the divide between McPherson creek and Athabaska river.

In view of the fact that coal has been mined for several years in the southern part of this area and in areas to the south and

west, and that a lot of prospecting has been done in this general coal producing area, it seems strange that no conclusive evidence of the presence of valuable seams in Athabaska valley has been disclosed. The occurrence of a thick mantle of river terrace deposits in this stream valley was suggested as a reason for this in report No. 11. It now appears more evident than ever that this is the main reason why coal has not been found there, since the evidence of its presence is much stronger as a result of the findings on McPherson creek in 1925.

It is the opinion of the writer that the best properties to investigate are sections 20, 21, 22, 27, 28 and 29, of township 51, range 24. It would be advisable to keep to the south of the Grand Trunk grade since the river deposits are thick to the north of it. Some of these sections cited are not surveyed, but each one of them adjoins a section that is surveyed, and it would not be difficult to determine the location of those mentioned which are not surveyed.

The locations given above are believed to be the best from the interpretation of the data that is available. This, however, does not exclude possibilities in places to the east or west of the sections mentioned. It does not seem advisable to suggest prospecting any further to the north-east than the north boundary of township 51. All of the area between Bliss and Hinton stations has possibilities, and none of it can be excluded until finally tested by prospecting or drilling.

Different methods could be followed in attempting to locate the seams in Athabaska valley. One method would be to extend the prospecting north-west from the exposed seams on McPherson creek, across the divide and down into the valley of the Athabaska. This would require a lot of work and considerable difficulty would be met with in the muskeg covered areas at the headwaters of McPherson creek.

It seems possible that time and labour would be saved by starting to prospect at the divide where the covering of recent deposits is thinnest. This country is unsurveyed and exact locations cannot be given. The writer would suggest that prospectors follow the Cache Percotte trail from Bliss south-west to the divide into McPherson creek. This trail branches off from the road about a mile east of Bliss station and passes under the Grand Trunk bridge in the south-east quarter of section 30, township 51, range 24. At the divide, prospecting should be extended to the north-east along the top of the divide. If the seams can be located on the divide it would be comparatively easy to trace them to the north-west into the valley of the Athabaska.

Drilling alone in Athabaska valley would prove this property but prospecting on the higher parts may help considerably in choosing the best drilling sites.

Should coal seams be found in Athabaska valley, they are immediately accessible by the main line of the Canadian National Railway. Those on McPherson creek are at present some distance from a railway. The spur line from Hargwen to the sawmill is about nine miles long. This road has not been in operation for

over a year, and was not constructed for heavy railway traffic. It could, however, be easily ballasted and repaired for such purposes. A wagon road extends up McLeod river from the sawmill to the mouth of McPherson creek and a trail from here up McPherson creek to the prospects. In order to connect up this coal district by rail the spur line would have to be extended at least six miles to the south-west from the sawmill. Those interested in the prospects have suggested a railway extension almost directly from the sawmill to the prospects which would not follow McLeod river. This would have steeper grades than one built along the river. In building a road along the river a small amount of rock cutting would be necessary at a point about a half-mile below the mouth of McPherson creek unless two bridges were made across McLeod river.

If the seams were opened up at the river there would not be over 300 feet of mining above the level of the river, since the elevations of the surrounding district are relatively low. Similar conditions prevail to the north-west at the prospects, but the surface rises to the north-west in a direction parallel to the strike of the strata.

Those interested in the McPherson creek prospects were of the opinion that the coal could probably be mined by stripping methods. The possibilities of adopting such a method in this district would have to be determined by an engineer who is acquainted with stripping methods and certain facts regarding the occurrence of the coal would have to be taken into consideration. The seams are not flat-lying, but dip at least 10 degrees to the north-east. They dip into the side of the valley, thus the elevation of the land and the amount of cover on the coal increases in the same direction as the dip. The slope of the valley side is gentle at prospects numbers 1 and 2, but it increases to the north-west and is much steeper at prospects numbers 3 and 4. The seams are only very gently folded as shown by the dip, and are not thickened by deformation as are the seams at Sterco and Coal Valley along the Alberta Coal Branch where considerable coal has been mined by the stripping method.

