Scientific and Industrial Research Council of Alberta *Report No. 4*

THIRD ANNUAL REPORT

ON THE

MINERAL RESOURCES OF ALBERTA, 1921

GEOLOGY OF DRUMHELLER COAL FIELD, ALBERTA

BY

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LIST OF PUBLICATIONS

Report No. 1

FIRST ANNUAL REPORT ON THE MINERAL RESOURCES OF ALBERTA (1919). pp. 104.

By Dr. J. A. Allan, Professor of Geology at the University of Alberta. This report contains a summary of the geological, economical and statistical information so far collected with regard to the mineral resources of Alberta, classified under the following headings:—

Bitumen,	Gypsum,	Petroleum,
Building Stone,	Iron,	Phosphate,
Clay,	Lead,	Potash,
Coal,	Mineral Springs,	Salt,
Copper,	Natural Gas,	Talc,
Gold,	Nickel,	Zinc.

Report No. 2

SECOND ANNUAL REPORT ON THE MINERAL RESOURCES OF ALBERTA (1920). pp. 138+14.

Dr. J. A. Allan supplements the information contained in the First Annual Report on the Mineral Resources of Alberta, and deals with the following:

Bituminous Sands,	Mica,
Building Stone,	Petroleum,
Clay and Clay Products,	Salt,
Coal,	Sodium Sulphate,
Iron	Talc.

Report No. 3

FIRST ANNUAL REPORT OF THE ADVISORY COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH OF ALBERTA. (1920). pp. 36.

Includes: (a) A report by Prof. N. C. Pitcher on some aspects of the coal situation in Alberta, to which are attached results of some screening and boiler tests made on Alberta coals at the University of Alberta; (b) Results of analyses by Mr. J. A. Kelso, Provincial Analyst, on coals collected in the Lethbridge and Crow's Nest Pass areas; (c) Report by Dr. J. A. Allan on a salt well drilled by the Alberta Government at Fort McMurray, and its carefully preserved core; and (d) Report by Dr. K. A. Clark on the problems involved in the improvement of Alberta highways, with a short note on the "Tar Sands".

Report No. 4

THIRD ANNUAL REPORT ON THE MINERAL RESOURCES OF ALBERTA (1921): GEOLOGY OF DRUMHELLER COAL FIELD, ALBERTA. By Dr. J. A. Allan. pp. 72 and map. (Price $1.00).

This report deals with the geology of the coal measures, and the stratigraphic position, extent and variation of the coal seams that are exposed in the Drumheller district, a district which includes an area from Kneehills creek to the Rosebud river. The report is accompanied by a geological map showing the outcrops of all the coal seams, by profile sections showing the position of the coal seams, by stratigraphic sections showing the relationship of the coal seams to the interbedded formations, and also by a plate which gives the cross section of the coal seams exposed in each of the mines in operation in the district.

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Geology of Drumheller Coal Field Alberta, Canada

BY

JOHN A. ALLAN

CHAPTER I

INTRODUCTION

The third annual report on the mineral resources of Alberta deals specifically with the geology of the coal deposits in one of the several coal basins in Alberta. The first report for 1919 includes a summary of what has been previously written on various minerals, mineral products and allied resources. A bibliography is given after each of the various resources mentioned, so that anyone seeking information on the mineral resources of Alberta may use this report as a guide to earlier published information. The second report for 1920, includes additional information and a discussion of certain resources, especially salt (sodium chloride), iron, petroleum, bituminous sand and coal.

Early in 1921, the Scientific and Industrial Research Council of Alberta, under which this geological report is published, decided that detailed geological investigation should be commenced on certain coal basins within this province, as coal is the basic mining industry in Alberta. The Drumheller district was chosen because it was central, in the settled portion of the province, and because this district is the most important and largest mining centre of domestic coal in the province.

In the following pages the physiography is described very briefly, but the general geology and the character and variation of the various coal beds are discussed and described with fuller detail. The outcrops of the coal beds have been mapped and all the seams correlated, and other data collected are included in this report.

Location of the Field.—The district dealt with in this report has been called the Drumheller coal field, as the mining town of Drumheller lies centrally in the area mapped. This district lies along Red Deer river between the mouth of Kneehills creek and Rosebud river, within townships 28 and 29 in ranges 19 and 20 west of the fourth meridian. This area is situated 85 miles east northeast from Calgary and 185 miles south from Edmonton (see key map inset with geological map in pocket). As the geological formations are exposed only along the sides of the valleys, the area described is rectangular in shape and covers approximately 75 square miles, being about 15 miles long and 5 miles wide.

Field Work and Acknowledgments.—Besides supervising the field work in the Drumheller district the writer examined mineral deposits in a number of localities throughout Alberta, including deposits of clay and shale in the Lethbridge, Medicine Hat and Redcliff districts, and a geological section was examined along the Peace between the town of Peace River and Hudson Hope. The results of this geological work appear in the second annual report of the Scientific and Industrial Research Council of Alberta and are not included in this report.

The field work on which this report is based was carried out in three and a half months in 1921, between the middle of May and the first of September. The field study was extended beyond the limits of the accompanying map for the purpose of correlation. In a southeasterly direction down the Red Deer valley beyond the eastern limit of the map, the coal seams and the associated sedimentary beds were mapped on the left side of the valley for a distance of about five miles to the mouth of Willow creek, where the underlying marine shales of the Bearpaw formation are exposed. Correlation observations were made beyond Willow creek to the Murray coal prospect in section 28, township 27, range 18. On the right side of the valley observations were made on the coal prospects opened up in East coulee, a short tributary entering the Red Deer from the southwest in section 28, township 27, range 18. In Rosebud valley the various coal seams were mapped with less detail, beyond the limit of the map as far as Benyon station in section 29, township 27, range 20, and general field observations were made along the Canadian National railway westward from Benyon to the prairie level. Along the valley of Kneehills creek at the northwest end of the map area the coal seams were mapped with less detail as far as Hesketh in section 12, township 29, range 22. An attempt was made to correlate the coal seams worked in the vicinity of Carbon in Kneehills valley in section 14, township 29, range 23, with those in the Drumheller district. A reconnaissance survey was made of the coal seams in the vicinity of Big Valley about 48 miles north from Drumheller.

The field party consisted of five men, graduates or undergraduates from the University of Alberta. Much credit is due Ralph L. Rutherford who was in charge of the field party and who was ably assisted in the geological mapping by J. O. G. Sanderson. The instrument work was carried out by A. D. MacGillivray, efficiently assisted by Frank W. Marleau. W. A. Lang carried out the duties of cook and rodman in a very satisfactory manner. The writer wishes to acknowledge with thanks the assistance given him by I. F. Morrison, associate professor in Civil Engineering at the University of Alberta, in directing the instrument surveys in the field and for the use of the transits and other essentials which were kindly loaned by the Department of Civil Engineering at the University. It is not possible to thank individually all mine managers, other mine officials and individuals who assisted the writer by supplying information in the field, but he wishes to gratefully acknowledge collectively their co-operation and willingness in allowing the writer to visit their respective mines, and to inspect mine plans and other data compiled in their offices. This friendly willingness on their part supplied valuable data, and reduced the amount of time

it would otherwise have been necessary to spend in the field. The writer wishes to especially acknowledge the information and geological data supplied by Mr. Gordon L. Kidd, mining engineer and geologist, who has spent a few years surveying mines and tabulating data on geological conditions related to coal mining in this part of Alberta.

Miss Vera V. Lee, a graduate in geology from the University of Alberta, as efficient office assistant, has lightened the duties of the writer most markedly in preparing this report and in dealing with correspondence and requests relative to information on the mineral resources of Alberta. During the year 1921, 580 letters were received and 556 sent out, dealing with various phases of the mineral wealth of Alberta. The compilation of stratigraphic sections and sections of the coal seams in the mines, used in this report, have been prepared by J. O. G. Sanderson in the office since the completion of field work. Helpful criticism and discussion on various points dealing with field problems have been gratefully received from Mr. John T. Stirling, Chief Inspector of Mines, and from Research Professor E. Stansfield, and Professor Norman C. Pitcher, at the University of Alberta.

Preparation of Geological Map.—The sectional maps published by the Dominion Topographical Surveys Branch on a scale of one inch to three miles, were used as a base upon which the economic and geological data were placed. All traverses and lines of levels were tied on to the land corners in these sections which are marked by iron posts. At many points where these iron posts could not be found or had been removed by erosion forces or in other ways, pace traverses were made from the nearest corner posts. Between the section corners the outcrops of the formations or contacts were mapped by compass and pace traverses. In this way the geological information contained on the accompanying map has been orientated with a considerable degree of accuracy. (See Plate I).

The elevations determined by the Topographical Surveys Branch along the Canadian National railway between Munson and Rockyford were taken as the datum line to which all other traverses were connected. The altitude of certain section corner posts beyond the upper edges of the valley, which were obtained from the Topographical Surveys Branch were used when mapping the uppermost limit of the exposures.

A base line was established along the bottom of the valley throughout nearly the entire length of the area mapped. The northwestern end of the base line is at the northwest corner of the southwest quarter, section 24, township 29, range 21, between the Canadian Pacific railway and Kneehills creek, about 1600 feet from the mouth of the creek. The southeastern end of the base line is northeast of the Yoho mine and southeast of Rosebud river in the northwest quarter, section 21, township 28, range 19. This base was established by transit, level and chain so that it is accurately determined. In order to get accurate profiles of the valley and to accurately determine the positions and elevations of the various coal seams at a number of places, four cross-sections were made with stadia traverse from the prairie level on one side of the valley to the prairie level on the opposite side of the valley. The position of these cross-sections are represented on the map by lines C-D, E-F, G-H and J-K. The profiles and the geology along these sections are shown on Plates II and III. The last named section was continued up Rosebud valley beyond Wayne, and from this base the altitudes of a number of points including the positions of the coal seams were accurately determined by vertical angles. Two subsections were determined in the same way from the base line southwestwards to the prairie level. One subsection is between C-D and E-F, and passes midway between the Atlas and Newcastle Junior mines, the other was run south from the Newcastle mine to the upland level. The railway spurs to all the mines were also surveyed with the same accuracy and the altitude of each of the mines determined at the entrance to the mine. A bench mark was established at each of the mine entrances and these are recorded on the map. Close to each bench mark which is indicated with a six inch spike, a white painted board is attached on which is stamped "Alberta Geological Survey B. M.——.—" Only the surveyed roads are shown on the map.

The geological survey of the Drumheller coalfield was undertaken primarily to study and map the coal seams, and to collect data on the composition and variation of the beds in the coal-bearing formations.

All outcrops of the principal coal seams, eleven in number, escarpments, ledges and buttes, were traced with compass and paced traverses. These traverses were corrected for position at frequent intervals by connecting them with land corners or established stations on the base line, cross-section and subsection lines. The elevations were determined with the aneroid, and by vertical angles taken with the transit. In this way every possible care was taken to make the map data accurate.

Another point to note about the map is that the outcrops indicate the topographical features of the district, as the beds are comparatively flat-lying. There is a general dip to the beds in the series here exposed of about twenty feet to the mile in a westerly direction. The irregular shaped blank areas on the map within the lateral limits of the valley sides indicate comparatively level ledges, and the tops of buttes and mesas. These ledges are marked as 5a, 7b, 7c and 8a. The figure indicates the number of the nearest coal seam below the ledge, and when there is more than one ledge between two coal beds these are lettered upwards.

All field data were plotted on a scale of 1,000 feet to one inch, which has been reduced to approximately 2,000 feet to one inch on the published map. The field work connected with the tracing and mapping of the outcrops was carried out efficiently by Ralph L. Rutherford assisted by J. O. G. Sanderson.

Only that portion of the townsite of Drumheller is marked on the map which was shown on the registered townsite plan. There are several clusters of buildings south of the railway. The town now extends for nearly half a mile down stream between the railway and the river, beyond that shown on the map. West of the mapped townsite most of the area is built on north of the railway as far west as the railway bridge over the Red Deer. Several small villages have been built around several of the mines, the largest of these are Nacmine at the Monarch mine, and Wayne in Rosebud valley. The population of Drumheller and the surrounding smaller centres varies with the seasons and the mining activities. When the mines are operating it is estimated that upwards of 8,000 people of many nationalities inhabit this district.

CHAPTER II.

GENERAL CHARACTER OF THE DISTRICT

Topography.—The broad treeless upland is a deeply dissected portion of the central Alberta plain which has an average altitude of about 2,670 feet above sea-level. Red Deer river has dissected this upland to a depth of about 435 feet. The floor of the valley at Drumheller has an altitude of 2,225 feet, and Munson station close to the plain-level has an altitude of 2,661 feet above sea-level. The grass-covered plain slopes gently to about 2,550 feet above sea-level, where it is terminated abruptly by the eroded precipitous escarpment that continues to the valley-floor below at a depth of about 300 feet, broken only by occasional ledges of harder rock.

The trend of Red Deer valley is here about south 60 degrees east, and the width varies from three quarters to two miles. The river at normal level varies from 500 to 800 feet in width, and throughout the entire length of its course shown on the map has intrenched itself 15 to 25 feet in the older flood-plain and outwash deposits of clay, sand and gravel. This trench represents approximately the change of level of the water-line during flood stages. The grade of the river in the area mapped is about six feet to the mile. The course of the river follows irregular meanders from side to side in the valley-floor. From the northwesterly corner of the area mapped to the mouth of Kneehills creek, the river swings to the south; deeply incised badlands are developed on the inside of the curve on the northerly side of the valley, while precipitous escarpments extend continuously from the water-line to the upland level on the opposite side of the valley. This is seen in Plate VII taken half a mile west of Monarch mine in the southwest quarter section 18, township 29, range 20. At the railway bridge south of Midland mine the course of the river swings to the north; this is largely due to the erosion of Michichi creek. This broad meander terminates directly opposite the town of Drumheller. Here on the north side of the river a precipitous escarpment has been developed, while to the south of the town the badlands extend a mile and a half south of the river. Between Drumheller and Rosedale, a distance of approximately five miles, the river follows a comparatively straight course and the force of the current is directed towards the southerly side of the valley. The large amount of silt and alluvium deposited by Rosebud river at its mouth just below Rosedale has caused the course of Red Deer river to turn abruptly to the north, and a precipitous escarpment has been formed. At an earlier period the course of the Red Deer below the mouth of the Rosebud followed a straight and southeasterly direction to the mouth of Willow creek, a distance of four miles beyond the area shown on the map.

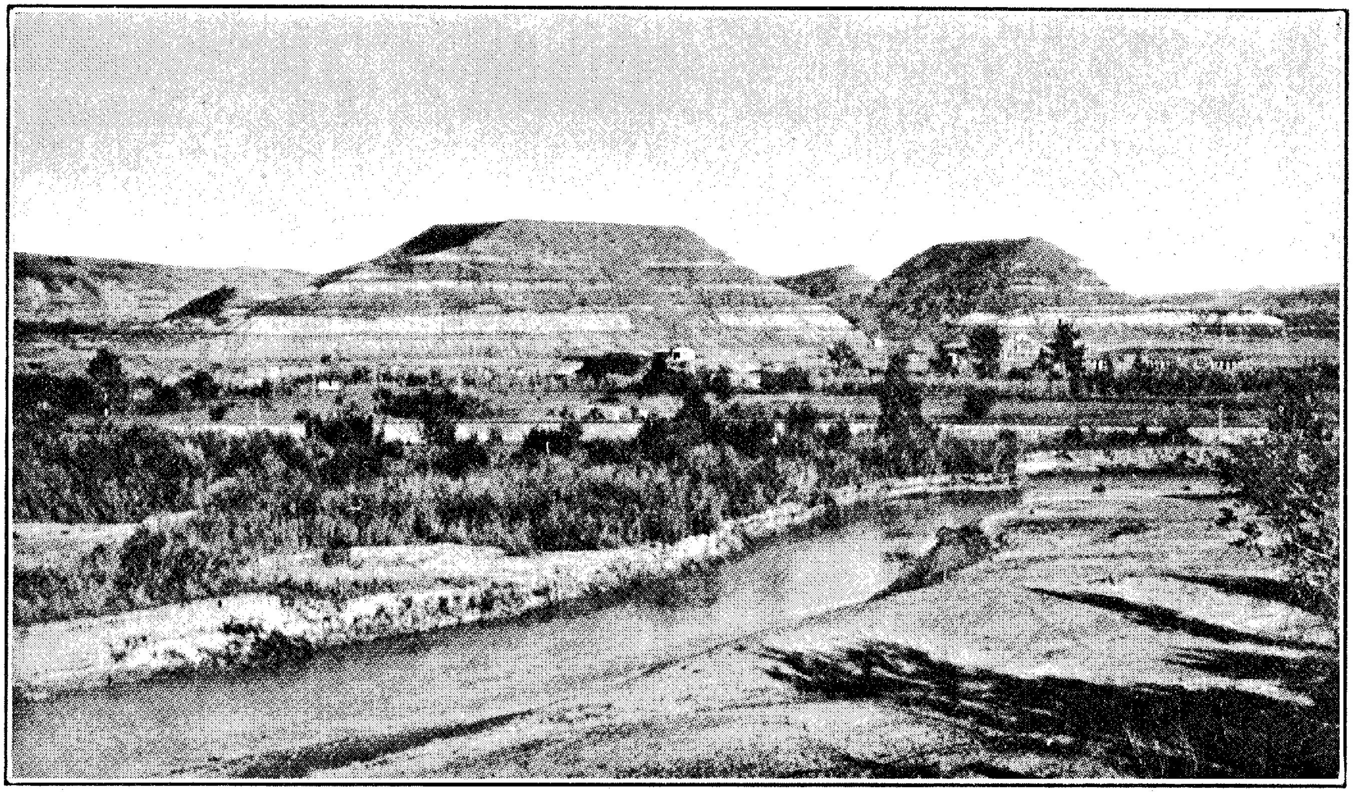

Plate V.—Typical buttes, near mouth of Rosebud river, looking east, showing characteristic bed of white bentonitic sandstone.

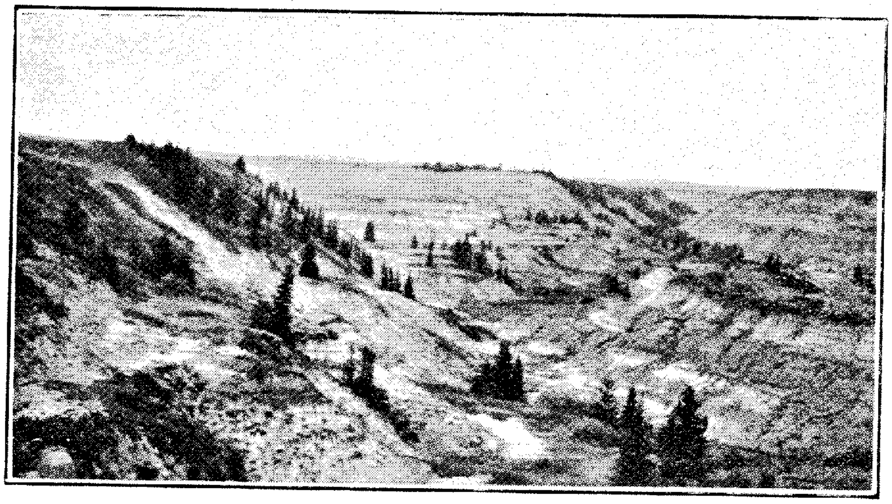

Plate VI.—Typical coulee from upland south of Kneehills creek. Shows type of vegetation in badlands.