The above mentioned districts appear to be the only parts of the area that have future possibilities of producing coal. Since much of the entire area is covered with muskeg there may be other districts that have good possibilities, but these will only be disclosed by extensive prospecting. The entire series of strata underlying the area is of the coal formation type and seams may occur at any horizon within it.

There are thin seams under two feet thick at several places in the area. Some of these thin seams have been prospected, but were not promising. The occurrence of a thin seam on McLeod river south-east of Edson is worthy of note. It occurs in section 11, township 53, range 17, and is of interest in that it occurs in the stratigraphically highest rocks in the area.

CHAPTER V [APPENDIX].

NOTES ON THE STRUCTURE ALONG THE ALBERTA COAL BRANCH

In August, 1925, the writer visited the operating mines along the Alberta Coal Branch, between Coalspur and Lovett. Recent mining and development here has afforded new data on the structure of the coal seams and associated strata.

This area was included in the area reported on by the writer in 1924 (Report No. 9). Only general features of the structure along the Coal Branch were mentioned in that report, which dealt with a much larger area. A topographical map with a 50-foot contour interval or preferably less is necessary before the geology of this district can be shown in detail, and as yet such a map has not been made. The following reports have dealt in part with this area:—

Dowling, D. B., Geol. Surv., Can., Summ. Rept., 1909, p. 147.
Stewart, J. S., Geol. Surv., Can., Summ. Rept. 1916, p. 100.
Allan, J. A., Sec. Ann. Rept., Min. Res., Alta., 1920, p. 50.
Dowling, D. B., Geol. Surv., Can., Summ. Rept., 1922, Pt. B, p. 102.
Allan, J. A., and Rutherford, R. L., Sci. & Ind. Res. Coun., Alta., Rept. No. 9, 1924.

The earliest mining operations in this district were carried on at Lovett, and later several mines were opened near Coalspur. During the last three years, however, most of the mining has been done at points between Coalspur and Lovett where thick bodies of coal occur near the surface which can be mined by open pit methods. The location and geographical relations of these mines are shown on the accompanying map. Plate II.

From Coalspur to Lovett the direction of the railway is in general parallel to the structure of the underlying strata. The beds along this route form the south-west limb of a broken anticline. The axis of this structure lies north-east of the railway. The position of the axis is not well defined, and some have held the view that the anticline is not faulted. Definite evidence of a break in this anticline can only be obtained by examining the structure over a large area.

The following is a list of the mines now operating in the area between Coalspur and Lovett:—

Name and Location of Mine.	*Seam Mined, and Method.*
Sterling Collieries, at Sterco, Mile 47	*Mynheer*, open pit.
Coal Valley Mining Co., at Coal Valley, Mile 48	*Mynheer*, open pit.
Foothills Collieries, at Foothills, Mile 50	*Val d'Or*, slope entry.
Reco Hard Coal Co. (Mine No. 1014), Mile 52½	*Mynheer*, open pit and slope entry.
Reco Hard Coal Co. (Mine No. 896), Mile 53½	*Mynheer*, open pit and level entry.
Superior Collieries, Mile 54	*Mynheer*, level entry.

From this is to be seen that at present most of the mining is being done in the *Mynheer seam* and within a small part of the area between Coalspur and Lovett.

The Sterling Collieries at Sterco (Mile 47) are situated almost on the drainage divide between a branch of Embarras river and a branch of the Pembina. These two branch streams flow in a direction that is parallel to the strike of the underlying strata, and the divide between these streams is near to the centre of the anticlinal structure. At Sterco the coal seams and associated strata, being near to the top and centre of the structure, are much more broken and folded than the corresponding beds at Coalspur or Lovett. Coalspur is almost 800 feet lower than Sterco, so that the coal exposed at Coalspur is considerably more than 800 feet further down the dip of the strata than the same beds exposed at Sterco.

Broken and irregular structure continues south-east from Sterco for about 4 miles, but at Lovett, which is over 200 feet lower than Sterco the beds are less deformed. Still further to the south-east on Brazeau river the strata corresponding to those at Lovett are only gently folded and the structure is similar to that at Coalspur. This position on the Brazeau is at about the same elevation as Coalspur, so that the exposures compared are about equal distances down the dip from the centre of the anticlinal structure.

It does appear, then, that a possible reason for the broken and closely folded beds exposed in the vicinity of Sterco is its position with respect to the centre of the anticlinal structure.

The stratigraphical succession at Lovett as shown by drilling is given by Stewart[20] and by Allan.[21] This section in condensed form showing the relative stratigraphical positions of the coal seams is as follows:—

Sediments		51	feet
Coal (Silkstone seam)		14	"
Sediments		19	"
Coal		1	"
Sediments		2	"
Coal		4	"
Sediments		146	"
Coal		1	"
Sediments		22.5	"
Coal	Mynheer seam	6.5	"
Shale		1	"
Coal		6.5	"
Sediments		114	"

The earliest mining in this district was carried on at Lovett by the Pacific Pass Collieries (a subsidiary of the North American Collieries). This company operated in the *Silkstone* and *Mynheer* seams at Lovett where the strata dip about 12 degrees to the south-west. The mine was opened in 1910 and closed by the Company in 1920, although mining was continued in some of the entries until 1921.

The coal mines which were developed at Coalspur and vicinity worked in a seam that is stratigraphically above the *Silkstone*. This

20 and 21opp. cit.

PLATE 2.