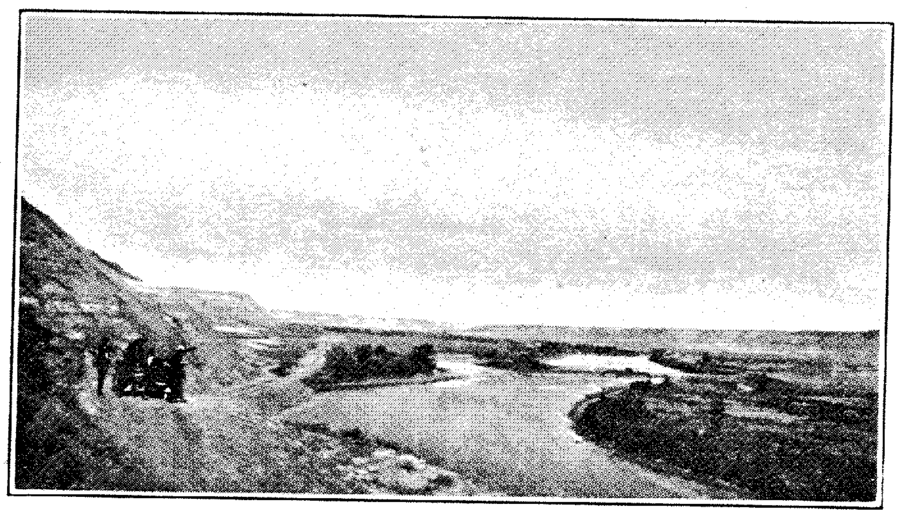

Plate VII.—Red Deer valley looking northwest towards Kneehills creek from Sec. 18, Tp. 29, R. 20, west of the 4th meridian.

The largest tributary of Red Deer river in the area shown on the map is Rosebud river which enters from the south. Plate V (frontispiece) shows the character of the river about a quarter of a mile from its mouth. This river heads on the plains in the vicinity of Didsbury, about 60 miles west of Rosedale and about 35 miles north of Calgary. It has an extremely tortuous course, and in section 10, township 27, range 22, west of the fourth meridian, is joined by Serviceberry creek, which is fed largely by water from the irrigation ditches. The water supply in the Rosebud is kept up largely from this source. When viewed from the upland, the valley of the Rosebud in the mapped area is gorgelike, on either side the walls rise abruptly 250 to 300 feet to the grass-covered slopes on the upland. At the top of the uppermost escarpments the valley is about half a mile wide, except in places where the regularity is broken by ravines and coulees.

Michichi creek enters the Red Deer valley from the north just opposite the town of Drumheller. This creek heads on the west slope of Hand Hills, fifteen miles to the east. The present stream is quite insignificant, as it is intermittent or has a dry course for several months in the year. The size of the stream was much larger at an earlier period, this is indicated by the size of the valley and the fan-shaped alluvial plain which has been built up at the mouth of the valley. The former deposits from this creek have forced Red Deer river southwards for a short distance above the position of the traffic bridge. The valley of Michichi creek is about 275 feet deep and in places less than a quarter of a mile wide. The west branch of this valley affords a convenient grade for the only highway out of Red Deer valley to Munson and the plains to the north.

Fox coulee enters Red Deer valley from the north in section 9, township 29, range 20, just west of Midland mine, and extends northward to Munson a distance of nine miles. In this distance there is a difference in elevation of 409 feet. The Canadian National railway follows this depression from the upland to the floor of Red Deer valley. There is no water in this coulee except during the spring run-off.

Kneehills creek entering the Red Deer from the south at the westerly end of the area mapped is the second largest tributary of the Red Deer in this district. This creek heads on the plains east of Olds about 75 miles west of its mouth.

Carbon, which is becoming a coal producing centre, is situated on Kneehills creek in section 15, township 29, range 23. The geology of this valley was mapped as far west as Hesketh in section 12, township 29, range 22, west of the 4th meridian, about 17 miles from the mouth, but only about one half mile of this valley is shown on the published map. The valley is gorgelike, less than half a mile wide, with precipitous walls rising 250 to 300 feet from a broad floor of outwash debris. The stream is confined to a gorge 15 to 25 feet deep. A branch line of the Canadian Pacific railway follows the Kneehills creek from Carbon. In October 1921 construction was completed on the railway to the mouth of the valley and the grade is completed as far as Monarch mine.

Numerous other ravines and coulees have incised both sides of Red Deer valley and have developed an intricate system of badlands. The general appearance of these badlands is shown in Plates VIII, IX, XIII, while some of the fantastic forms of erosion, as buttes and mesas are shown in Plates V, X, XVII. The head of one of these coulees, situated midway between Kneehills creek and Monarch mine is shown in Plate VI.

Origin of Red Deer Valley.—Red Deer valley is of pre-glacial origin. No evidence is left which would indicate the size or character of the valley before the southerly advance of the ice sheet, which covered at least a greater portion of the plains to a depth of several hundred feet. The glacier which occupied the pre-existing valley of the Red Deer deepened and widened this depression. When the glacier melted from the valley, the bottom of this depression stood within fifty feet of the present river level, so that there has been very little post-glacial deepening of the Red Deer valley.[1] The fact that no remnants of river deposits were observed along any part of the valley above the outwash plains is sufficient evidence for this statement. On the other hand deposits of glacial gravels from which sand and clay have been removed, occur in irregular patches at a number of places, down to the outwash plains and possibly even lower. Some of these deposits referred to have not been washed down to lower levels during the period of post-glacial erosion. Glacial boulders and erratics occur on ledges and flat-topped buttes which have not been affected by river erosion. A number of these erratics occur on the small butte on which the water tower is located just south of the railway station at Drumheller. It would seem that the larger valleys, tributary to the Red Deer, such as Kneehills creek, Fox coulee, Michichi creek and Rosebud river, are largely the result of post-glacial erosion, or were possibly started during the closing stages of glacial retreat, when large volumes of water from the melting ice, or from lakes left by the retreating ice sheet, followed these slopes to the Red Deer valley. These valleys are all much too large for the streams which follow their courses today. A former course of the Red Deer can be traced through section 10, township 29, range 20, between the Atlas and Hy-Grade mines, eastward past the Elgin mine to the river in section 1, about half a mile below Drumheller.

Origin of the Ledges and Flat-topped Buttes.—There are five distinct ledges shown on the map; these are designated 5a, 7a, 7b, 7c and 8a. The figure refers to the nearest coal bed below, and the

[1]R. L. Rutherford is of the opinion that the deepening of the Red Deer valley by glacial action has been considerably less than that attributed to this cause by the writer.

letters indicate one or more ledges between two coal beds. Towards the western side of the map, north of the river, there are three ledges between No. 7 and No. 8 coal seams. The ledges represent hard sandstone members in the formation, overlain and underlain by softer members. None of these ledges are river terraces, as river erosion has not been responsible for their formation. These ledges are the direct result of sub-aerial erosion, and in many cases are of post-Glacial age. The sides of the valley have been incised by the run-off into ravines which frequently are connected to form irregular or flat-topped buttes. When the disconnected mass has a flat top which corresponds to a ledge nearer the side of the main valley, the term "mesa" describes the form. Plate X shows a mesa, a conical butte, and an irregular butte, which are situated on the north side of the golf course, and a quarter of a mile west of the intersection of cross-section G-H and the railway. One of the most prominent mesas in the centre of the map area is marked as 8a ledge, one mile south of Drumheller station. Cross-section A-B passes over this mesa, the top of which corresponds to the elevation of the uppermost beds in the escarpment on the south side of the valley. (See Plate II).

Table of Altitudes.—In the following table, the altitudes of a number of points (indicated by *) along the Canadian National railway between Munson and Benyon were obtained from Topographical Surveys Branch, Ottawa. The other bench marks were established by our party in 1921.

TABLE OF ELEVATIONS

*Munson station, base of rail	2,661.82
*Red Deer river, water level, Oct. 9, 1915	2,229.12
Red Deer river, water level, Aug. 1921	2,237.24
*Bridge over Red Deer river, base of rail	2,252.12
Mouth of Kneehills creek (end of base line)	2,264.24
Monarch mine	2,275.04
Midland mine	2,262.99
Scranton mine	2,260.65
Western Gem mine	2,271.79
Newcastle mine	2,247.57
Premier mine	2,262.17
A. B. C. mine	2,273.76
Atlas mine	2,263.51
Newcastle Jr. mine	2,281.93
Hy-Grade mine	2,265.41
Elgin mine	2,286.20
Gibson mine	2,309.64
Midwest mine	2,304.37
North end, section C-D	2,485.00
South end, section C-D	2,683.00
*About 1¼ miles west of Drumheller station etc	2,256.74
*Drumheller school house, etc	2,251.43
*Drumheller station base of rail	2,258.26
Drumheller traffic bridge over Red Deer R	2,246.90
Superior mine	2,268.36

TABLE OF ELEVATIONS—*Continued*

Brooks mine	2,391.19
North end, section E-F	2,545.00
South end, section E-F	2,564.00
Drumheller mine	2,262.81
North end, section G-H	2,534.00
South end, section G-H	2,506.00
*Rosedale station, base of rail	2,236.17
Red Deer river, water level at Rosedale, (approx.)	2,212.00
Rosedale mine	2,282.34
Star mine	2,259.62
*Bridge over Rosebud river at Rosedale	2,235.21
*Rosebud river, water level	2,218.21
Yoho mine	2,247.06
Moonlight mine	2,266.47
Phoenix mine	2,293.10
Shamrock mine	2,343.47
*Water level at second railway bridge across Rosebud river	2,232.77
*Water level at third railway bridge across Rosebud river	2,243.81
*Water level at fourth railway bridge across Rosebud river near K	2,250.79
*Water level at fifth railway bridge across Rosebud river	2,253.92
*Water level at sixth railway bridge across Rosebud river	2,258.49
Sunshine mine	2,276.90
Celtic mine	2,292.48
*Wayne station, base of rail	2,282.79
Rosedeer mine	2,293.25
Western Commercial mine	2,290.88
Jewel mine	2,292.88
Excelsior mine	2,310.35
*Beynon station, base of rail	2,415.22
McGuchie mine	2,313.48
Road level at mouth of Willow creek	2,217.17

Climate.—The climate in the Drumheller district might be classed as semi-arid. The rainfall is light and the annual precipitation is small. The run-off is rapid, due to the more or less impervious character of the surface deposits. There is no meteorological station in this district so that no accurate records of rainfall and snowfall are available. The nearest meteorological station is at Calgary, 85 miles distant. The following table gives the annual precipitation for the last six years, recorded at the Calgary station:

PRECIPITATION TABLE

Year	Rain	Snow	Total
1916	9.81	4.22	14.03 inches
1917	6.58	4.68	11.26 inches
1918	13.12	2.94	16.06 inches
1919	8.35	3.86	12.21 inches
1920	8.30	6.12	14.42 inches
1921	....	....	13.52 inches

During the field season in 1921 the temperature in the valley at Drumheller on several days rose above 100 degrees with a maximum of 108 degrees on July 20th.

Vegetation.—The upland is grass covered, but shrubs and trees are rare. The sides of the valleys are almost void of vegetation, except on the flood plains and portions of outwash plains, and in some of the deeper ravines where there is an available supply of moisture. Plate VI shows the head of one of these ravines where occasional clumps of spruce occur. The flood plains are irregularly wooded close to the edge of the river with cottonwood, balm of gilead, poplar and willow. One of these wooded spaces has been converted into a natural park on the downstream side of Drumheller. This spot is a veritable oasis to the citizens during the hot summer days. Plates VII and XIII show the wooded character of the valley floor. That the soil is capable of producing a luxuriant vegetation when well watered, is evidenced by the green lawns and hedges around several residences in Drumheller.

Water Supply.—In the valley and on the upland the water supply affords a difficult problem. On account of the lensy nature and impervious character of the beds in the formation exposed along the valley, there are no adequate reservoirs for a water supply. The sandstone members are all more or less bentonitic which make them almost as impervious to ground waters as the compact bentonitic clay and shale beds. The surface moisture does not penetrate very far on account of the character of the surface rocks and unconsolidated materials. Locally a small water reserve may be retained in a natural depression, but this supply is frequently evaporated or otherwise exhausted before a fresh supply is added. Springs are rare. A weak one was noticed west of the Monarch mine, immediately below the sandstone in ledge 7b. Another water horizon occurs below the cross-bedded sandstone in ledge 5a in section 14, township 29, range 20, in the valley of Michichi creek. Another spring occurs below ledge 7a southeast from G in L.S. 13, section 32, township 28, range 19. There are a few wells in the valley bottom but the majority of the inhabitants utilize river water. The water supply in Drumheller is very bad. The intake pipe for the town supply is situated close to the west side of the traffic bridge, but a considerable portion of the town is situated close to the river above the point of intake. Health conditions are more serious as there is no sewerage system within this town of upwards of 2,500 inhabitants. The water supply and sanitary conditions of this important mining centre require careful and immediate consideration.

Road Problems.—It would be necessary to read that section of this report dealing with the composition of the geological formations before the road problem can be appreciated. The detriment to good roads in the valley is bentonite, which is found in varying percentages in almost all the members of the formation exposed in the Red Deer valley. When dry the roads are hard, but it requires only a slight rain shower to make many of them impassible as the bentonite absorbs water readily and becomes soapy. The main highway in the Red Deer valley extends from the Monarch mine downstream through Drumheller and Rosedale to the mouth of Willow creek. The main highway from Drumheller to the upland to the north is by way of Michichi creek and its north branch. There are three roads to the upland south of the valley, two south of the town of Drumheller and the main highway which leaves the valley floor close to Monarch mine, up what is locally known as "Howland hill." There is no valley highway between Drumheller and Wayne. From Wayne there are two roads with very steep grades leading respectively to the upland on either side of Rosebud valley. During or immediately after a heavy rainfall it is almost impossible to get out of the Red Deer and Rosebud valleys in this district by motor vehicle.

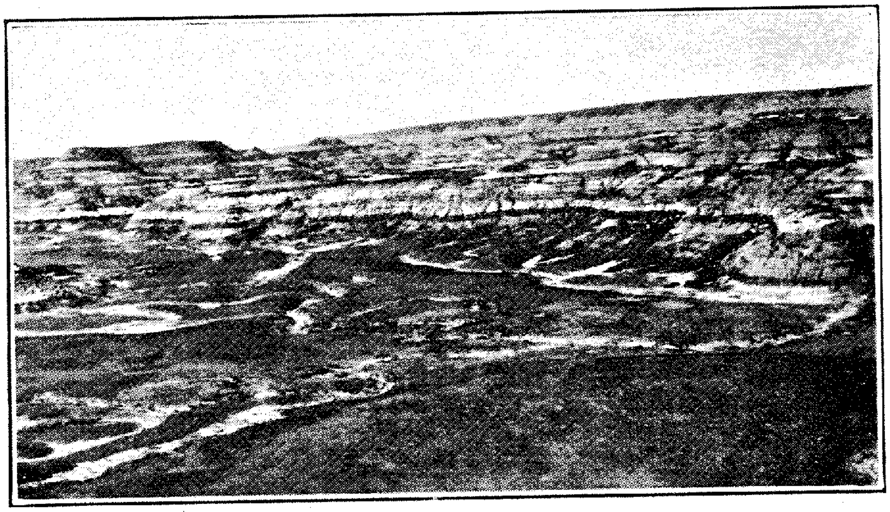

Plate VIII.—Badlands in S. W. ¼, Sec. 1, Tp. 29, R. 20, looking northwest, No. 5 coal seam showing in foreground; mesa to left capped by ledge 7a, seam No. 6 shows below bentonite in mesa.

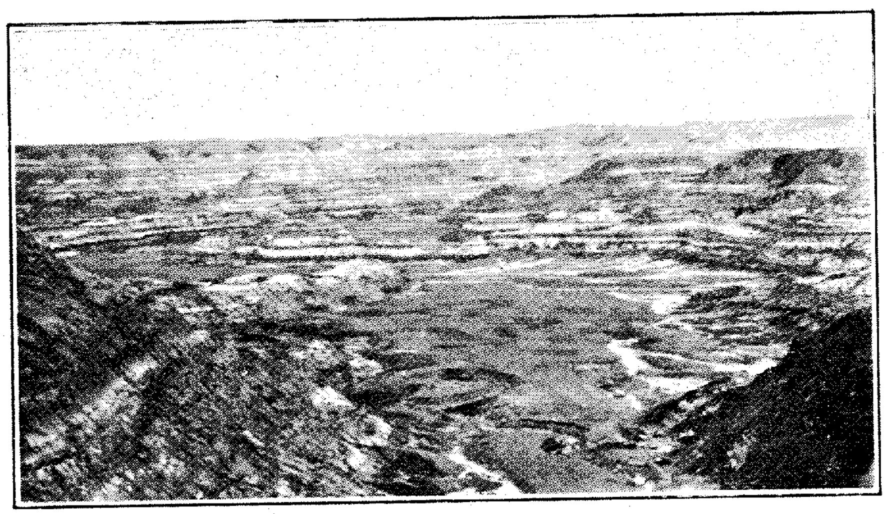

Plate IX.—Looking east along golf course. No. 5 coal seam at base of badlands, No. 7 seam near top, in centre of photograph.

CHAPTER III.

STRATIGRAPHY

The rocks in the district described in the report belong to two periods, namely the Quaternary and the Upper Cretaceous. Those of Quaternary age consist of recent alluvium, outwash and glacial deposits, all of which are classed as superficial deposits. The older series includes the coal seams and associated sediments and belong to the Edmonton formation which is the uppermost member in the Upper Cretaceous.

1. SUPERFICIAL DEPOSITS

Alluvium.—Alluvial or flood deposits consist of gravel, sand, silt and clay deposited within the flood zone of Red Deer river. Clay predominates in the alluvium, as the rocks exposed along the sides of the valley which have supplied much of the flood plain material contain varying amounts of clay. The extent of these deposits has been shown on the map, but the depth was not determined. The flood plain is broad at the mouth of the Michichi valley, and also below Rosebud creek, due to the alluvial material brought down by those tributary streams.

Outwash.—The high clay content in the rocks exposed along Red Deer valley allows rapid erosion, and large quantities of clay and sand have been washed down the slopes during rain storms and immediately afterwards. Wind erosion has also added much to these deposits. The outwash deposits form gentle slopes from the base of the exposures to the flood plain level. In most places the flood plain and outwash deposits can be readily differentiated. The aggregate in the outwash has not been sorted under water during deposition. The buttes and mesa-like outliers along the sides of the valley are rapidly disintegrated to form outwash plains. At many places all that remains of former outliers is a low conical elevation of outwash. The surface of the outwash becomes extremely hard when dry, due to the quantity of bentonitic clay in the deposits. There is a former course of the river which passes west of Hy-Grade mine, southwest to the Elgin mine, then east to the present position of the river in section 1, township 29, range 20, half a mile below the town of Drumheller. The alluvium along this course has been almost entirely covered by more recent outwash.

Glacial Deposits.—The upland within this district is capped by yellowish silty clays which vary in thickness from zero to a maximum of 75 feet. Boulders occur but are not abundant in these indistinctly stratified clays which are remarkably uniform in composition. This is a wide spread deposit as it is known to extend for several miles both up and down stream, and also to the west. In composition these deposits are very similar to those exposed in the vicinity of Calgary.

The origin of these clays is not definitely established, but they appear to be largely of glacio-lacustrine origin, and, therefore, represent clays and silts washed into a lake formed by the impounding of the water close to the front of the retreating ice sheet. The lower member in the series consists of very fine textured clays free from sand and carbonaceous material, and may prove to be econonically valuable.

These clays were utilized in the manufacture of common brick in a plant which operated for a time in section 1, at the outlet of the Michichi valley. Tests made on this clay showed marked shrinkage, but other tests made from clays from the corresponding beds in the vicinity of Rosedale mine proved to be of much better quality. Other samples showed that this clay possesses some of the properties of Fuller's earth, that is the clay has the property of absorbing impurities from impure crude oils and various other substances. Very little attention was given to these deposits during the time spent in the field, and closer study of them will have to be made before the economic importance of these deposits can be ascertained.

The surface clays are intermixed with carbonaceous material and are darker in color. In other places where the clay deposits are thin, a gumbo-clay has resulted from the admixture of the bentonitic clay from the underlying formation. This characteristic is best seen along the road to Munson, north of Michichi creek.

Glacial gravels and boulders are sparsely distributed throughout of the valley. Three localities might be mentioned where such gravels are more abundant; these include the north half of section 18, and the southwest quarter, section 19, township 29, range 20; towards the south end of cross-section G-H; and along the slopes of the valley of Rosebud river. At a number of places in Red Deer and Kneehills valleys such deposits occur on top of ledge 7a. A pit has been opened up in a small deposit of well washed gravel and sand on the upland in section 12, opposite the town of Drumheller, this material has been used for construction purposes.

Glacial erratics occur on the small butte on which the water tower is situated, opposite the railway station at Drumheller, and at several other places, but such boulders are not abundant in this district.

2. COAL HORIZONS IN ALBERTA

Before discussing the coal-bearing measures exposed in the Drumheller district it is advisable to remind the reader that in Alberta there are three distinct coal-bearing formations, all belonging to the Cretaceous period, but separated from each other by several hundred feet of other sedimentary formations. In these three horizons all grades of coal occur from lignite up to localized areas of anthracitic coal. The higher grades of coal are formed within or near the front ranges of the mountains, or in the deeper, and, therefore, older measures. The two most important factors in the formation of coal are *pressure* and *age*, so that a coal bed which is lignitic in composition where it is exposed or comes close to the surface the greatest distance from the mountains, may be represented by bituminous or semi-anthracite coal in the foothills or within the mountains. It is a fact of considerable importance when discussing coal resources that the quality of coal in one district may be very different from that in the same geological horizon in any other district, no matter how distant these districts may be from each other.

In order of age, beginning with the oldest, the coal horizons in Alberta occur in the Kootenay, Belly River and Edmonton formations. The Kootenay coal measures outcrop within or close to the Rocky Mountains and contain the highest grades of coal. The Belly River coal measures are considered to have an areal distribution of about 26,000 square miles and extend from the mountains eastward across Alberta into Saskatchewan. The coal measures in the Edmonton formation have a greater areal distribution, estimated at approximately 27,000 square miles within Alberta. As this is the youngest of the three coal-bearing formations, these coal beds have not been subjected to as great a pressure for so long a period, so the coal is classed as sub-bituminous and lignite. The coal measures in the Drumheller district belong to this formation. The Kootenay horizon is lower Cretaceous (Comanchean) in age and the upper two horizons are late Upper Cretaceous in age.

3. EDMONTON FORMATION

Distribution.—The *Edmonton* formation is today recognized by most geologists as representing the uppermost member in the Upper Cretaceous series of formations. It is distributed over the western two-thirds of Alberta and is known to occur at least as far north as Lesser Slave lake. This formation occupies a broad trough-shaped structure with a northwest trend, so that the lower members of the formation outcrop on either side of the structure, in the foothills on the west and along the eastern portion of Alberta. Red Deer river has cut its valley through the entire thickness of the Edmonton formation. In the Drumheller district the lower 650 feet of beds are exposed in the badlands along the sides of the valley of Red Deer river and along its tributaries as far back as the badlands extend (Plate III).

The contact between the top of the *Edmonton* formation and the overlying *Paskapoo* formation, which is Tertiary in age, is exposed along the sides of Red Deer valley in section 10, township 38, range 24, west of the 4th meridian, six miles west of Ardley on the Canadian National railway, formerly the Grand Trunk Pacific, on the line between Edmonton and Calgary. The base of the Edmonton formation is exposed along the sides of Red Deer river, five miles southeast of the mouth of Rosebud river which is shown on the accompanying map, (Plate I). Plates XVI and XVII show the contact between the light colored basal sandstones of fresh-water origin of the *Edmonton* formation and the underlying dark chocolate brown marine shales of the *Bearpaw* formation. The entire thickness of the Edmonton formation in this part of Alberta has not yet been definitely determined, but it is between 700 and 850 feet. Southwest of the area mapped along Rosebud river the contact between the *Edmonton* and the *Paskapoo* occurs a short distance west of Redland station near the junction of Serviceberry creek with the Rosebud, in township 27, range 22, west of the fourth meridian. On Kneehills creek the Paskapoo fresh-water beds overlie the Edmonton formation along the upper slopes of the valley between Carbon and Hesketh, a station on the Canadian Pacific railway branch line, the construction of which was completed to Red Deer river in October 1921.

The general character of the various strata in the lower 650 feet of the Edmonton formation as exposed in the Drumheller district is shown in Plate III.

Identification of Coal Seams.—The Edmonton formation contains several coal seams irregularly distributed throughout the entire thickness of strata exposed in the Drumheller district. This feature is shown on Plates II and III. There is reason to believe that other coal seams occur in the uppermost measures in the formation which are not exposed within the area mapped. The coal seams mined at Carbon to the west, and Big Valley to the north, are believed to belong to a horizon higher than those exposed in the vicinity of Drumheller. As the geology of this district was worked out largely on the succession of outcrops of the more persistent coal seams, the traceable more persistent coal seams are numbered consecutively from the lowest members of the series. The thickest seam in the series, and one which is worked at the greatest number of points in the district, formerly known as the "Deep seam" or "Drumheller seam," was designated No. 1 seam. Those above were given consecutive numbers up to No. 10 seam which is the highest in the series exposed within the area included on the accompanying map, (Plate I). Only four of these seams are of special importance economically; these are No. 1, No. 2, No. 5 formerly known as the "Newcastle seam," and No. 7 formerly known as the "Daly seam," or the "Vulcan seam." Most of the other seams are of no economic importance in this district, but they are persistent in lateral extent, and are excellent horizon markers. The outcrops of all ten seams are shown on the accompanying map (Plate I). At a few points an irregular lensy seam outcrops above No. 7, and this one is designated No. 7X. Others may occur in adjoining districts.

Below No. 1, a thin seam outcrops along Red Deer river below the mouth of Rosebud river. This seam is designated as No. 0 seam. Other thin and unimportant seams occur between No. 0 and the top of the Bearpaw formation. These outcrop near the mouth of Willow creek, six miles southeast of Rosedale, and also at the mouth of East coulee, three miles downstream from Willow creek. Numbers have not been given to these thin seams as they are not known to occur within the area shown on the accompanying geological map. A description of each of the coal seams shown on the map is given elsewhere in this report.

General Character of the Formation.—The *Edmonton* formation consists largely of sediments deposited under fresh and brackish water conditions, in shallow fresh-water basins, or in estuaries and deltas, or in littoral zones along the border of an advancing or retreating sea. Some of the members in this formation were deposited on mud flats and along flood plains that were exposed above the water level for short spaces of time, possibly of a seasonal character. Some of the beds, particularly those containing carbonaceous material, have originated in enclosed basins and swamps. Crossbedding, current marks, lensy structure, nodular masses, ironstone bands, erosion during deposition, younger beds enclosing fragments of older beds and especially those immediately under, are a few of the indications that prove the continental origin of the sediments in the *Edmonton* formation.

The composition of the beds in this formation varies greatly both laterally and vertically. In general the formation in this district consists essentially of sandstone, bentonite, clay, arenaceous and bentonitic shales, and more indurated shales, nodular shales, ironstone bands, carbonaceous shales and coal. Bentonite is the prevailing constituent throughout the whole series. There are thin beds of pure bentonite and many are classed as bentonic clays, shales and sandstones. The sandstone members contain more or less bentonite and clay. There are no true sandstone members in the whole series with the exception of certain hard flaggy sandstones that occur in well defined horizons. On account of their resistance to erosion agencies they form ledges, and cap the mesas, buttes and numerous irregular outliers in the badlands, but even these hard members were found to change laterally to softer, argillaceous sandstones. Five of these ledge forming members occur in the area shown on the map, one between No. 5 and No. 6 coal seams, three between No. 7 and No. 8 coal seams, and one above No. 8 coal seam. These ledges are designated on the map as 5a, 7a, 7b, 7c, and 8a respectively. Ledge 5a occurs 54 feet above No. 5 coal seam and is best developed in the outliers and flat-topped buttes immediately south of the town of Drumheller. Plate V (Frontispiece) shows ledge 5a in the flat-topped butte at Yoho mine across Rosebud river from Rosedale. The prominent white band in this photograph is bentonitic sandstone and shale which is locally prominently developed between No. 3 and No. 4 coal seams. Plate II shows this ledge in profile as it occurs in the badlands. Ledge 7a occurs 10 to 12 feet above No. 7 coal seam, and ledge 7b horizon is 40 to 46 feet above No. 7 seam. Both of these ledges are prominent features throughout the badlands between Rosebud river and Kneehills creek, and are shown on the profile sections (Plate II), and in blank color on the map, (Plate I). The lower ledge (7a) is shown in Plates VIII and X. The northwesterly dip in the formation can be noticed by tracing ledge 7a from the south end of section G-H, where the ledge occurs close to the top of the valley sides, upstream to the westerly end of section A-B, where the ledge occurs close to the level of the river. The dip in the beds is about twenty feet to the mile towards the west. Ledge 7c is not a prominent feature but this horizon occurs about 125 feet above No. 7 coal seam, and is shown near the west end of section A-B in Plate II. The uppermost ledge 8a occurs in only one mesa, which rises prominently above the surrounding badlands about a quarter of a mile southeast from the Midwest mine. Section A-B, Plate II crosses this mesa. These various ledges resemble river terraces, but they have been formed by subaerial erosion, as described in a previous part of this report on the topography of this district.

Other hard bands of siliceous shale in the sandstone beds form prominent features. These masses occur as flattened or spherical nodules that are resistent to erosion. Plate XII shows one of these bands which occurs in the badlands south from Newcastle Junior mine, between ledge 7a and the unconsolidated clays. At a number of places a resistent siliceous shale overlies soft bentonitic sandstone. Fantastic erosion forms are common. Such forms occur in the basal sandstone members of the Edmonton formation and are shown in Plate XVII.

Bands of ironstone and clay ironstone nodules are common throughout the formation, several of these are shown in the columnar sections in Plate III. These bands are seldom more than four inches in thickness, and consist of hard irregularly rounded or flattened nodules, usually less than three inches in thickness. The iron content has become oxidized in the outer surface of the nodule, so that the color is red, deep brown and black. The surface is frequently marked into small irregular polygons; these are called septarian nodules. The markings are due to contraction cracks formed in the ferruginous muds during consolidation. On account of the hardness, the ironstone nodules are resistent to erosion and frequently cover the surface in the badlands where the softer beds have been washed away. The color, weight and apparent abundance have caused these nodules to be regarded as a possible commercial source of iron. The quantity of this material is insignificant and the iron content varies. Analyses have been made on some of the heavier and some of the lighter nodules by J. A. Kelso in the Industrial Laboratories at the University of Alberta. These analyses are as follows:

Insoluble	13.02	28.02
Alumina	6.52	5.78
Lime	2.04	4.38
Iron Oxide	62.38	36.24
Magnesia	2.70	3.16
Loss on Ignition	13.02	22.16
Equivalent of oxide of iron as metallic iron	43.66	25.36

Stratigraphic Sections.—Plate III contains a series of stratigraphic sections that show the variation in the composition of various members in that portion of the Edmonton formation shown on the accompanying map, and extended to the base of the formation where it is in contact with the underlying Bearpaw marine shales. These sections were all compiled from accurately measured beds exposed at various points throughout the district, and situated on or close to cross-sections C-D, E-F, G-H and J-K; from information obtained from the various mine workings; and, from observations on the lowest members in the series exposed along Red Deer valley between the eastern limit of the map and Willow creek, where the older Bearpaw shales are exposed. The position of the various coal seams on these sections were all determined by running a series of levels from the base line established along the floor of Red Deer valley.

The first four columnar sections (Plate III, 1-4) represent the series on the south side of Red Deer valley, and numbers 5-8 represent the stratigraphic succession along the north side of the valley from northwest to southeast. It will be noticed that the measures as indicated by the coal seams rise towards the southeast, and also that there is a rise in the measures towards the north side of the valley. This indicates clearly that there is a general dip in the beds towards the west. The lensy character of several of the members is particularly well shown in the sections in Plate III, and also in the photograph (Plate XIV) taken up the Rosebud valley, which shows a lense of white bentonitic sandstone in clay shales. This feature indicates that there were frequent shallowings and deepenings of the basin in which these sediments were deposited.

The following generalized section may be regarded as representing the composition of the beds in the Edmonton formation as exposed in Drumheller district.

No. 1 GENERAL SECTION OF EDMONTON FORMATION

	Feet Thickness	Feet Depth
Yellowish clays, unconsolidated	60	60
Dark grey shales	2	62
Light grey sandstone, shaly lenses and hard yellowish sandstone nodules	12	74
Coal, No. 10 seam	1.6	75.6
Whitish sandstone with hard nodular lenses, fossil bones horizon	19.1	94.7
Yellowish grey shale	5.3	100.0
Whitish sandstones with ironstone bands about 2 feet apart and bituminous shaly lenses	20.0	120.0
Red ironstone band	1.5	121.5
Coal, and carbonaceous black shale, No. 9 seam	1.5	123.0
Dark grey shales	9.0	132.0
Coal, No. 8 seam	4.0	136.0
Dark grey arenaceous shales with white sandstone lenses and ironstone beds about 1 foot thick	31.5	167.5
Carbonaceous shale	1.5	169.0
Whitish sandstone grading into light grey shales	8.5	177.5
Yellowish grey sandy shales (*dinosaur fossils*)	25.7	203.2
Ironstone	2.0	205.2
Whitish bentonitic sandstone	7.0	212.2
Light grey and yellowish sandy shales	12.0	224.2
Brownish yellow shales	3.0	227.2
Ironstone and black carbonaceous shales	1.2	228.4
Beds of dark grey shales becoming more arenaceous to base, corresponds to ledge 7b (*dinosaur fossils*)	11.5	239.9
Whitish bentonitic sandstone	9.3	249.2
Grey shales grading down to bentonitic shales	15.5	264.7
Crossbedded sandstone of ledge 7a	2.0	266.7
White bentonitic sandstone	6.0	272.7
Coal, No. 7 seam	2.0	274.7
Ironstone and yellowish grey clay shales and bentonitic sandstone	6.0	280.7
Bentonitic grey shales and sandstones	20.0	300.7
Yellowish bentonitic shale	9.0	309.7

NO. 1 GENERAL SECTION EDMONTON FORMATION—*Continued*

	Feet Thickness	Feet Depth
Coal, No. 6 seam	2.0	311.7
White bentonitic sandstone	3.0	314.7
Coaly shale	1.0	315.7
Yellow clay shale	1.0	316.7
White bentonitic sandstone	5.0	321.7
Yellow grey and white bentonitic sandstone or shale, with ironstone bands towards base	23.5	345.2
Carbonaceous shale, No. 5X seam	2.0	347.2
Brownish yellow bentonitic shale	11.5	358.7
White bentonitic shale and sandstone	6.5	365.2
Brown fissile shale	0.5	365.7
Yellowish and grey sandy shales	10.0	375.7
Brown shale	2.0	377.7
Coal, No. 5 seam	3.5	381.2
White and grey shales	6.5	387.7
Carbonaceous shale	0.5	388.2
Brown yellow shale	1.5	389.7
White bentonitic sandstone and shale	5.5	395.2
Reddish shale with wood fragments	1.5	396.7
Coal, No. 4 seam	1.5	398.2
Brownish shale	0.5	398.7
Grey bentonitic sandstones (shown in Plate V)	8.0	406.7
Yellowish shale and small ironstone band, ochre toward base	3.0	409.7
Coal, No. 3 seam	2.0	411.7
Grey bentonitic shale	4.5	416.2
Yellow ochre or ironstone	1.0	417.2
Coal and shale, No. 2 seam	1.0	418.2
White bentonitic sandstone with clay lenses and ironstone band	38.0	456.2
Dark arenaceous shale	3.0	459.2
Coal, No. 1 seam	6.0	465.2
Bentonitic sandstone and ferruginous shale	28.0	493.2
Grey bentonitic clay shale	9.0	502.2
Coal, No. 0 seam	2.0	504.2
Dark clay shale	9.0	513.2
White bentonitic sandstone	42.0	555.2
Chocolate brown marine Bearpaw shales, with gypsum crystals		

The upper part of this section, down to 264.7, was measured along an accurately leveled sub-section line south from the Atlas mine to the upland level in the centre of section 3, township 29, range 20. That portion of the section between 264.7 and No. 2 coal seam was measured in the butte west of Rosedale, and close to section J-K. The remainder of the section down to the Bearpaw shales was compiled from sections made between Rosebud river and Willow creek.

Another section is given here which shows the general character of the Edmonton formation. This section was accurately measured along the line of cross-section E-F, (Plates I and II), down to No. 5 coal seam, the remainder of the section was measured close to the north end of G-H.