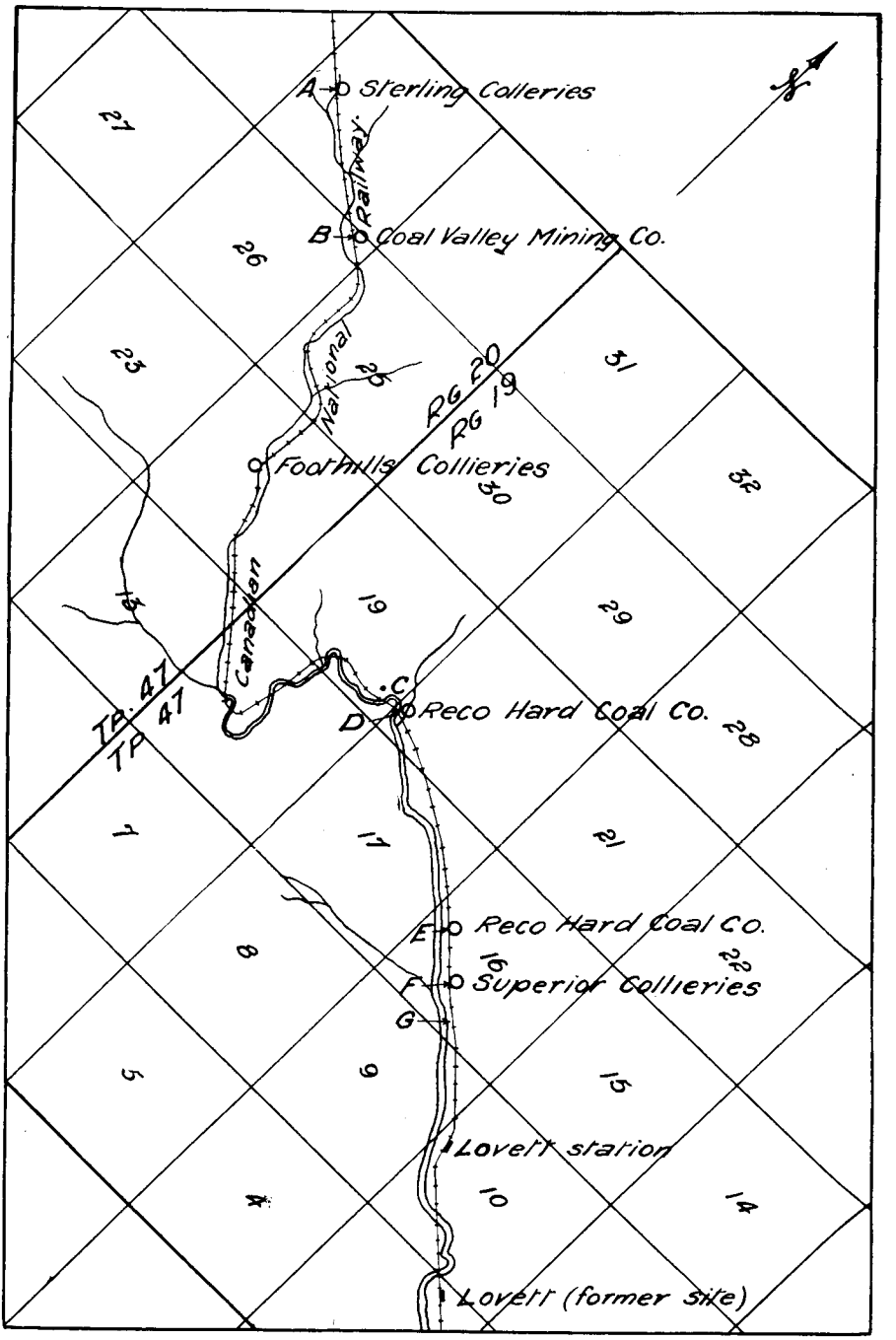
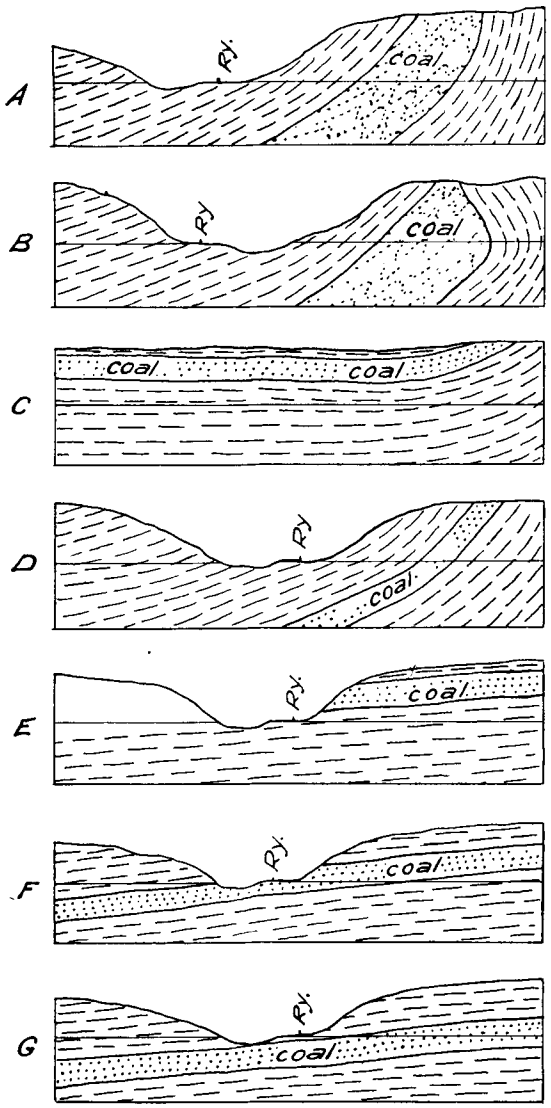

A Sterling Collieries
Railway
B Coal Valley Mining Co.
National
Foothills Collieries
Canadian
C
D Reco Hard Coal Co.
E Reco Hard Coal Co.
F Superior Collieries
G
Lovett station
Lovett (former site)
TP. 47
TP 47
RG 20
RG 19
21
26
23
25
31
30
32
19
29
28
1
11
21
8
16
22
5
9
15
4
10
14

PLATE 3.