NO. 2 GENERAL SECTION EDMONTON FORMATION

	Feet Thickness	Feet Depth
Yellowish clays, unconsolidated	35.0	35.0
Bluish brown shale	15.0	50.0
Coal, No. 10 seam	2.1	52.1
Grey crude shale	6.0	58.1
Bluish white sandstone	23.5	81.6
Shale with sandstone layers near bottom, clay ironstone band at base	17.0	98.6
Seam No. 9		
Lignite coal	2.2	
Dark carbonaceous shale	2.5	103.3
Reddish clay shale with two ironstone bands	10.0	113.3
Coal and coaly shale, No. 8 seam	4.8	118.1
Mixed sandstone and shales, brown carbonaceous shale at base	8.0	126.1
Sandstone and ironstone nodules	2.2	128.3
Dark ferruginous shale, brown carbonaceous shale at base	3.7	132.0
Dark mixed shales, much ironstone at base	10.2	142.2
White to reddish sandstone	1.4	143.6
Dark shales containing dinosaur bones	9.0	152.6
Grey sandstone	1.5	154.6
Ironstone and brown carbonaceous shale	5.2	159.3
Brown carbonaceous shale	1.3	160.6
Dark coaly shale	4.7	165.3
White sandstone	4.0	169.3
Ferruginous sandy shale	5.7	175.0
White sandstone	5.0	180.0
Grey weathering shale	11.4	191.4
Brown fissile carbonaceous shale	1.0	192.4
Sandstone, bentonitic shale	14.8	207.2
Grey carbonaceous shale	5.0	212.2
Nodular sandstone and shale interbedded	16.7	228.9
Grey shale, coaly near top	4.8	233.7
Dark carbonaceous shale	0.8	234.5
Hard white sandstone	10.5	245.0
Coal, including 2.6 feet hard shale parting, No. 7 seam	6.8	251.8
Brown sandy shale	2.6	254.4
Carbonaceous shale	0.4	254.8
Reddish to grey interbedded shales	14.2	269.0
Blue bentonitic shale varying in thickness	8.0	277.0
Conspicuous white sandstone	6.3	283.3

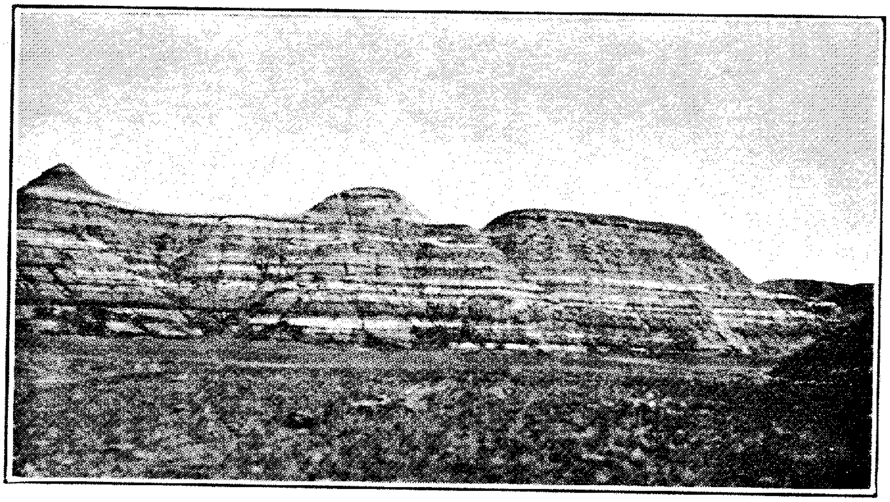

Plate X.—Three types of buttes, north side of golf course in Sec. 1, Tp. 29, R. 20. Ledge 7a caps flat-topped butte and is underlain by No. 7 coal seam. Seam No. 5 is prominent near the bottom of the escarpment.

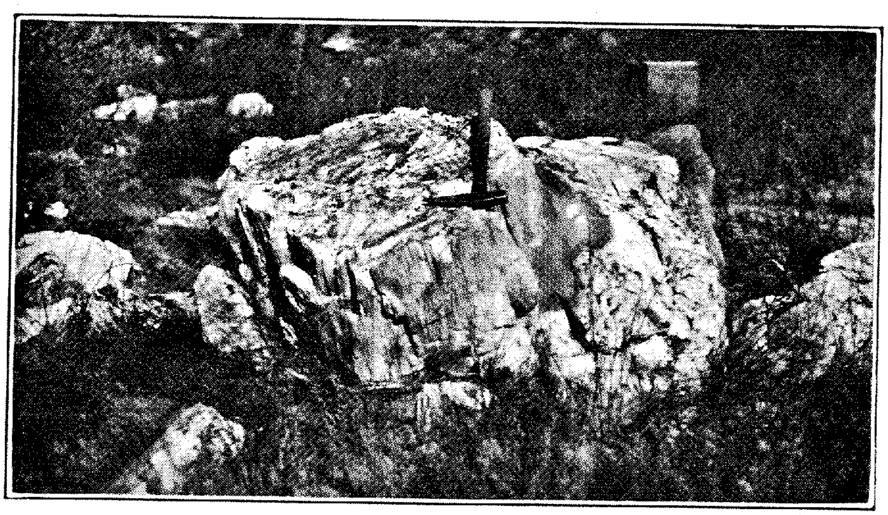

Plate XI.—Silicified tree stump in upright position above No. 1 seam.

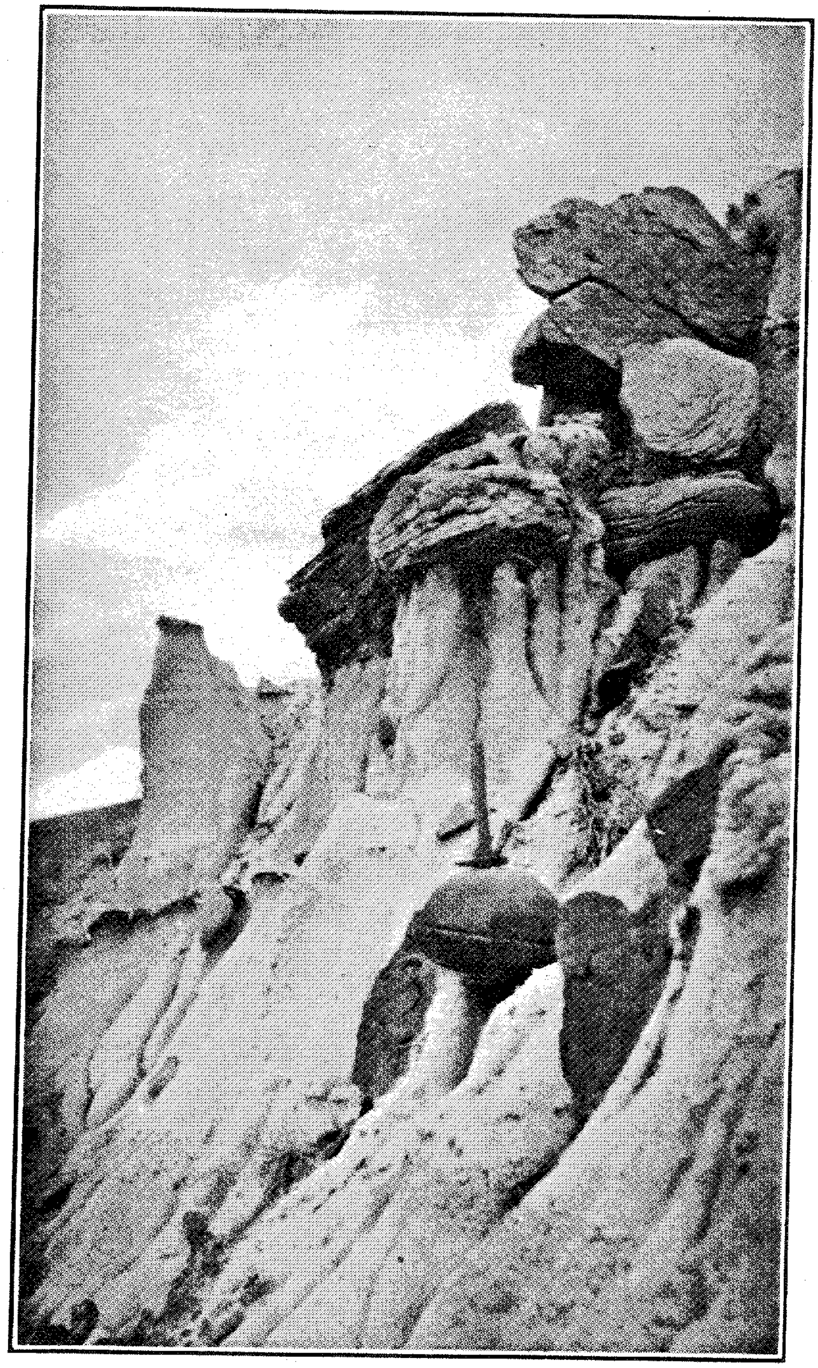

Plate XII.—Spherical and irregular nodules in bentonitic sandstone between No. 7 and No. 8 seams, south of Newcastle Junior.

NO. 2 GENERAL SECTION EDMONTON FORMATION—*Continued*

	Feet Thickness	Feet Depth
No. 6 seam		
Brown fissile shale	1.7	
Fossilized wood	0.1	
Dark carbonaceous shale	1.8	286.9
White hard sandy shale	2.0	288.9
Fine yellowish shale, flaky	1.0	289.9
White nodular sandstone, forms cap ledge 5a	6.8	296.7
Grey coal shale	7.9	304.6
Black carbonaceous shale	1.8	306.4
Yellowish grey shale	11.0	317.4
Black carbonaceous shale	1.2	318.6
Lensy sandstone and shale	5.0	323.6
Creamy to yellow shale	10.2	333.8
White weathering sandstone, two bands of clay ironstone near centre	12.6	346.4
Massive shale, weathering dark grey	3.4	349.8
Coal, clean lignite, No. 5 seam	3.6	353.4
Red weathering shale, with wood fragments	2.0	355.4
White cross-bedded bentonitic sands and light grey shales	28.0	383.4
Coal, No. 4 seam	1.5	384.9
Outwash		

A very typical section of the beds between ledge 7a and No. 2 coal seam is exposed in the flat-topped butte shown in Plate X. This photograph shows three characteristic forms of hills, the conical, the irregularly rounded and the flat-topped butte. The tops of these hills show ledge 7a, with No. 7 coal seam 10 feet below. No. 5 coal seam shows up near the base of the slopes. The following section was accurately measured in the flat-topped outlier to the right of the photograph:

NO. 3 SECTION BETWEEN LEDGE 7A AND COAL SEAM NO. 2

	Feet Thickness	Feet Depth
Ledge 7a. Hard brown flaggy sandstone	2.0	2.0
Light yellow crossbedded sandstone	9.0	11.0
Coal, No. 7 seam	3.0	14.0
Dark grey shales grading into characteristic blue bentonitic shales	22.0	36.0
Coal, No. 6 seam	2.0	38.0
Dark grey shales	12.5	50.5
White bentonitic sandstone, cross-bedded and with lenses of light grey shales	16.0	66.5

No. 3 SECTION BETWEEN LEDGE 7A AND COAL SEAM No.2—*Continued*

	Feet Thickness	Feet Depth
Yellowish brown fissile shale, No. 5X seam	2.0	68.5
Light grey bentonitic shales with white bentonitic sandstone lenses about 10 feet thick, carrying ironstone bands towards the base	40.0	108.5
Coal, No. 5 seam (Elev. 2,292 feet)	3.0	111.5
Light grey shales with lenses of white crossbedded bentonitic sandstone 4 to 6 feet thick	21.0	132.5
Coal, No. 4 seam	1.5	134.0
White bentonitic sandstone with 2 inch band of yellow ochre shale	9.5	143.5
Coal and carbonaceous shale, No. 3 seam	1.0	144.5
Dark grey bentonitic shale	5.5	150.0
Brownish shale	2.5	152.5
Coal, No. 2 seam	2.5	155.0
Light grey bentonitic shales and sandstone	3.0	158.0

The character of the beds in other points in the district mapped can be ascertained from the sections on Plate III. The beds appear to become more arenaceous towards the south and southeast.

Fossils.—Fossilized wood and plant fragments, fresh-water shells, and dinosaur bones represent the evidence of former life in this part of Alberta. Fossilized tree stumps, blocky fragments and smaller plant impressions are common. There are a considerable number of tree stumps up to three feet in diameter occurring in the beds immediately on top of No. 3 coal seam. Several of these stumps are found in an upright position which would seem to indicate that they had not been transported from the position in which they grew. One of these stumps is shown in Plate XI and several other small fragments of wood can be seen in the same photograph. There is another horizon in which wood fragments seem to be quite abundant, close to the top of No. 1 coal seam. It has been reported that stumps have been found extending upwards from the base of the coal seam, but none of these were observed in the field. Large fragments of wood and tree stumps are replaced by crystalline silica and frequently by opal and chalcedony, the amorphous forms of quartz. In a few specimens jasper seems to have been the replacing mineral. Smaller fragments of wood and fragments of bark as well as twigs and leaves are widely associated with No. 6 coal seam. The woody band in many places does not exceed half an inch in thickness, but the persistence of this particular layer of drift fragments forms an excellent horizon marker throughout the whole of the district shown on the map (Plate I).

by W. C. Knight under the name of "taylorite"[1], but as that name had already been used he suggested the name "bentonite" as it was associated with the Benton formation.

Bentonite usually contains impurities, so that the color varies. Pure bentonite is yellowish green when fresh and white when air dried. Impure varieties are grey, light cream, brown and even black in color depending upon the percentage of impurities. The fresh material when moist cuts with a smooth shiny surface. Thin shavings of pure bentonite are translucent to transparent. The fracture is roughly conchoidal to shaly and when dry breaks up into small fragments with curled edges. *Bentonite absorbs three times its weight and seven times its volume of water.* On account of its high absorptive power, it is extremely soapy when wet and with further addition of water forms a jelly-like mass. When bentonite is ground finely and thoroughly mixed with water a portion of its mass will remain in suspension indefinitely. In order to obtain the chemical composition of the pure conchoidal material, a quantity was mixed with water and after the mixtures were allowed to settle the particles in suspension were collected by evaporation. Analysis No. I was made from such material obtained in this way. This sample was taken from an irregular bed close to Gibson mine, which varies in thickness from 3 to 6 feet and which occurs between No. 6 and No. 7 coal seams. Analysis No. II was made from a sample taken from the main parting in No. 1 coal seam at Rosedale mine. Both analyses were made by J. A. Kelso at the Industrial Laboratories, University of Alberta.

	No. I per cent	No. II per cent
Silica	69.52	69.46
Iron Oxide	3.06	3.35
Alumina	21.64	16.25
Lime	0.00	2.06
Magnesia	0.21	2.76
Ignition Loss	5.45	5.04
Alkalis, etc.	0.00	1.08

Plate IV shows a bed of bentonite in No. 1 coal seam dividing the top coal from the bottom coal. This bed is quite persistent throughout the whole district where the seam was observed, but varies in thickness from a fraction of an inch up to a maximum of about 2 feet.

Other varieties of bentonite with a larger percentage of impurities occur in many horizons associated with both shale and sandstone members. Some of the bentonitic sandstones contain as high as 45 per cent bentonite by weight. A microscopic examina-

[1]Eng. & Min. Jl. Vol. LXIII, p. 600, 1898.

The only fresh-water shells found in this formation are Unio and Ostrea. The Unio or common fresh-water or brackish-water clam shell is associated principally with ironstone bands, so that the fossils are replaced by a hydrated form of iron. An Ostrea bed made up almost entirely of fossil shells, occurs at an elevation of 2,630 feet above sea level near the top of the escarpment in the first ravine southeast of the Monarch mine, through which the south end of profile section C-D has been measured. A corresponding Ostrea bed, yellowish in color, about 8 inches in thickness, occurs in the first cut in a coulee just west of Munson station on the Canadian National Railway, at an elevation of 2,660 feet above sea-level. As the beds above and below the Ostrea horizon in the two localities are similar, there is reason to believe that the Ostrea bed in both places belongs to the same horizon. The difference in elevation between these two points that are 7 miles apart, is 30 feet.

Fossilized vertebrate remains are also common in a number of horizons. These fragments belong to forms in the reptilian phyllum, in the order known as *dinosaurs*. The fossilized remains of these reptilian animals, already excavated from the Edmonton and Belly River formations exposed along Red Deer valley, have made this district in Alberta the most wonderful dinosaur hunting ground yet discovered.

Previous to 1921 no collection of these remarkable fossils has been made for Alberta. The first field party was sent out from the University of Alberta during the summer of 1921 under the direction of G. F. Sternberg, to collect dinosaurian fossils from the Belly River formation for the provincial collection. These specimens are now being prepared and mounted at the University. It is the intention to continue field work each summer.

Details regarding these remarkable animals cannot be given in this report, but it is necessary to mention that bone beds occur at a number of horizons in the Drumheller district. One horizon in which many fragments were found occurs close above the top of No. 7 coal seam, south of A. B. C. mine. In a few places fossil bones were found in ledge 7b. Articulated specimens occur on the south side of the valley a short distance below No. 10 coal seam. None of the specimens observed would indicate that any fairly complete specimen might be found, although from one place over forty vertebrae were collected. Fuller details on the fossils occurring in this formation appear in various publications of the Geological Survey of Canada prepared by L. M. Lambe and others.

Bentonite [1].—One of the chief characteristic constituents in the whole of the *Edmonton* formation is *bentonite* or soap-clay. The name *bentonite* has been applied to clay-like material with strong colloidal properties and high absorptive powers. This peculiar variety of clay was first described from Laramie Basin, Wyoming

[1]Allan, J. A., Second Ann. Rept. Mineral Resources Alberta, Edmonton, p. 36, 1920.

tion of these sandstones shows that the sand grains are coated with bentonite. When wet the exposures of bentonitic sandstone appear green but when dry become very white in color. (Plates VI, XII, XVII). The bentonitic sandstones are hard when dry but become quite soft and easily eroded when subjected to moisture. This fact is of considerable importance in mining. The roof of No. 5 seam, in particular, in many places consists of bentonitic sandstone which is hard and stands up so long as it remains dry, but when water reaches this bed it forms a poor and even dangerous roof.

Bentonite is becoming an important mineral on account of the many uses to which it can be put. It is used extensively in the manufacture of antiphlogistine, a medical absorbent dressing; as a filler in soap; an adultrant in drugs and candies; as an ingredient in gypsum and lime plaster; as a retarder in gypsum salt plaster; as a packing and dressing for horses' hoofs; and as a filler in the manufacture of paper. On account of the extreme hardness of bentonite when dried or burnt, it is used as a clay ballast in the construction of certain types of roads. Bentonite also has a limited use as a binder on account of its exceedingly fine texture and colloidal properties.

4. BEARPAW FORMATION

The name *Bearpaw* was first applied to a thick series of marine shales that are well exposed on the slopes of the Bearpaw mountains in central northern Montana[1]. In the southern portion of Alberta this formation is well developed under the brackish and fresh water beds known as the *Edmonton* formation. The Bearpaw is not exposed in the portion of the Drumheller district shown on the accompanying map, but the uppermost beds of this formation are exposed along Red Deer valley four miles southeast of Rosedale. It is necessary to describe the basal beds in the Edmonton formation, and to refer to the underlying Bearpaw formation which occurs about 100 feet from the surface at Rosedale.

The Bearpaw consists of interbedded dark grey and dark chocolate colored marine shales enclosing numerous crystals of transparent gypsum. The contact between the Bearpaw shales and the basal member of the Edmonton formation, which here is a white bentonitic sandstone, is clearly shown in Plates XVI and XVII. About one mile northwest from the mouth of Willow creek there is exposed a wedge-shaped lense of Bearpaw shale overlying the basal member of the Edmonton. This represents a westward advance of the Bearpaw sea over the top of the oldest sediments in the Edmonton formation. During this advance brackish water sands and clays of the Edmonton were washed away and an unconformable contact developed between the two formations. Plate

[1]Stanton, T. W. and Hatcher, J. B., U. S. Geol. Survey Bull., 257, p. 13, 1905.

XV shows a part of this lense of marine shales overlying the white bentonitic sandstone of brackish water origin. At Willow creek the top of the Bearpaw shales is about 92 feet below No. 1 coal seam. In Plates II and III, the approximate position of the top of the Bearpaw is shown in relation to the coal seams in the Edmonton formation. The information available on the Bearpaw in this part of Alberta would indicate that this formation is about 600 feet thick in the Drumheller district, and is underlain by the brackish and fresh water beds of the Belly River series that also contains several coal beds.