GENERALIZED SECTIONS SHOWING THE STRUCTURE OF THE MYNHEER SEAM.



is known as the *Val d'Or* seam and is correlated with that mined at the Balkan and Bryan mines to the east of Coalspur and at Mercoal on the Branch to Mountain Park. At present the Foothills Collieries at Mile 50 is the only company that is mining the *Val d'Or* seam in the area beween Coalspur and Lovett. At Lovett this seam lies about 200 feet stratigraphically above the *Silkstone*. The *Val d'Or* seam is composed of two parts: the upper part is about 6 feet thick and is known as No. 1 seam; the lower part is about 10 feet thick and is known as No. 2 seam. No. 1 and No. 2 are separated by about 8 feet of sediments and thin coal bands. Most of the mining has been done in the No. 2 seam.

The local structure at Sterco (Plate III,A) and at Coal Valley (Plate III,B) are different in some respects, but alike in that the *Mynheer* seam has been appreciably thickened by repetition of beds due to deformation. This thickening of the coal is near the surface, and when the mantle of recent deposits is removed the coal is mined by open pit methods. There appears to have been a greater thickening of the coal at Sterco than at Coal Valley. It is not possible to determine the true thickness of the *Mynheer* seam at these mines.

The *Mynheer* seam may be thickened by folding at points north-west of the Sterling Collieries' properties in the direction of Coalspur, but in this direction the elevation of the surface becomes lower, the distance of the outcrop of the coal seam from the centre of the anticlinal structure increases and consequently the *Mynheer* seam is not so likely to be thickened to the same extent as it is at Sterco and Coal Valley, which are near the structural axis.

At Coal Valley the hanging walls on the west and east sides of the open pit appear as limbs of an eroded anticline with coal occupying the centre of the structure (Plate III,B). The coal adjacent to the west hanging wall is different from that adjacent to the east hanging wall. On the west side there is from 5 to 10 feet of clean coal adjacent to the hanging wall, whereas on the east side there are several clay bands as much as one foot thick in the first 10 feet of coal beneath the hanging wall. This appears to indicate that these two hanging walls are not the same beds stratigraphically. It is the opinion of the writer that the hanging wall on the east side of the open pit is in reality the footwall of the *Mynheer* seam, and would occur stratigraphically below the coal in places where the beds are less deformed.

The Sterco-Coal Valley structure extends for only a short distance to the south-east. There is a marked irregularity in the local structure as shown by exposures along Little Pembina river and the railway line in sections 18 and 19, township 47, range 19. In section 18 the stream makes a sharp turn to the north, and in section 19 turns south-east again to its general direction.

The *Silkstone* seam which ~~is~~ was mined at ~~Foothills~~ Lovett is exposed near the railway in legal subdivision 11, section 18. The seam and beds to the west dip to the south-west approximately 25 degrees in regular succession. The beds to the north-east of this outcrop, however, are much more broken and folded than those to the south-west, and no general structure can be assigned to them.

The *Mynheer* seam outcrops in the south-east quarter of section 19 where it is mined by the Reco Hard Coal Co. (formerly Blackstone Coal Co.). The structure from this point to Lovett is more regular, although at several places some minor folds and faults occur. The development at this Reco mine shows the local structure to be a synclinal basin. The axis of the basin pitches to the south-east and the *Mynheer* seam outcrops a short distance to the north-west of the railway track and river, in the south-east quarter of section 19. Little Pembina river in section 19 cuts across this basin a short distance south of the surface outcrop of the *Mynheer* seam. The stream valley has eroded through almost flat-lying beds on the west side of the basin and steep dipping beds of the east limb. The attitude of the coal seam at the north end of the basin is shown in Plate III,C, and the structure on the east side of the basin at a point south of that illustrated by Plate III,C, is shown by III,D.

Open pit methods have been used on the northern end of this basin. Slope entries are being driven from the open pit on the west side of the basin down towards the centre of the basin where the cover is too thick for open pit methods. The direction of these entries and the dip of the strata reveal the basin-line structure at this mine.

The same company have a second mine about a mile and a-half to the south-east towards Lovett. At this mine the *Mynheer* seam and the associated strata dip about 7 degrees to the south-west, and mining has been done here both by open pit methods and by level entries. The strata have not been as much deformed here as they have been at the mine in section 19. The footwall of the coal seam is approximately at the track level. Plate III,E illustrates the structure at this mine.

Vitaly-Dino & Company's property adjoins that of the Reco mine in section 16. This is known as the Superior mine, and was earlier known as the Brookdale mine. At this locality the footwall of the *Mynheer* seam is below the track level, and the strata dip gently to the south-west as shown in Plate III,F. About a quarter of a mile to the south-east of this mine the top of *Mynheer* seam is at the level of Little Pembina river.

The *Mynheer* seam is in places over 25 feet thick including the partings, but all of this thickness cannot be mined as coal. In places where entries are driven the total thickness mined is about 12 feet. The development at the Reco mines and at the Superior mine exposes the *Mynheer* seam. The total thickness of the seam can be obtained at these mines, but not at Sterco or Coal Valley.

INDEX

A

B

C

T

V

W

Y

LIST OF PUBLICATIONS

OF

THE SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA.

ANNUAL REPORTS OF COUNCIL

No. 3 (for the calendar year 1920); pp. 36. **Price 5 cents.**
No. 5 (for the calendar year 1921); pp. 86. **Price 35 cents.**
No. 8 (for the calendar year 1922); pp. 64. **Price 35 cents.**
No. 10 (for the calendar year 1923) with 4-color map of Alberta coal areas; pp. 76. **Price 50 cents.** Map No. 6 only, **15 cents.**
No. 12 (for the calendar year 1924); pp. 66. **Price 35 cents.**
No. 16 (1925); pp. 65. Reviews the work done during 1925 under the auspices of the Research Council. This includes a chemical survey of Alberta coals, their use in domestic furnaces and for residence heating; geological investigations of the Foothills region and the Blackstone Gap and the Bighorn Basin, a discussion of the available coal supply of Alberta, and a geological map of Alberta; bituminous sand separation plant operations for 1924-1925 and the use of separated bitumen and Wainwright crude oil for road surfacing; a continuation of the study of Alberta trees for use as mine timber. **Price 35 cents.**

REPORTS—FUELS

No. 10A (1923); COMBUSTION OF COAL FOR THE GENERATION OF POWER, by C. A. Robb, Professor of Mechanical Engineering, University of Alberta. Multigraphed copies only. **Price 50 cents.**
No. 14 (1925); pp. 64. ANALYSES OF ALBERTA COALS, with 18 maps and 2 charts. By E. Stansfield, R. T. Hollies, and W. P. Campbell. **Price 25 cents.**

REPORTS—GEOLOGY

By Dr. J. A. Allan, Professor of Geology, University of Alberta.

No. 1 (1919); pp. 104.—A summary of information collected with regard to the mineral resources of Alberta. **Price 10 cents.**

No. 2 (1920); pp. 138+14. Supplements the information contained in Report No. 1. **Price 25 cents.**

No. 4 (1921); GEOLOGY OF THE DRUMHELLER COAL FIELD, ALBERTA; pp. 72, and 6-color map (Serial No. 1). **Price $1.00.**

No. 6 (1922, Part I); GEOLOGY OF THE SAUNDERS CREEK AND NORDEGG COAL BASINS, ALBERTA, by J. A. Allan and R. L. Rutherford; pp. 76, and 2-color map (Serial No. 2). **(Out of print.)**