CHAPTER IV

STRUCTURE

Major Structure.—The beds in the Edmonton formation in the Drumheller district are lying nearly flat. Except for slight local undulations and warpings, the dips are so small that they cannot be readily detected. The major structure was determined from numerous accurately measured sections, and by establishing the altitude of the various coal seams at many points along the outcrops and in the underground workings throughout the district. From all available data it has been found that in general the strata have a west southwesterly dip at the rate of about 20 feet to the mile. There are local exceptions as shown in Plate II, profile A-B, where No. 5 coal seam west of Drumheller approaches No. 1 seam at the rate of 29 feet to the mile. Between Rosedale and Wayne the structure is nearly flat. Continuing up Rosebud valley beyond the limit of the map there is a marked fold between Wayne and Beynon, a distance of six miles. The maximum rise in this structure, midway between these two places is about 80 feet. The major structure such as it is in this district can be accounted for in two ways. The general westerly dip in the beds represents the slope on the eastern side of the broad synclinal trough that has a north northwest trend through central and western Alberta. Other subsidary major structures, such as the one noted between Wayne and Beynon, have resulted from the orogenic forces which disturbed the formations to the northeast in Misty hills and Mud Buttes, south of Monitor. It may be that these forces have been transmitted across Alberta during the Rocky Mountain uplift. This is a problem that cannot be discussed at fuller length here.

Minor Structure.—Minor structures are common throughout the formation and include the numerous rolls which occur in the coal seams in several of the mines in the Drumheller district. In one of the mines a roll in the coal, roof and floor was observed that rose six feet within a distance of 115 feet. Many other smaller rolls were observed. From all observations made on this minor structure, it is evident that there is no uniform trend to these rolls. It is a fact, however, that the local rolls in most cases have been formed and are still being formed where water enters bentonitic beds in the roof and floor of the coal seam. As bentonite absorbs seven times its volume of water, the accompanying expansion has caused a local buckling of the beds. It was also observed that in many cases the rolls occurred within certain mines in positions under or close to water courses on the surface of the ground. At a number of places in the underground workings the coal seam was observed to be thicker where the cover was light, due to the resulting expansion of bentonite beds or bentonitic shale bands in the coal seams.

Conical Slips.—Cylindrical or conical shaped blocks of rock frequently fall from the roof of the coal seam after the coal has been extracted. These blocks are frequently locally designated "tree stumps," but this is a misnomer as they consist of the same material as the formation in which they occur, and are surrounded by slickensided or smooth slip surfaces. The angle of slip is usually steep and ranges from about 60 to 85 degrees from the bedding plane. Slickensided surfaces frequently occur on the roof in contact with the coal about the slip blocks and elsewhere. This structure indicates that there has been some movement of the beds along this plane in order to form the smooth slip surfaces, possibly due to an uneven compression of the coal seam and the beds in the roof during consolidation. The slip blocks, that are usually conical shaped with the apex upwards, can be accounted for by vertical pressure from the overlying load during or after the period of deposition. Similar conical structure can be produced artificially by subjecting cubes or blocks of rock, concrete or brick to crushing stresses.

Faults.—With the exception of the numerous breaks in the formation caused by slumping along the sides of the Red Deer and tributary valleys, there is only one fault that shows up prominently in the area mapped. This fault is shown on the map to cut across a narrow shoulder between two branches on the north fork of Michichi creek, in the northwest quarter, section 14, township 29, range 20, less than half a mile west of E on cross-section E-F. The fault plane dips at about 85 degrees to the south, with the downthrow to the south. The vertical displacement is 77 feet. South of the fault No. 7 coal seam outcrops near the bottom of the valley, but north of the fault it outcrops close to the top of the valley where it is worked at the Brooks mine, less than half a mile north of the fault. On the downthrow side the beds are dipping in a northerly direction towards the fault. This seems to indicate that the displacement has been caused by the beds in the narrow shoulder settling, due to some of the lower members having been washed away by the two streams on either side of the shoulder, about 500 feet apart. In other words this fault has been formed in the same way as the breaks behind the many slump blocks along the valley slopes. Minor faults with slight displacement occur in some of the mines under escarpments or under places where there is evidence on the surface of slumping movements.

Dikes.—In one of the mines irregular dike-like masses of white bentonitic sandstone traverse the coal from the roof downwards. These irregular masses consist of sand and clay washed into cracks in the coal from overlying beds.

Clevaage.—The major cleavage or cleat in the coal seams is quite regular in all of the mines in both No. 1 and No. 5 seams. The trend of the cleat in No. 1 seam varies from north 43 degrees east to north 50 degrees east, and in No. 5 from north 50 degrees east to north 55 degrees east.

CHAPTER V.

DESCRIPTION OF THE COAL SEAMS

General.—In this brief description the coal seams are numbered from the oldest to the youngest according to the system of identification described in Chapter III of this report. The most important seam from the base of the Edmonton formation is designated as "No. 1", and the coal seams are numbered consecutively to the highest, "No. 10." This seam outcrops in the highest beds of the formation in the area shown on the map. Below No. 1 seam there is "No. 0" seam. Other thin seams are known to occur below No. 0 but these are not described here as they do not outcrop in the district shown on the map accompanying this report.

At present mines are being operated on four of the seams, namely Nos. 1, 2, 5, and 7, but a brief description is given of seven other coal horizons, as the outcrops of these were used in mapping in the geology of the formation. The outcrops of the eleven coal seams are shown in red on the accompanying geological map.

Plate IV shows a generalized section of the coal seam in each of the mines in operation in 1921. Each section in Plate IV is given a number which corresponds to the registered number of each mine as it occurs on the records of the Alberta Mines Branch.

Small specimen samples were taken from the top, middle and bottom of the coal seam in most of the mines, for the purpose of determining vertical and lateral variations in texture, fracture, and composition in the seam at various points throughout the district where this particular seam is mined. These samples were all analysed but not for the purpose of classifying the coal, so the analyses are not included in this report.

The fuel ratios obtained from the analyses were plotted for each part of the seam throughout the area where this seam is mined. The fuel ratio is obtained by dividing the percentage of volatile matter by the percentage of fixed carbon. The results are as follows:

Fuel Ratio—No. 1 seam—Average in thirteen mines

Top	1.34
Middle	1.36
Bottom	1.39

Average of seam for whole district—1.36

No. 2 seam—Average in Celtic and Sunshine mines

Top	1.41
Middle	1.44
Bottom	1.43

Average fuel ratio—1.43

No. 5 seam—Average in eight mines

Top	1.45
Middle	1.44
Bottom	1.44

Average of seam for district—1.44

No. 7 seam—Brooks mine

Top	1.38
Middle	1.50
Bottom	1.43

Average of seam—1.44

These results show that there is no marked variation in the composition of the coal in the seam either vertically or laterally. In the case of No. 1 seam, this average applies to the coal in mines between Kneehills creek and Wayne. The mines on No. 5 seam are grouped in a smaller area so that the fuel ratio results on this seam apply only to a limited area in the seam, as it is known that impurities increase in this seam in at least three directions as described later in this chapter.

The coal from the Drumheller district is blocky and bright when freshly mined. It assumes a dull lustre on exposure to the air. The most prominent physical feature about this coal is its tendency to slack when unprotected from the air. This is due to the moisture content in the coal. On exposure the moisture evaporates, and the difference in volume between fresh and air dried coal is represented by numerous cracks which are developed in the coal. Frequently these cracks are in planes at right angles to each other so that resulting fragments are usually rectangular and blocklike.

The moisture in the coal in the Drumheller district averages about 16 per cent. Official analyses from samples of coal taken from some of the mines in this district, by the District Inspector of Mines, are included in the Second Annual Report of the Scientific and Industrial Research Council of Alberta for 1921. No analyses to show the composition of the coal are given in this report. Investigations are now being made to classify Alberta coal more uniformly. At the present time coal from Drumheller, Rosedale and Wayne is regarded as high grade lignite, bordering on sub-bituminous. From the discussion of the individual seams on the following pages, and the brief notes on the various mines, it will be understood that the coal in this district must be classed between broad limits. In general, the coal is attractive when mined, and the impurities in most places occur in such a way that with care these can be readily discarded and a clean coal placed on the market. The characteristics of each of the seams are described on the following pages.

Seam No. 0.—The only exposure of this seam in the area mapped is on the north side of Red Deer river below Rosedale. The first exposure occurs about 30 feet below the entrance to the Star mine and close to the level of the river. The exposure of this seam continues to rise above the river in a southeasterly direction and at the mouth of Willow creek occurs about 100 feet above the river. The seam is 14 inches thick at the Star mine, but thins towards the east.

Seam No. 1.—This seam was formerly known as the "Deep seam" or "Drumheller seam," because it is the lowest workable seam in the series, and was opened up in the Drumheller (now Callie) mine. This is the thickest seam in the district, and on the average ranges from six to seven feet in thickness. It is mined at fourteen places in the district shown on the geological map as follows:—Monarch, Midland, Scranton, Western Gem, Drumheller, Rosedale, Star, Yoho, Moonlight, Shamrock, Rosedeer, Western Commercial, Jewel and Excelsior. A generalized section of the seam in each of these mines is given in Plate IV. The section of the seam at the Murray mine (No. 675) is included because at this point, 10 miles southeast from Rosedale on the east side of Red Deer river, No. 1 seam reaches a maximum thickness of 80 inches of clean coal. No. 1 seam lies 30 to 50 feet above No. 0, and 90 to 95 feet above the base of the Edmonton formation in contact with the Bearpaw shales.

The exposures of this seam are limited to the southeastern portion of the area mapped. The seam first appears on the surface in a ravine about half a mile west of Rosedale mine. It is exposed at the base of the butte in which Yoho mine is located (Plate V), and comes close to the outwash contact between Rosedale and Wayne.

The dip in No. 1 seam can be calculated from Plates II and III. Below Rosedale the seam rises so that at the Star mine it outcrops 30 feet above the river level, at an elevation of 2,254 feet above sea level. At the Moonlight mine, the seam is 61 feet above the river, 2,266 feet above sea level, and at the Murray mine nearly opposite East coulee the seam outcrops about 200 feet above the river level. Following upstream from Rosedale, the seam at Drumheller mine has a cover of 85 to 90 feet, and an altitude of 2,177 feet above sea level. At Midland mine the altitude of the seam is 2,142 feet, and at Monarch mine 2,102 feet above sea level under a cover of 173 feet. If this dip continues to Kneehills creek the seam would have an altitude of about 2,080, or approximately 180 feet below the level of the river at that point. Plate III shows that this seam also dips in a southerly direction. The true dip, computed from all data obtained, is in a west-southwesterly direction at the rate of about 20 feet to the mile. At the western end of the field the seam is moist and in some mines wet, where water has entered the seam from the river or from an overlying water-bearing horizon. Small quantities of gas occur in the seam where the cover is greatest.

The most characteristic feature of No. 1 seam is its division into two benches by a band of bentonite varying in thickness from a fraction of an inch up to 20 inches. As a rule the bottom of this band is quite regular, but the top undulates; this observation applies to most of the prominent bands of impurities. In a number of mines along the Red Deer valley above Rosedale, the bentonite band is underlain by a band of bone or coaly bone or hard granular coal, and overlain by a few inches of grey granular coal. In Rosedeer and Western Commercial mines in the vicinity of Wayne in Rosebud valley, the bentonite band disappears and is replaced by bone, coaly bone, and hard granular coal which is frequently eliminated when mined. There is a zone from Rosedale southeast where the band of impurities between the upper and lower benches increases in thickness and reduces the amount of marketable coal. Farther to the southeast below Willow creek this prominent band disappears and the entire seam is clean coal. In the Murray mine (Plate IV, No. 675) this condition exists. The coal seam is 80 inches thick and contains two partings less than a quarter of an inch thick. Similar conditions were found in No. 1 seam where it is exposed in East coulee on the south side of Red Deer valley, and 9 miles southeast of Wayne.

The band of impurities between the two benches is in some places too wide to warrant its extraction in order to work the lower bench of coal. There is also a band of hard granular coal in several of the mines near the top of the lower bench. The texture of this coal is not attractive on the market, although analyses show that its heating value is just as high as much of the looser textured coal in this seam. The lower bench varies from 18 inches to 42 inches in thickness and in places contains a band of bone a few inches thick. All of the mines are working the upper bench, and a few are mining the whole seam.

The upper bench varies in thickness from 5 feet to 6 feet 4 inches, and in places contains one or more thin bands of bone, shale or bentonite. The roof is shale and bentonitic sandstone. At a number of places a band of bone separates the coal from the roof, and in other places a lense of coal occurs between the bone and the true roof. In a few places the roof is soft and a few inches of coal are left on the roof for support.

The coal is bright in color when it is first mined, but assumes a dull lustre on exposure for a time to the air. The moisture content averages about 16 per cent and the ash varies greatly. Exposure to the air causes slacking as shown by numerous cracks on the surface, but this class of coal does not disintegrate easily, and with reasonable care in handling the percentage of slack is low. The coal from this seam can in most places be extracted in block form, the size of the block varying from two or three inches to twelve inches across the face. The main cleavage plane in this seam of coal trends north 43 to 50 degrees east. There are local areas where the coal is finer and in some cases rusty, but these areas might easily be avoided as they are usually associated with local rolls, slips or where the seam is shattered and moist. Much of this coal is glossy and amorphous. The jet-like lenses are formed from logs and massive blocks of wood. Such lenses are quite prominent in some parts of the seam, some are two inches in thickness and often the woody structure can be seen on the glossy surface. The amorphous coal is formed from smaller types of vegetation including leaves and bark. Specimens from Rosebud valley show a very intimate association of the two varieties of coal and a very finely laminated texture is present. So-called "nigger heads" are common in some areas in the seam. These masses of hard bone, represent the clay, sand and plant material, washed or blown into depressions on the floor of the basin in which the coal was being formed.

Another pronounced characteristic of No. 1 seam is the presence of numerous grey translucent and transparent crystals of selenite (gypsum) along the cleavage faces in the coal. This mineral does not lower the value of the coal but frequently produces a dull grey lustre on the surfaces of the blocks of coal when mined.

There is another distinct variety of coal in this seam which is called "granular coal" or "hard grey coal." Bands of this coal occur in some parts of this seam near the bottom of the upper bench and also below the bentonite parting in the lower bench. This granular coal is fine textured, hard, and a little heavier than the normal coal. The granular texture is due to the presence of innumerable conchoidal fracture surfaces, and not to individual grains of coal. The examination of this variety of coal has not yet been completed but this texture seems to have been caused by pressure and slight movement on a bed of coal material made up chiefly of plant seeds and soft structured vegetation, possibly grasses and other marsh growth. An air dried specimen of this granular coal from the lower bench in the Rosebud valley was analysed by J. A. Kelso, at the Industrial Laboratories, University of Alberta. This analysis is as follows:

	Air Dried	Moisture Free
Moisture	15.1	
Volatile matter	32.8	38.6
Fixed carbon	44.4	52.3
Ash	7.7	9.1
B. T. U.	9,690	11,410

There is very little shrinkage to this variety of coal on exposure to the air, but on account of its hardness and appearance it is not in demand on the market. At some of the mines this variety of coal is discarded, and at others it is marketed with the normal grade of coal.

Hand samples were taken from each of the mines, from the top, middle and bottom of the upper bench in No. 1 seam. These were analysed for the purpose of determining lateral and vertical variation in No. 1 seam. The fuel ratio from each of these specimens shows that there is no marked variation in the coals in this seam in the Drumheller district. These results are given below.

Average fuel ratio in No. 1 Seam in thirteen mines

Top	1.34
Middle	1.36
Bottom	1.39

Average for the district—1.36

A few specimens were analysed from the lower bench where it was being mined, but the analyses on these showed that in general the fuel ratio in the lower bench was similar to that in the upper bench.

Seam No. 2.—This seam is worked in the Celtic and Sunshine mines on the east side of Rosebud valley between Rosedale and Wayne. The thickness of the seam varies from 22 inches to at least 40 inches, with a half inch band of bone about the centre of the seam. In other places the seam consists of clean coal from roof to floor (see Plate IV, Nos. 697 and 737). There are places on the north side of Red Deer valley below cross-section G-H where No. 2 seam thickens to 4 feet. The seam has a similar thickness down stream below Rosedale between the ferry and Willow creek. At the various points where this seam was observed it is separated from No. 1 seam by 39 to 50 feet of shale and sandstone.

The coal when fresh has a dull lustre due to the fact that it consists largely of the amorphous variety of coal. There are irregular lenses of glossy coal; one was observed which measured four inches in diameter and was surrounded by the completely carbonized bark of the tree represented by the glossy coal. Rusty coal and joint planes covered with selenite crystals are common features of the coal in No. 2 seam. The fuel ratio determined from analyses of specimens taken from the top, middle and bottom of this seam is as follows:

Top	1.41
Middle	1.44
Bottom	1.43

Average for seam where mined—1.43

Seam No. 3.—This seam is seldom more than one foot in thickness and is of no commercial importance, but it was used as a horizon marker and is exposed from the town of Drumheller eastwards. No. 3 seam is separated from No. 2 by 8 to 12 feet of sediments.

Seam No. 4.—This seam occurs 10 feet above No. 3. It has a maximum thickness of one foot, but it is continuous and was useful for correlation purposes. No. 4 and No. 3 beds are exposed near the base of the outliers between Drumheller and Rosedale (Plates V and X).

Seam No. 5.—No. 1 and No. 5 seams are the two most important coal seams in this district. No. 5 has formerly been known as the "Top seam" or "Newcastle seam" because it is mined at or close to the surface, and Newcastle mine was one of the first to work this seam.

The following eleven mines are working No. 5 seam: Newcastle, Alberta Block Coal Co. (A. B. C.), Premier, Atlas, Newcastle Junior, Hy-Grade, Elgin, Gibson, Midwest, Superior, Western Gem. These mines are situated south and west of the town of Drumheller in sections 2, 3, 9, 10 and 11, in township 29, range 20, west of the fourth meridian.

No. 5 seam is exposed at the base of the badlands in contact with the outwash half a mile south of the water tower at Drumheller, and close to the spur running to the Midwest mine. This coal seam was exposed at the base of the butte a few feet south of the railway station, but the outcrop has been covered with ballast during railway construction. This seam has been eroded from the flat between the railway and the river on which the town of Drumheller is situated. On the north side of the valley No. 5 seam is exposed in the escarpment below the traffic bridge and is worked in the Superior mine about 25 feet above the river level. This seam is also exposed near the bottom of the escarpment in Michichi valley. Between Drumheller and Rosedale the seam rises higher in the badland slopes. No. 5 seam is exposed near the base of the hills at the golf links, and is shown in Plates VIII and IX, about half way up the slope in Plate X, and near the top of the valley at Rosedale mine, shown in Plate XIII (see Plate III, No. 8). The formation continues to rise to the southeast, and No. 5 seam reaches the upland and has been eroded below Willow creek. West of Drumheller this seam dips at the rate of about 20 feet to the mile, but in section 9, township 29, range 20, the dip increases to 29 feet to the mile. This change of dip is shown in profile section A-B on Plate II. The thickness of strata between No. 1 and No. 5 coal seams increases towards the southeast. At Monarch mine the thickness of beds between No. 5 and No. 1 is 47 feet, 54 feet at the Midland, 65 feet at the Western Gem, 80 feet at Drumheller mine, 85 feet at Rosedale, and more at Willow creek.

No. 5 seam varies in thickness from 3 feet 6 inches to 5 feet 5 inches, but the average thickness of the seam where mined is about 4 feet 8 inches of clean coal (Plate IV). There is one band of bone varying from a mere parting up to a maximum of 12 inches, but in most places this band measured less than 3 inches.