No. 7 (1922, Part II); AN OCCURRENCE OF IRON ON THE NORTH SHORE OF LAKE ATHABASKA, by J. A. Allan and A. E. Cameron; pp. 40; two maps (Serial Nos. 3 and 4). **Price 25 cents.**

No. 9 (1923); GEOLOGY ALONG BLACKSTONE, BRAZEAU AND PEMBINA RIVERS IN THE FOOTHILLS BELT, ALBERTA, by J. A. Allan and R. L. Rutherford; pp. 48, and 6-color map (Serial No. 5). Continuation of the field work in the area described in Report No. 6. **Price 75 cents.**

No. 11 (1924); GEOLOGY OF THE FOOTHILLS BELT BETWEEN McLEOD AND ATHABASKA RIVERS, ALBERTA, by R. L. Rutherford; pp. 61, and 8-color map (Serial No. 7). One inch to two miles. Continuation of the area described in Report No. 9. **Price 75 cents.**

No. 13 (in preparation); GEOLOGY OF RED DEER AND ROSEBUD SHEETS, by J. A. Allan and J. O. G. Sanderson. Two geological maps in 8 colours. Scale, one inch to three miles. Serial No. 8 Red Deer Sheet and No. 9 Rosebud Sheet. Five structure sections.

No. 15. GEOLOGY OF THE AREA BETWEEN ATHABASKA AND EMBARRAS RIVERS, ALBERTA, by R. L. Rutherford; pp. 29 and 3-color map (Serial No. 11). One inch to two miles. Eastward extension of field survey described in Report No. 11. **Price 50 cents.**

MAP NO. 11

Magnetic Declination N 27° to 28° E

SYMBOLS

- Fault
- Flexure
- Fossil Locality
- Dip and Strike
- Coal prospect
- Surveyed line
- Unsurveyed line
- Trail
- Wagon Road
- Railway grade used as a Wagon road
- Contour interval 100 ft.
- Rock outcrop

Sources of Information

Geology by R.L. Rutherford 1925.
Topography sketched by R.L. Rutherford 1925.

Base map compiled from surveys by Topographical Survey of Canada. Railway surveys. River traverses in unsurveyed areas by R.L. Rutherford 1925.

To accompany Report Number 15, 1926.

KEY MAP

Scale in miles.

Scect 14. 52 — 19

Scientific and Industrial Research Council of Alberta

GEOLOGICAL SURVEY DIVISION

J. A. ALLAN, GEOLOGIST

GEOLOGICAL MAP

OF THE AREA BETWEEN

Athabaska and Embarras Rivers

ALBERTA

SCALE 1 INCH TO 2 MILES

MILES

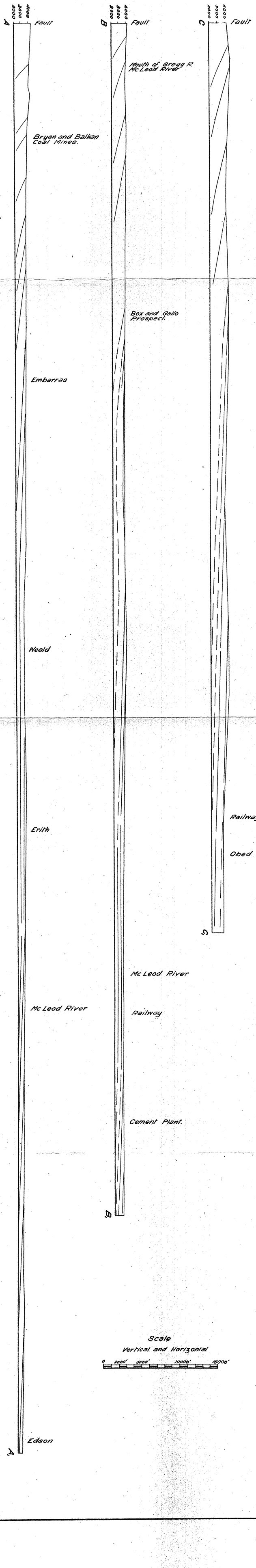
1925

TO ACCOMPANY REPORT NO. 15, 1926.

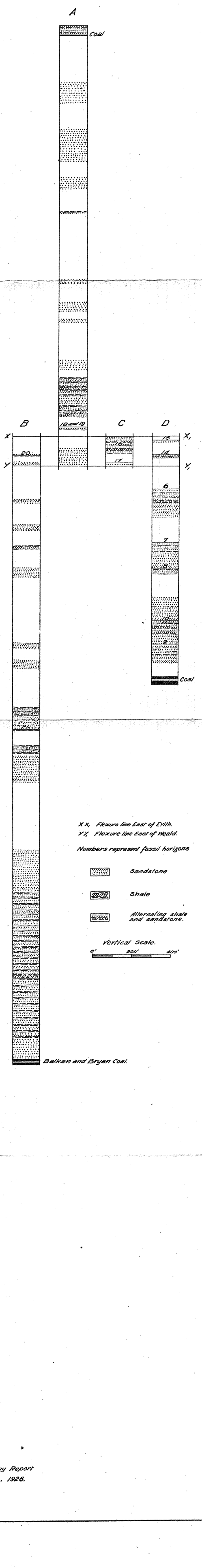
PLATE NO. 1.

SECTIONS

STRUCTURE



COLUMNAR



Scale

Vertical and Horizontal

0 2000' 5000' 10000' 15000'

To accompany Report
Number 15. 1926.

Base Map compiled from surveys by:
Dominion Forestry Branch.
Topographical Survey of Canada.
Topographical Division, Geological Survey, Cadomin Sheet.
Topography outside of Cadomin Sheet sketched by R. L. Rutherford, 1924.

Scientific and Industrial Research Council of Alberta

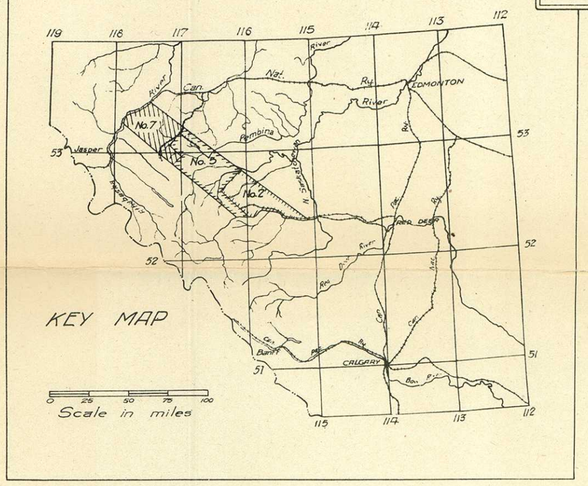
HONOURABLE HERBERT GREENFIELD, CHAIRMAN

Geological Division

J. A. ALLAN, GEOLOGIST

GEOLOGY by R. L. Rutherford, 1924
To accompany Report No. 11, 1925.

MAP NO. 7



SYMBOLS

- Geological boundary observed
- Geological boundary assumed
- Fault observed
- Fault assumed
- Contours interval 100'
- Bighorn sandstone
- Kootenay conglomerate
- Trails
- Waggon road
- Cabin forestry branch
- Cabin parks branch
- Mine Entry
- Coal prospect
- Dip and strike
- Flat lying beds
- Overturned beds
- Surveyed line
- Unsurveyed line

Magnetic declination approximately 28°

LEGEND

Quaternary	RECENT
Upper Cretaceous	SAUNDERS
	COLORADO
Lower Cretaceous	KOOTENAY
Jurassic	FERNIE
Paleozoic and Triassic	UNDIVIDED

GEOLOGICAL MAP

BETWEEN

McLEOD & ATHABASKA RIVERS

FOOTHILLS BELT, ALBERTA

Scale 1:126,720

1 inch to 2 miles

1925