It appears that this seam is being mined where it is thickest. It thins to 3½ feet in Michichi creek in section 14, to 40 inches on the northeast side of Red Deer valley between the Superior and Rosedale mines, and to 36 inches on the south side of the valley east of Midwest mine. West of section 3, township 29, range 20, there is evidence that the bone increases and the thickness of clean coal decreases. There are indications that No. 5 seam thickens towards the northwest from section 3, township 29, range 20.

The roof consists of shale and bentonitic sandstone. The shale is lensy between the coal and the bentonitic sandstone, so that if the roof is shale, the sandstone will be found within a few inches of the top of the coal. Both of these rocks form an excellent roof so long as they are dry, but a small amount of moisture in the sandstone will cause the bentonite ingredient to swell, and scaling will result. At some points the roof is crushed under or close to escarpments where there was evidence of slumping on the surface. This condition is only local.

From some parts of the seam the coal is mined in a blocky form, from other parts of the seam the fragments are smaller, and irregularly angular. The coal is shiny, the bright lustre being quite pronounced. From still other parts of the seam the coal is extracted in irregular sized fragments from block to nut sizes. The quantity of the smaller sizes increases where there has been movement in the seam as evidenced by slight local rolls, or where water has entered the seam either from the surface or from the river.

The physical property of this coal varies in different parts of the seam. The most pronounced physical property is its tendency to slack on exposure to the air, but the rate at which disintegration takes place varies. This slacking tendency in the coal is due to the fact that the moisture content is high, and on exposure the water evaporates causing shrinkage in volume. The difference in volume between the fresh and the air dried coal is represented by an irregular net work of cracks. As these cracks widen on the surface of the blocks, fragments break away and the block is reduced in size.

This coal is classed as a high grade lignite bordering on subbituminous grade. Hand specimens of coal were taken from the top, middle and bottom of the seam from each of the mines. These were analysed for the purpose of determining lateral or vertical variation in the composition of the coal in No. 5 seam. The fuel ratio was determined from the analyses of each specimen, and the results were plotted according to the vertical and lateral position of each specimen. These results show that there is no marked variation in the composition of the seam from top to bottom and no marked lateral variation throughout the area where the mines are located. The fuel ratio is obtained by dividing the percentage of volatile matter by the percentage of fixed carbon in the analyses. The results are as follows:

Fuel Ratio—Average in eight mines

Top	1.45
Middle	1.44
Bottom	1.44

Average from top to bottom—1.44

A microscopic study of this coal has not yet been made, but specimens were collected for this purpose and these will be examined at a later date.

A macroscopic examination of the coal shows that the principal structure is usually parallel to the bedding. The coal consists of three different kinds of material, (1) jet-black glossy lenses that represent massive fragments of wood, logs and roots; (2) dull amorphous laminated bands resulting from decayed wood, twigs, leaves, bark and possibly seeds; (3) mineral charcoal layers in which the woody structures of the fragments are readily visible. This last type is often intermixed with clay and grades imperceptibly into bone.

Between No. 5 and No. 6 seams there is an irregular band of coal, shale and carbonaceous shale, which varies from a few inches up to two feet in thickness. This band has been designated No. 5X, but it was not mapped as it disappears entirely in some sections.

Seam No. 6.—The thickness of this seam varies from 6 inches up to 37 inches, but it can scarcely be called a coal seam as it contains very little coal and at many places consists entirely of black carbonaceous shale. The outcrop has been mapped and it has been given a number in the series, because it is a good horizon marker 70 feet above No. 5 seam. The outcrop can be traced from the position of cross-section C-D (Plate I) to the eastern limit of the area mapped. In Michichi creek No. 6 seam is 37 inches thick and consists of brown fissile shale, fossilized wood and black carbonaceous shale. The most prominent feature in this seam is a layer, seldom more than one inch in thickness, near the centre of the band which consists of carbonized and silicified fragments of wood, bark and leaves. Many of the carbonized fragments are mineral charcoal and may represent the products of forest fires of Upper Cretaceous age.

Seam No. 7.—This is a rather important seam on account of its composition and variation in thickness. It is mined at only one point in the area mapped (Brooks mine, No. 464), on the north fork of Michichi creek, close to the upland at an altitude of 2,391 feet above sea level, or 134 feet above Drumheller station. This is the first seam in the series that is exposed throughout Red Deer valley from the mouth of Kneehills creek to Rosedale. This seam was formerly called the "Vulcan seam" or "Daly seam."

No. 7 was found to be a particularly useful horizon marker as it occurs 20 to 28 feet above No. 6, and about 185 feet above No. 1 seam wherever sections could be measured. The thickness of this seam varies greatly. In section 36, township 28, range 20, and in section 32, township 28, range 19, east of cross-section G-H, it is less than one foot in thickness. At several places in Michichi valley near cross-section E-F it has a maximum thickness of 6 feet 8 inches, but this includes a shale parting 24 inches thick. The section at Brooks mine (Plate IV No. 464) shows 42 inches of coal with 13 inches of bone near the centre. Along the escarpment west of Michichi creek in section 10, township 29, range 20, No. 7 seam splits into two seams, separated by 10 feet of shale and sandy lenses, but in a coulee in the southwest quarter section 15, township 29, range 20, the parting thins to 11 inches of shale. On the opposite side of the valley, south of the A. B. C. mine, the seam shows 18 inches of coal, and it lies within 18 feet of No. 6 seam but this is only local. There is a dinosaur bone bed on top of No. 7 seam at this point. Between Monarch mine and Kneehills creek, No. 7 outcrops close to the base of the escarpment. In section 14, township 29, range 21, No. 7 seam is exposed at the edge of Kneehills creek. A prospect was opened in this section in this seam in October 1921. At this point the seam is about 3 feet 6 inches thick. A section of No. 7 seam near Wayne in Rosebud valley shows one foot of coal separated by two feet of shale. The coal is bright and blocky, and samples from Brooks mine gave a fuel ratio of 1.44.

A seam called No. 7X shows up prominently at a number of places about 4 feet above ledge 7a, or 15 feet above No. 7 seam. As it is not continuous throughout this district it was not mapped, but it might frequently be taken for No. 7. In most places it is less than one foot in thickness.

Seam No. 8.—This seam is also persistent throughout the area shown in the map. It occurs between 80 and 130 feet above No. 7, and varies in thickness from a fraction of an inch up to a maximum of 4 feet of clean coal where it is exposed near the top of the escarpment in section 3, township 29, range 20. In section 2, township 29, range 20, the seam is 4 feet 10 inches thick with a shale parting one foot thick. At the south end of cross-section G-H the seam is one foot thick. In Fox coulee it is represented by 14 inches of coal. The highest mesa in the district capped by ledge 8a, shows No. 8 seam four feet below the ledge (Plate II (A-B)). In Kneehills creek No. 8 seam splits into three parts, the interbedded shale bands are in places 10 feet thick.

Seam No. 9.—This seam is only mapped as a horizon marker as at no place in this district does it contain more than one foot of clean coal. In most places it consists of carbonaceous shale, and lies between 10 and 20 feet above No. 8 seam.

Seam No. 10.—This seam is the highest in the series occurring in the Drumheller district. The most easterly outcrop is close to the south end of cross-section E-F where it is in contact with unconsolidated deposits. It occurs about 55 feet above No. 8 and is prominently exposed up Kneehills valley. It does not contain commercial coal as it does not include more than a few inches of clean coal where it is exposed along Red Deer valley, but thickens to two feet of coal in Kneehills valley. It is regarded as an important horizon marker as it has been traced up Kneehills creek as far as Hesketh, and it may be possible to correlate it with the coal seam mined at Carbon in section 15, township 29, range 23, west of the fourth meridian.

CHAPTER VI.

ORIGIN OF COAL

Accumulation of debris.—That coal has been formed by the carbonization of an accumulation of vegetable matter is universally accepted. The exact condition under which this plant growth existed before its metamorphism into coal in a particular district offers ground for discussion. Three theories have been put forward to account for the accumulation of plant material necessary for the formation of coal beds. These are (1) accumulation of peat in situ, (2) drift wood accumulation, (3) sediment deposition.

It is generally accepted that most coal beds have resulted from the accumulated growth, burial, and formation of peat of some kind in shallow water. The variation, thickness and lateral extent of coal beds necessitates different physical and climatic conditions during the accumulation of the material from which the coal was formed. Without discussing details it may be accepted that many coal beds represent plant material that has accumulated in bogs and low coastal swamps bordering bodies of brackish water or even marine seas, also around expansive lakes with shallow swampy shores. The thickness of coal in a bed would depend on the length of time when slow subsidence permitted continued accumulation of vegetable material.

Some coal beds are believed to have resulted from the accumulation of drift wood carried by currents and deposited in sheltered alcoves or bays along deeper bodies of water. Coal beds formed entirely in this way are lense shaped and are dove-tailed in the enclosing sediments. Drift wood scattered along a low shore line might later become surrounded by swamp growth, and in this way add to the resulting coal formation.

There are a certain number of investigators of this subject who hold that some coal has resulted from age long accumulation of vegetable matter such as seeds and other wind-blown plant material in open bodies of water. All three methods of accumulation have added plant material in the formation of coal in Alberta.

There is a wide difference of opinion on the rate at which peat is formed. In north temperate zones today peat forms at the rate of about one foot per century, but there is reason to believe that during the tropical Cretaceous period vegetation flourished more luxuriantly and peat was formed at the rate of three feet per century.

SUMMARY TABLE OF THE SERIES OF COAL SEAMS AND SEDIMENTS

	Thickness: Coal Seam	Thickness: Sediments
Seam No. 10	1 - 2 feet	
Sediments		40 - 55 feet
Seam No. 9	0 - 1 feet	
Sediments		10 - 20 feet
Seam No. 8	0 - 4 feet	
Sediments		80 - 130 feet
Seam No. 7	1 - 6.7 feet	
Sediments		20 - 28 feet
Seam No. 6	0.5 - 3 feet	
Sediments		68 - 75 feet
Seam No. 5	3.5 - 5.5 feet	
Sediments		8 - 20 feet
Seam No. 4	0.5 - 1 feet	
Sediments		7 - 10 feet
Seam No. 3	0.5 - 1 feet	
Sediments		5 - 12 feet
Seam No. 2	1.8 - 4 feet	
Sediments		25 - 50 feet
Seam No. 1	6 - 7 feet	
Sediments		30 - 50 feet
Seam No. 0	0.5 - 2 feet	
Sediments to top of Bearpaw		90 - 100 feet
Total	15 - 37 feet	383 - 550 feet

Time Factor.—Various estimates have been given for the length of time required for the formation of coal. It would seem that three hundred years is a fair estimate of the length of time required for the formation of one foot of coal. In the Drumheller district the total series of coal horizons represents a thickness of 15 to 37 feet of coal. If 30 feet is taken as the average thickness of this series, the time required for the formation of 30 feet of coal according to the above estimate, would be nine thousand years. Besides the coal beds there are other interbedded sediments which amount to between 383 and 550 feet in thickness. It is generally accepted that under normal conditions it requires about two centuries for the formation of one foot of rock. At this rate of deposition, the sediments in the Edmonton formation, including the coal, exposed in the Drumheller district from No. 10 coal seam down to the top of the Bearpaw marine shales, represent a period of about 120,000 years for their accumulation. The time that has elapsed since this coal was deposited is believed to have been at least twenty-five times as long as the period of deposition. The coal in the Edmonton formation is spoken of as young because the length of time since its formation is short in comparison with the age of the world. Although most coal beds originated as beds of peat, yet it is only by pressure and age that the required metamorphism of the vegetable matter takes place. The longer the coal matter has been subjected to these forces, the higher will be the grade of coal, and the lower will be the moisture content.

CHAPTER VII.

DESCRIPTION OF COAL MINES IN OPERATION

History.—A complete history of coal mining development in Alberta has yet to be written, but D. B. Dowling has commented on the rise of the coal mining industry in Alberta and other western provinces in some of his publications.[1]

The earliest recorded discovery of coal in the great plains of Canada was made by Peter Fidler on a journey across the plains in 1793, when he found coal in the Red Deer valley somewhere near the mouth of the Rosebud. This information is found in a later edition of a map published by Arrowsmith in 1811. A note on this map near the mouth of Edge Coal creek which is now known as Rosebud creek, mentioned the quantity of coal outcropping along this stream.

List of Mines in Operation in 1921.—In that portion of the Drumheller district included on the accompanying map, there are shown the exact position of 27 operating mines, and one abandoned mine, the Sterling in the southwest quarter section 9, township 29, range 20, about midway between the Monarch and the Newcastle. Thirteen of these mines are operating on No. 1 seam, two on No. 2, ten on No. 5, one on No. 7 and one, the Western Gem on both No. 1 and No. 5 seams.

The following list gives the name of the mine, the mine number as registered in the records of the Alberta Mines Branch, the seam worked and the type of entry:

[1]Coal Fields of Manitoba, Saskatchewan, Alberta and Eastern British Columbia—Geol. Surv., Can., Memoir 53, 1914, p. 3.
History of Discovery of Western Coal Fields—Canadian Mining Journal, Vol. 42, No. 41, October 1921, p. 819.

Name	Number	Seam	Entry
Monarch	402	No. 1	Shaft
Midland	367	No. 1	Slope
Scranton	695	No. 1	Shaft
Western Gem	678	No. 1	Shaft
Drumheller	349	No. 1	Slope
Rosedale	346	No. 1	Shaft
Star	436	No. 1	Drift
Yoho	734	No. 1	Drift
Moonlight	766	No. 1	Drift
Shamrock	770	No. 1	Slight Slope
Rosedeer	347	No. 1	Slope
Western Commercial	640	No. 1	Slope
Jewel	643	No. 1	Shaft
Excelsior	703	No. 1	Slope
Murray	675	No. 1	Drift
Celtic	697	No. 2	Slope
Sunshine	737	No. 2	Drift
Newcastle	317	No. 5	Slope
Alberta Block Coal Co.	620	No. 5	Shaft
Premier	439	No. 5	Slope
Atlas	684	No. 5	Slope
Newcastle Jr.	816	No. 5	Shaft
Hy-Grade	776	No. 5	Slope
Elgin	819	No. 5	Shaft
Gibson	998	No. 5	Shaft
Midwest	848	No. 5	Shaft
Superior	701	No. 5	Slope
Western Gem	678	No. 5	Shaft
Brooks	464	No. 7	Drift

Description of Each Mine.—The following pages contain a brief tabulated description of each mine. Plate IV gives a generalized section of the coal seam as it was observed in each of the mines. The character of all the seams varies to such an extent as was described in an earlier part of this report, that no one section of the coal seam in a mine could be taken as accurate in detail for all the working faces in that particular mine. The number over each section in Plate IV refers to the registered number of the mine. The mines are mentioned according to their position on the map from the northwest to the southeast. The tabulated information on each mine except the elevation, was supplied from the records in the Alberta Mines Branch.

MINES IN NO. 1 SEAM

Monarch Mine.—(Mine No. 402)

Capital authorized—$1,000,000.00.
Name of Operator—North American Collieries Ltd.
Mine Manager—J. B. DeHart.
Location of Mine—On the road allowance between Sec. 7 & 8, Tp. 29, R. 20, W. of 4th.
Area in lease—3,500 acres.
Surface Elevation at Entrance—2,275.04 feet.
Seam mined—Seam No. 1.

Entrance to mine—Shaft.
System of mining—Room and Pillar Triple Entry Panel system.
Method of mining (Machine)—Compressed air under-cutting machines, Puncher Type.
Yearly capacity—300,000 tons.
Date mined opened—1913.

The top of No. 1 seam is 173 feet from the surface at an altitude of 2,102 feet. The distance between No. 1 and No. 5 seams is 47 feet 6 inches. A generalized section is given in Plate IV, No. 402. The roof varies in character from brown shale to bone and coal which thickens locally to nearly ten inches. The whole seam is about 8 feet 5 inches thick as follows:

Coal	5 feet 5 inches
Bentonite	6 inches
Coal	2 feet 6 inches

Only the upper bench of the seam is now mined, the lower bench is known as grey granular coal. The seam appears to thicken to the northeast. The cleat is pronounced and trends N. 45° 20′ E. There are local rolls in the seam, especially where the cover is light. The mine is fairly dry except where water has come from an overlying water-bearing member.

Midland Mine.—(Mine No. 367)

Capital authorized—$300,000.00.
Name of Operator—Midland Collieries Ltd.
Mine Manager—Francis Apsinall.
Location of mine—L.S. 10, Sec. 9, Tp. 29, R. 20, West of the 4th.
Area in lease—1,240 acres.
Surface Elevation at Entrance—2,262.99 feet.
Seam mined—Seam No. 1.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Compressed air under-cutting machines, Puncher Type.
Yearly capacity—230,000 tons.
Date mine opened—1912.

The slope is 380.6 feet to the bottom of the seam and the angle is 19° 30′. The distance from the surface to the coal seam is 121 feet, which makes the altitude of the top of Seam No. 1, 2,142 feet above sea level, or about 40 feet higher than the top of the same seam in Monarch mine, one and a half miles to the west. Plate IV No. 367 gives a generalized section of the coal, which is as follows:

Bone and coal	4 inches
Coal	6 feet 2 inches
Bentonite	8 inches
Grey granular coal	8 inches
Bone	2 inches
Coal	2 feet 0 inches

About 6 feet 2 inches of coal is mined from the upper bench which contains local partings. By cutting at the top about six inches of the coal is lost. The floor is bentonitic clay. The mine is wet on account of its proximity to the river.

Scranton Mine—(Mine No. 695)

Capital authorized—$50,000.00.
Name of Operator—Scranton Coal Co., Ltd.
Mine Manager—William Watson.
Location of mine—L.S. 5, Sec. 10, Tp. 29, R. 20, West of the 4th.
Area in lease—240 acres.
Surface Elevation at Entrance—2,260.65 feet.
Seam mined—Seam No. 1.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated machines of the Arcwall type cutting above the coal.
Yearly capacity—135,000 tons.
Date mine opened—July 1917.

The thickness of the cover measured in the shaft is 98 feet. This shows that seam No. 1 continues to rise towards the east. The vertical distance between No. 1 and No. 5 seam is about 55 feet.

A generalized section shown in Plate IV, No. 695 is as follows:

Coal	8 inches
Bentonitic sand-	4 inches
stone and shale	4 inches
Coal	5 feet 0 inches
Bentonite	1 feet 6 inches
Coal	2 feet 0 inches

In some parts of the mine the whole width of the seam is extracted. The cleat is N. 43° E. and the mine is quite wet. In some parts of the mine a lensy band of coal, thickening to 8 inches, appears above the bentonitic sandstone. There are slight irregularities in the contact between the top of the coal and the roof, due to the irregular surface of the coal-forming material during deposition.

Western Gem Mine—(Mine No. 678)

Capital authorized—$750,000.00.
Name of Operator—Western Gem Coal Co. Ltd.
Mine manager—Francis Aspinall.
Location of mine—L.S. 13, Sec. 10, Tp. 29, R. 20, West of the 4th.
Area in lease—320 acres.
Surface Elevation at Entrance—2,271.79 feet.
Seam mined—Seams No. 1 and No. 5.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain undercutting type.
Yearly capacity—240,000 tons.
Date mine opened—January 1, 1917.

Most of the workings are in No. 5 seam, but during the summer of 1921, a winze was sunk to No. 1 seam. The thickness of cover to the top of No. 5 is 59 feet and No. 1 seam where it is reached west of the shaft, is 65 feet lower. The upper seam is 5 feet 9 inches thick and is shown as follows in Plate IV No. 678:

Coal	2 feet 4 inches
Bone	2 inches
Coal	3 feet 0 inches

The workings on the lower seam are not sufficiently extensive to give an average section. Plate IV No. 678 shows:

Coal (6″ left for roof)	4 feet 6 inches
Bentonite	3 inches
Coal	5 feet 0 inches
Bentonitic clay	5 inches
Bony Coal	2 feet 3 inches

Drumheller Mine.—(Mine No. 349)

Capital authorized—$150,000.00.
Name of Operator—Callie Coal Company Limited.
Mine Manager—H. Crowder.
Location of mine—L.S. 14, Sec. 2, Tp. 29, R. 20, West of the 4th.
Area in lease—596 acres.
Surface Elevation at Entrance—2,262.81 feet.
Seam mined—Seam No. 1.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the Arcwall type cutting above the coal.
Yearly capacity—150,000 tons.
Date mine opened—1912.

Seam No. 1 is between 85 and 90 feet below the surface. A generalized section shown in Plate IV No. 349 is as follows:

Shale roof	3 feet 0 inches
Coal	2 feet 8 inches
Bone	1 inches
Grey coal	1 feet 4 inches
Bentonitic clay	7 inches
Coaly bone	1 feet 1 inches
Coal	1 feet 7 inches

Bentonite appears locally in the roof, and "nigger heads" in the lower part of the seam. The cleat of the coal is N. 55° E. There are local rolls of minor importance.

Rosedale Mine—(Mine No. 346)

Capital authorized—$1,500,000.00.
Name of Operator—Rosedale Coal Company, Limited.
Superintendent—W. A. Davidson.
Mine Manager—Thomas O'Donnell.
Location of mine—L.S. 14, Sec. 28, Tp. 28, R. 19, West of the 4th.
Area in lease—14,000 acres.
Surface Elevation at Entrance—2,282.34 feet.
Seam mined—Seam No. 1.
Entrance to mine—Shaft.
System of mining—Triple Entry, Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—300,000 tons.
Date mine opened—1912.

The cover at the shaft is 30 feet thick and No. 1 seam is about 8 feet 9 inches thick, made up as follows: (See Plate IV No. 346).

Sandstone		6 inches
Coal	2 feet	7 inches
Parting		½ inches
Coal	1 feet	8 inches
Bentonite		5 inches
Bone		10 inches
Coal	3 feet	3 inches

Until about a year ago the whole seam was extracted, but at the present time only the upper bench is mined, with a thickness of 50 to 58 inches. The bentonite band is quite pure in quality and varies in thickness up to about one foot. The mine is so dry that the main entry is dusty.

Star Mine—(Mine No. 436)

Capital authorized—$50,000.00.
Name of Operator—Great West Coal Company, Limited.
Mine Manager—J. D. Thomas.
Location of mine—L.S. 7, Sec. 28, Tp. 28, R. 19, West of the 4th.
Area in lease—240 acres.
Elevation of Outcrop—2,259.62 feet.
Seam mined—Seam No. 1.
Entrance to mine—Drift.
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—60,000 tons.
Date mine opened—1914.

No. 1 seam has here risen to a position above the surface level of the river, and outcrops on the east bank of the Red Deer about 30 feet above water line. The tipple is situated on the west side of the river, and the coal is taken by an aerial tramway from the mine to the tipple in the mine cars which are lifted from the track at the mine entry.

Only the upper bench is mined with an average thickness of about six feet. A generalized section of both the top and bottom coal is shown on Plate IV No. 436 as follows:

Bentonitic clay		2 inches
Shale		2 inches
Bone		5 inches
Coal	1 foot	6 inches
Bentonite and bone		2 inches
Coal	2 feet	6 inches
Clay parting		½ inches
Coal	1 foot	2 inches
Bentonite		8 inches
Coal	3 feet	6 inches

Seam No. 0 is exposed in the escarpment at the entrance to the mine about 30 feet below No. 1.

Yoho Mine.—(Mine No. 734)

Capital authorized—Not given.
Name of Operator—Marzoli & Company.
Overman—J. R. Miller.
Location of mine—L.S. 11, Sec. 21, Tp. 28, R. 19, West of the 4th.
Area in lease—160 acres.
Seam mined—Seam No. 1.
Entrance to mine—Drift.
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—45,000 tons.
Date mined opened—March 19, 1918.

This mine is situated at the base of a flat-topped butte shown in Plate V, on the east side of Rosebud river, near the junction with the Red Deer. The characeristic bentonite band which separates the top and bottom coal in most places in this coalfield is replaced by bone at many points in this mine. Plate IV No. 734 shows the following general section:

Coal		1 inches
Clay		6 inches
Coal	2 feet	6 inches
Bone		9 inches
Grey coal	1 foot	1 inches
Bone and bentonitic clay		9 inches
Coal	2 feet	10 inches

Moonlight Mine.—(Mine No. 766)

Capital authorized—Not given.
Name of Operator—Moonlight Coal Company Limited.
Overman—J. Berlanda.
Location of mine—L.S. 16, Sec. 16, Tp. 28, R. 19, West of the 4th.
Area in lease—40 acres.
Seam mined—Seam No. 1.
Entrance to mine—Drift.
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—15,000 tons.
Date mine opened—August 22, 1918.

The mine is situated in a coulee close to the easterly border of the map, on the south side of the Red Deer river about a mile and a quarter from Rosedale. The coal is hauled by motor trucks to the railway at Rosedale station. The workings are not extensive, but these show that the impurities in the seam increase in this direction. The following is an average section (Plate IV No. 766):

Coal	1 foot	8 inches
Parting		1 inches
Grey coal		11 inches
Bentonite		3 inches
Coal	1 foot	3 inches
Bone		5 inches
Coal	2 feet	3 inches

Shamrock Mine.—(Mine No. 770)

Capital authorized—Not given.
Name of Operator—Shamrock Coal Company Limited.
Overman—Charles Holme.
Location of mine—L.S. 10, Sec. 20, Tp. 28, R. 19, West of the 4th.
Area in lease—100 acres.
Seam mined—Seam No. 1.
Entrance to mine—Drift, slight slope.
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—15,000 tons.
Date mine opened—August 29, 1918.

No. 1 seam outcrops above the outwash in the Rosebud valley. "Nigger heads" are common in the lower part of the seam, and the quantity of pure coal in the entire seam is not large. Plate IV No. 770 shows the following section:

Coal	1 foot 0 inches
Bone	5 inches
Grey coal	9 inches
Coaly bone	4 inches
Bone	1 foot 3 inches
Coal	2 feet 9 inches

Rosedeer Mine.—(Mine No. 347)

Capital authorized—$1,000,000.00.
Name of Operator—Rosedeer Coal Mining Company Limited.
Mine Manager—Peter Allen.
Location of mine—L.S. 13, Sec. 7, Tp. 28, R. 19, West of the 4th.
Area in lease—6,000 acres.
Seam mined—Seam No. 1.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated machines of the Arcwall type cutting above the coal.
Yearly capacity—210,000 tons.
Date mined opened—1912.

Main and tail haulage has been installed for a distance of 2,700 feet from the bottom of the slope. The whole seam is mined and averages from 7 to 8 feet. The generalized section in Plate IV No. 347 shows two partings in the top coal that are quite persistent throughout this part of the coalfield. In some places the lower parting includes a few inches of bone. The bentonite bed between the top and bottom coal is missing, but this position is taken by 4 inches of bone. The bottom coal is about 30 inches thick. The section is as follows:

Coal	1 foot 6 inches
Parting	½ inches
Coal	2 feet 10 inches
Clay parting	2 inches
Coal	7 inches
Bone	4 inches
Coal	2 feet 6 inches

Western Commercial Mine.—(Mine No. 640)

Capital authorized—$1,500,000.00.
Name of Operator—Western Commercial Company Limited.
Mine Manager—H. R. Brown.
Location of mine—S. E. ¼, Sec. 7, Tp. 28, R. 19, West of the 4th.
Area in lease—3,000 acres.
Seam mined—Seam No. 1..
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Compressed air operated coal cutting machines of the Rand Radial Post type.
Yearly capacity—240,000 tons.
Date mine opened—June 19, 1916.

No. 1 seam is not exposed on the surface at this point on account of the heavy outwash and slumping of the higher beds. There is a pronounced dip in the seam of 6 feet in 1,000 feet to the southwest, but north of the main entry the dip is less pronounced, being about one foot in 1,000 feet. A fault with slight displacement occurs, but this is of no special importance as it is local and due to slumping movements in the overlying beds. The whole seam is mined, but there are marked variations in the character of the seam. In some places the bentonite band on top of the bottom coal becomes replaced by a thick bed of bone. A sample of the hard grey granular coal in the bottom bench gave the analysis quoted below. This analysis shows that the quality of this variety of coal is good, but this grade of coal from No. 1 seam is not in demand on the market:

	As Received	Moisture Free
Moisture	10.3	
Volatile matter	34.6	38.6
Fixed carbon	49.0	54.7
Ash	6.1	6.7
B. T. U.	10,670	11,890

Plate IV No. 640 gives a generalized section of the seam at this mine:

Shale		3 inches
Coal	1 foot	6 inches
Parting		1 inches
Coal	1 foot	3 inches
Parting		2 inches
Grey coal	1 foot	3 inches
Bone	1 foot	0 inches
Hard grey coal		9 inches
Coal	2 feet	7 inches

Jewel Mine.—(Mine No. 643)

Capital authorized——Not given.
Name of Operator—Jewel Collieries Limited.
Mine Manager—A. Higgins.
Location of mine—S. E. ¼, Sec. 7, Tp. 28, R. 19, West of the 4th.
Area in lease—160 acres.

Seam mined—Seam No. 1.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—150,000 tons.
Date mine opened—August 18, 1916.

At the shaft the thickness of the cover is 28.5 feet, and the elevation of the top of No. 1 seam is 2,264.4 feet above sea-level. The entire seam is 8 feet thick but only the top coal is mined, about five feet thick. A general section gives (Plate IV No. 643):

Bentonitic shale....		3 inches
Coal	1 foot	6 inches
Parting		2 inches
Coal	3 feet	9 inches
Bentonitic clay ...		6 inches
Bony coal		8 inches
Bentonite clay		2 inches
Coal	1 foot	6 inches

Excelsior Mine.—(Mine No. 703)

Capital authorized—$50,000.00.
Name of Operator—Excelsior Collieries Limited.
Overman—John Blair.
Location of mine—L.S. 3, Sec. 7, Tp. 27, R. 19, West of the 4th.
Area in lease—300 acres.
Seam mined—Seam No. 1.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—45,000 tons.
Date mine opened—September 18, 1917.

The whole seam is mined and averages about 6 feet of fairly clean coal. No machines are used, the bottom coal is mined and the top coal shot down. The two partings in the top seam that are characteristic in other parts of the district, are well developed in this mine. The following average section is shown in Plate IV No. 703:

Shale		4 inches
Coal	1 foot	1 inches
Bentonite parting		2 inches
Coal	4 feet	1 inches
Bentonite clay and bony coal	1 foot	2 inches
Coal	2 feet	0 inches

McGuckie Prospect.—(Mine No. 844)

Capital authorized—$150,000.00.
Name of Operator—Ideal Coal Company Limited.
Mine Manager—Thomas M. McGuckie.
Location of mine—L.S. 16, Sec. 1, Tp. 28, R. 20, W. of 4th.
Area in lease—350 acres.
Entrance to mine—Slope.
System of mining—Prospect slope only.
Date mine opened—Preparing to open.

This prospect is situated just inside of the limit of this map on the west side of Rosebud valley. It is the intention to open up No. 1 seam which is here covered by the outwash.

Preparations were being made in September 1921 to begin mining.

Murray Mine.—(Mine No. 675)

Capital authorized—Not given.
Name of Operator—J. N. Murray.
Mine Manager—Corey Wetherbee
Location of Mine—L.S. 12, Sec. 28, Tp. 27, R. 18, west of the 4th meridian, on the banks of the Red Deer river, 8 miles east of Rosedeer.
Area in lease—300 acres.
Seam mined—Seam No. 1.
Entrance to mine—Drift
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—4,000 tons.
Date mine opened—December 6, 1916.

This mine is situated about 10 miles southeast from Rosedale on the east side of the Red Deer river, near the top of the valley slope. It is outside of the area shown on the map, but is mentioned here because at this point No. 1 seam consists of 6 feet 8 inches of coal with only two partings less than an inch thick. There is no division into top and bottom seams. The production of coal is small as the seam outcrops about 200 feet above the river, so that most of the hauling is done by river route during the winter season. The section taken in the drift is given in Plate IV No. 675.

Coal	1 foot 5 inches
First parting	
Coal	5 inches
Second parting	
Coal	4 feet 10 inches

MINES IN NO. 2 SEAM

Sunshine Mine.—(Mine No. 737)

Capital authorized—$50,000.00.
Name of Operator—Sunshine Coal Company Limited.
Mine Manager—Thomas Mather.
Location of mine—L.S. 6, Sec. 19, Tp. 28, R. 19, West of the 4th.
Area in lease—160 acres.
Seam mined—Seam No. 2.
Entrance to mine—Drift.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—75,000 tons.
Date mine opened—August 3, 1918.

No. 2 seam outcrops just above the outwash. The seam is 3 feet 2 inches thick and has a sandstone roof and shale floor (Plate IV No. 737). Slight rolls occur here, but there is no displacement of the coal.

Celtic Mine.—(Mine No. 697)

Capital authorized—$150,000.00.
Name of Operator—Celtic Coal Company Limited.
Overman—W. C. Allen.
Location of mine—L.S. 7, Sec. 18, Tp. 28, R. 19, West of the 4th.
Area in lease—520 acres.
Seam mined—Seam No. 2.
Entrance to mine—Slope.
System of mining—Short wall.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—75,000 tons.
Date mine opened—July 18, 1917.

This mine is situated three quarters of a mile south of the Sunshine mine and the seam has similar characteristics. A section taken at the face showed 37 inches of coal with about one half inch of bone in the centre (Plate IV No. 697). The roof is dark shale and the floor is shale. This is the only mine in the district in which the short wall method of mining has been followed.

MINES IN NO. 5 SEAM

No. 5 seam has been described in an earlier part of this report, but it might be repeated, that the thickness varies from 4 feet to 5 feet 3 inches. The roof is white bentonitic sandstone or grey shale. Local thinning of the coal with the appearance of bone and shale lenses is a common characteristic. Where surface water reaches the bentonitic roof, local rolls and warpings occur due to the swelling of the bentonite.

Newcastle Mine.—(Mine No. 317)

Capital authorized—$250,000.00.
Name of Operator—Newcastle Coal Company Limited.
Mine Manager—D. A. Macaulay.
Location of mine—S. E. $\frac{1}{4}$, Sec. 9, Tp. 29, R. 20, West of the 4th.
Area in lease—400 acres.
Surface Elevation at Entrance—2,247.57 feet.
Seam mined—Seam No. 5.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated machines of the chain type, both of the under-cutting and Arcwall type.
Yearly capacity—255,000 tons.
Date mine opened—1911.

Ledge 7b forms the surface rock and the top of No. 5 seam at the air shaft is 43 feet below the surface. The thickness of the seam averages 4 feet 6 inches to 5 feet according to the thickness of the bone about 3 feet from the top. An average section shows (Plate IV No. 317):

Coal	3 feet	- 2 inches
Bone		1 - 4 inches
Coal	1 foot	8 inches

Minor local slips and lenses occur. In this and other mines, the coal is invariably irregularly arched and sometimes rusty under coulees. This structure is due to the surface water entering bentonitic sandstones and clays causing a swelling in the bentonitic content. There is a slight dip to the west in the coal seam as shown in Plate II. This is the oldest operating mine in the district.

A. B. C. Mine.—(Mine No. 620)

Capital authorized—$200,000.00.
Name of Operator—Alberta Block Coal Company Limited.
Mine Manager—D. A. Macauley.
Location of mine—N. W. ¼, Sec. 3, Tp. 29, R. 20, West of the 4th.
Area in lease—300 acres.
Seam mined—Seam No. 5.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—240,000 tons.
Date mine opened—March 1915.

This mine is situated between the buttes, half a mile south of the river. The thinnest part of the cover is 28 feet. Local rolls rising as much as six feet occur where the surface waters have caused the overlying bentonitic beds to swell and soften. A representative section shows 51 inches of coal with a thin bone layer about 18 inches from the floor (Plate IV No. 620).

Premier Mine.—(Mine No. 439)

Capital authorized—$50,000.00.
Name of Operator—Premier Coal Company Limited.
Overman—E. Reid.
Location of mine—L.S. 3, Sec. 10, Tp. 29, R. 20, West of the 4th.
Area in lease—160 acres.
Seam mined—Seam No. 5.
Entrance to mine—Slope.
System of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—60,000 tons.
Date mine opened—August 1914.

The cover ranges from 6 to 100 feet in thickness. In some parts of the workings a small quantity of water has entered from the overlying beds or from the surface. The cleat of the coal is N. 55° E. The seam thickens to over five feet where the bone thins out. One section shown in Plate IV No. 439 gave:

Coal	3 feet	0 inches
Bone		3 inches
Coal	2 feet	2 inches

Atlas Mine.—(Mine No. 684)

Capital authorized—$50,000.00.
Name of Operator—Atlas Coal Company Limited.
Mine Manager—James Holden.
Location of mine—S. E. $\frac{1}{4}$, Sec. 10, Tp. 29, R. 20, West of the 4th.
Area in lease—120 acres.
Seam mined—Seam No. 5.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated chain machine of the Arcwall type, also a Turbo compressed air operated chain machine of the under-cutting type.
Yearly capacity—135,000 tons.
Date mine opened—March 7, 1917.

The thickness of the cover varies from 18 to 25 feet. Characteristic local rolls occur. One section (Plate IV No. 684) shows:

Coal	2 feet	-	8 inches
Bone		2 -	6 inches
Coal	2 feet		8 inches

Newcastle Junior Mine.—(Mine No. 816)

Capital authorized—Not given.
Name of Operator—Newcastle Junior Mining Company Limited.
Mine Manager—D. A. Macaulay.
Location of mine—L.S. 9, Sec. 3, Tp. 29, R. 20, West of the 4th.
Area in lease—260 acres.
Seam mined—Seam No. 5.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain undercutting type.
Yearly capacity—210,000 tons.
Date mine opened—June 21, 1919.

At the shaft the cover is 32 feet 6 inches thick. A local slip with slight displacement occurs with a trend of N.15° W. The cleat of the coal is N.50° to 52°E. The coal thickens to 5 feet 2 inches where the bone thickens to a maximum of 12 inches. Profile section A-B passes through this mine. The section given in Plate IV No. 684 shows:

Coal	1 foot	-	4 inches
Bone		1 -	12 inches
Coal	3 feet	-	10 inches

Hy-Grade Mine.—(Mine No. 776)

Capital authorized—Not given.
Name of Operator—Hy-Grade Coal Company of Drumheller Limited.
Mine Manager—William Foster.
Location of mine—L.S. 4, Sec. 11, Tp. 29, R. 20, West of the 4th.
Area in lease—200 acres.
Seam mined—Seam No. 5.
Entrance to mine—Slope.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—210,000 tons.
Date mined opened—September 21, 1918.

The cover at this mine is seldom over 25 feet thick. The seam shows characteristics similar to those in adjoining mines. The coal becomes rusty and even wet under water courses on the surface, in other parts it is blocky and free from impurities. Minute lenses of coal frequently occur in the clay shale, and white bentonitic sandstone roof. Plate IV No. 776 shows this section:

Coal	2 feet 6 inches
Clay parting	½ inches
Coal	2 feet 2 inches

Elgin Mine.—(Mine No. 819)

Capital authorized—$50,000.00.
Name of Operator—Elgin Coal Company Limited.
Mine Manager—James McKelvie.
Location of mine—L.S. 14, Sec. 2, Tp. 29, R. 20, West of the 4th.
Area in lease—235 acres.
Seam mined—Seam No. 5.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—120,000 tons.
Date mine opened—August 23, 1919.

Profile section E-F passes through this mine. The cleat in the coal is N. 50° E. and the seam is about 4 feet 10 inches thick with one-half inch bone 10 inches from the floor. (Plate IV No. 819). In some parts of the roof 4 inches of coaly shale occurs below the regular shale roof.

Gibson Mine.—(Syndicate Mine) (Mine No. 998)

Capital authorized—Not given.
Name of Operator—Gibson Syndicate.
Mine Manager—William Foster.
Location of mine—L.S. 1, Sec. 2, Tp. 29, R. 20, West of the 4th.
Area in lease—1,200 acres.
Seam mined—Seam No. 5.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—300,000 tons.
Date mined opened—April 4, 1921.

Mining operations began here during the field season so that only a small quantity of coal had been extracted when the mine was visited. The roof is white bentonitic sandstone and grey shale. The percentage of bright coal in the seam is large. The following section was taken within 200 feet of the bottom of the shaft. (Plate IV No. 998):

Coal	1 foot 7 inches
Bone	3 inches
Coal	2 feet 3 inches
Bone	1 inches
Coal	7 inches

Midwest Mine.—(Mine No. 848)

Capital authorized—$250,000.00.
Name of Operator—Midwest Collieries Limited.
Mine Manager—William Jordan.
Location of mine—L.S. 7, Sec. 2, Tp. 29, R. 20, West of the 4th.
Area in lease—400 acres.
Seam mined—Seam No. 5.
Entrance to mine—Shaft.
System of mining—Room and Pillar.
Method of mining (machine)—Electrically operated coal cutting machines of the chain under-cutting type.
Yearly capacity—215,000 tons.
Date mine opened—April 7, 1920.

Coaly lenses in the roof, local rolls, and a softening of the coal under light cover are features in this part of the seam. Much blocky coal is extracted but the percentage of slack coal is high when the coal reaches the car, due to the excessive height of the tipple and the steep gradient in the loading chutes. The seam dips slightly to the northwest. One face showed 54 inches of coal but east of this mine the impurities in this seam increase. Plate IV No. 848 gives a general section.

Coal	1 foot 7 inches
Bone	½ inches
Coal	2 feet 7 inches

Superior Mine.—(Mine No. 701)

Capital authorized—Not given.
Name of Operator—John Givens.
Overman—John Givens.
Location of mine—L.S. 10, Sec. 11, Tp. 29, R. 20, West of the 4th.
Area in lease—160 acres.
Seam mined—Seam No. 5.
Entrance to mine—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—15,000 tons.
Date mined opened—July 26, 1917.

This mine is situated on the north side of Red Deer river opposite the municipal power plant in Drumheller. The entry to the mine is on the face of a steep escarpment, about 25 feet above the water level in the river. No. 5 seam has been eroded or is covered by outwash between this mine and the railway at Drumheller station. Slumping of the steep valley side has caused some slight disturbance in the seam in the mine. Plate IV No. 701 shows a section as follows:

Coal	3 feet 0 inches
Parting	$\frac{1}{2}$ inches
Coal	1 foot 4 inches

Western Gem Mine.—(Mine No. 678)

As both No. 1 and No. 5 seams are worked in this mine, the general conditions have been described on a previous page in the list of mines working on No. 1 seam. Plate IV No. 678-5 gives the following general section of No. 5 seam:

Coal	2 feet 4 inches
Bone	2 inches
Coal	3 feet 0 inches

MINE OPERATING COAL SEAM No. 7

Brooks Mine.—(Mine No. 464)

Capital authorized—Not given.
Name of Operator—B. T. Brooks.
Overman—B. T. Brooks.
Location of mine—L.S. 4, Sec. 23, Tp. 29, R. 20, West of the 4th.
Area in lease—100 acres.
Seam mined—Seam No. 7.
Entrance to mine—Drift.
System of mining—Room and Pillar.
Method of mining (machine)—Hand-pick.
Yearly capacity—30,000 tons.
Date mine opened—1915.

This mine is situated on the west branch of Michichi creek up which the road to Munson passes. It is the only mine in the district operating on this seam. Part of the output from this mine supplies the local trade on the adjacent upland.

A general section of the seam in this mine is shown in Plate IV No. 464.

Shale	6 inches
Coal	1 foot 3 inches
Shaly bone	10 inches
Bone	3 inches
Coal	2 feet 5 inches

CHAPTER VIII.

PRODUCTION AND RESERVE

Output.—Coal production in the Drumheller district may be considered to have begun in 1912. Prior to 1912 the production of coal from this field was grouped with that from a much larger mining area, but the quantity of coal mined from Drumheller district prior to that date was quite small, because the Canadian National railway (formerly the Canadian Northern) did not reach Red Deer valley until 1912, and was not completed to Calgary until 1914. The following table of coal production includes a small quantity from coal mines beyond the limits of the area shown on the map accompanying this report.

TABLE SHOWING THE COAL OUTPUT FROM THE DRUMHELLER DISTRICT

Year	Tons
1912	14,581
1913	52,894
1914	161,755
1915 (sold)	215,895
1916	377,618
1917	660,974
1918	881,081
1919	804,930
1920	1,210,687
1921	992,456
Total coal mined	5,372,871

Estimated Reserve.—The quantity of coal mined from this district is relatively insignificant when compared to the quantity in reserve. It has already been pointed out that although eleven seams of coal have been mapped, seven of them are of no commercial value, two are being worked in three mines, but almost the entire production is coming from two seams. It is known that these two seams (No. 1 and No. 5) cannot be mined in all parts. Up to date most of the coal produced has been extracted from the seams where the cover is thinnest, but these seams extend laterally in every direction under the upland. It may not be found profitable to mine in the present age, the coal under the surrounding country, but the coal is there in reserve for future generations.

Another factor which enters into any estimate of reserve is the loss on extraction. In the Alberta Mines Branch Report for 1919 Mr. John T. Stirling, Chief Inspector of Mines pointed out that during the period of mining in Alberta, over one hundred million tons of coal have been affected by mining operations, of which only 47,227,498 tons had been actually extracted. Of the remainder

26,628,770 tons have been lost beyond any chance of recovery. A percentage of this loss is included in the Drumheller district. The accessibility of the coal seams to the surface, easy transportation facilities, and quantity of coal available have encouraged wasteful methods in order to increase production. More attention should be given to conservation.

Fires in past ages have burnt out much coal, but fortunately these fires have been confined to some of the thinner seams, and have been local in extent as evidenced by red clinker which consists of baked clays.

It has already been stated that fourteen out of twenty-seven mines are working the lower (No. 1) seam. At a few of these mines the No. 5 seam was opened up first, but all except one, the Western Gem, abandoned work on the higher seam, either because it was found to contain too much bone and other impurities, or because the No. 1 seam could be mined more profitably. The question is frequently asked if the mining of the lower seam first will prevent the extraction of the coal from No. 5 seam. Between No. 1 and No. 5 seams there are interbedded sandstones and shales ranging in total thickness from 47 feet at the Monarch mine to about 90 feet east of Rosebud river. These beds are hard and resistent when dry, but become soft when wet. Field observations warrant the conclusion that wherever the intervening beds between No. 1 and No. 5 seams are dry, especially in those areas where No. 5 is exposed at or above the level of the bottom of the valley, there is no particular danger of spoiling the higher seam by extracting the coal from No. 1 first. If, however, water reaches the intervening bentonitic sandstones, local caving might occur if the lower seam is mined before No. 5.

Where mining is carried on without considering the best mining practice for that particular area considerable coal reserves might easily be destroyed. After taking these possible losses into consideration it is still a fact that the coal reserves in this district are very large. Only an approximate estimate of the coal in reserve can be made as in the future demands will meet the varying conditions.

Coal of a quality such as occurs in the seams in the Drumheller district will yield about 1,900 to 2,000 tons per acre-foot, assuming that the density of the coal ranges between 1.3 and 1.4. It is reasonable to assume that there is an aggregate of ten feet of workable coal over at least 6,000 acres, underlying or adjacent to the Red Deer and tributary valleys within the area mapped. This reserve alone amounts to over one hundred million tons.

These figures will give one an idea of the vastness of the coal reserves in this one district. Nevertheless, it is of the greatest importance that care should be taken to adopt the best mining methods and to prevent fires from devastating these deposits. Conservation should be the keynote in all mining operations regardless of the apparently unlimited supply of coal in reserve.

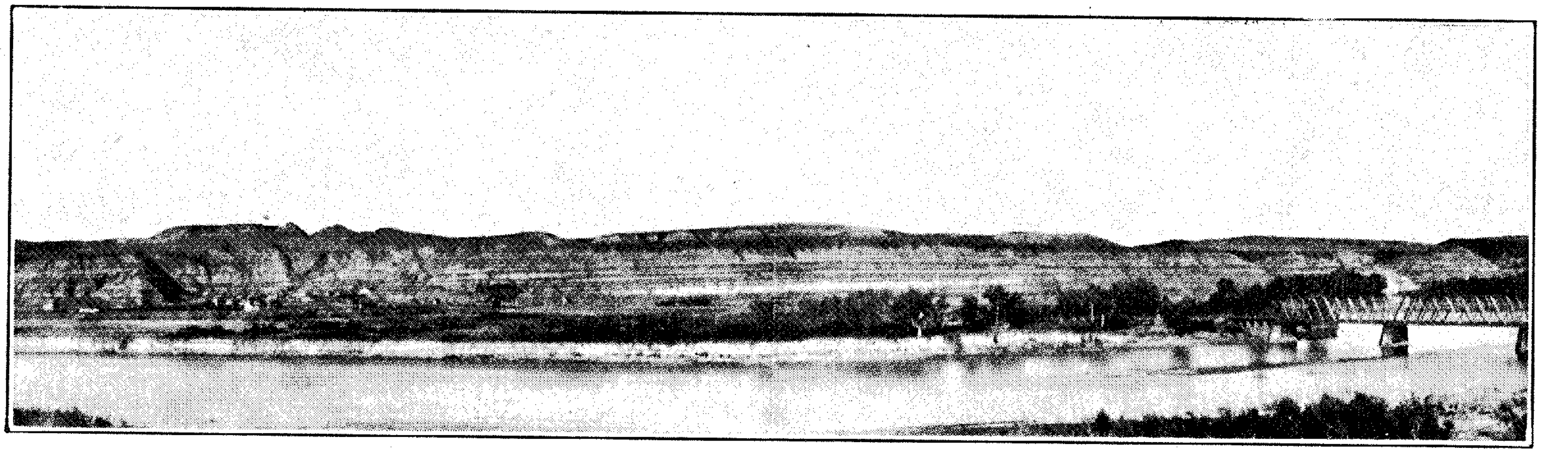

Plate XIII.—Looking northeast from Rosedale station. Lense of white bentonitic sandstone above seam No. 1 shows in centre.

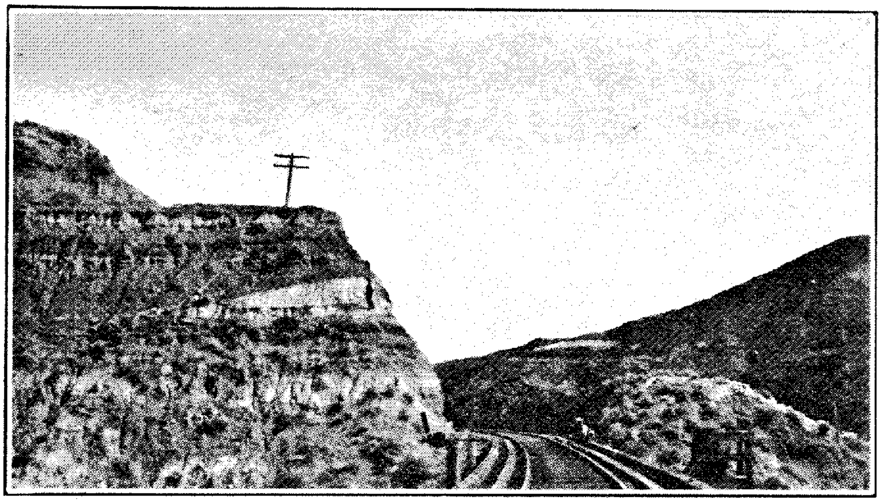

Plate XIV.—Lense of white bentonitic sandstone on top of seam No. 6 along Rosebud river south of Wayne. Typical structure in the Edmonton formation.

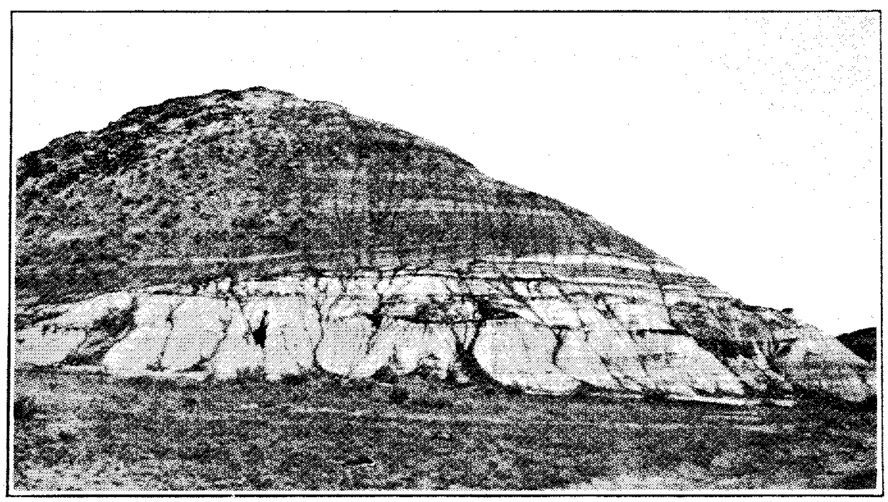

Plate XV.—Transitional beds between the Edmonton and Bearpaw formations. Marine shales locally overlapping brackish-water Edmonton sandstones.

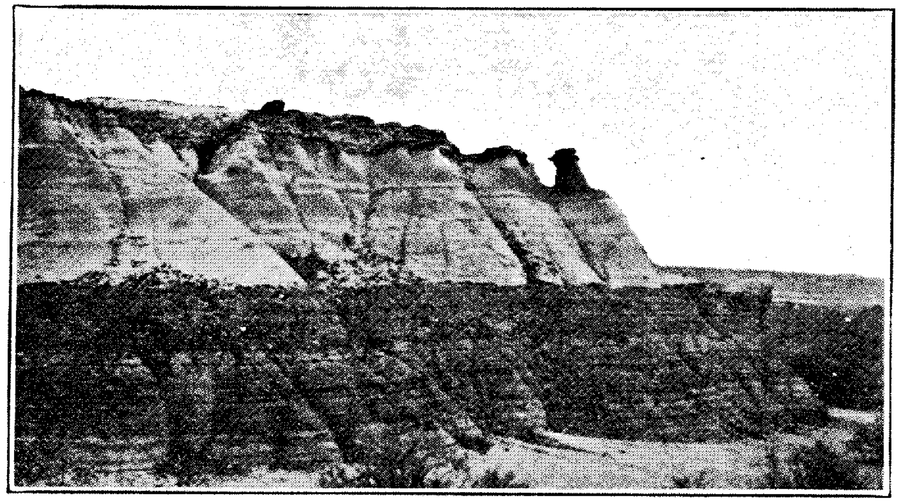

Plate XVI.—Sharply defined contact between light colored basal sandstone in the Edmonton formation and chocolate brown marine shales in the Bearpaw formation.

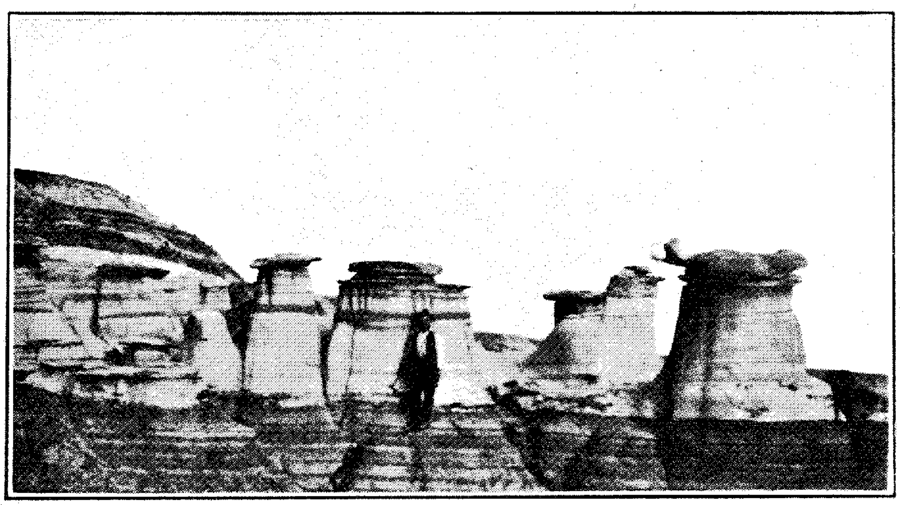

Plate XVII.—Edmonton-Bearpaw contact between Rosedale and Willow creek. Shows wind-formed "hoodoo" forms in bentonitic sandstones at base of the Edmonton formation.


PLATE I
LEGEND.
Flood Plain Deposits.
Outwash Sands & Clays.
Glacial Clays.
Sediments above Seam 8.
Sediments between Seams 7 & 8.
Sediments between Seams 6 & 7.
Sediments between Seams 5 & 6.
Sediments between Seams 1 & 5.
Sediments below Seam 1.
Coal Seams Nos. 1, 5 & 7 Heavy Lines.
UPPER CRETACEOUS
Edmonton Formation.
Surveyed Waggon Road.
Ry Double Track. Single Track. Under Construction.
Mine, Shaft.
Mine, Slope.
Mine, Tunnel.
Geological Boundary.
Fault.
Mesas & Ledges.
Note:- Elevations refer to Sea-level.
Scale of Miles
Camrose
Drumheller
Grass Covered
RED DEER RIVER.
DRUMHELLER
ROSEDALE
BROOKS
SUPERIOR
ROSEDALE
STAR
MOONLIGHT
SHAMROCK
HY-GRADE
ELGIN
MIDWEST
GIBSON
N. CASTLE
ATLAS
PREMIER
A.B.C.
NEW CASTLE
MIDLAND
WESTERN GEM
SCRANTON
MONARCH
SUNSHINE
CELTIC
WAYNE
ROSEDEER
WESTERN COM.
EXCELSIOR
Canadian Northern Ry.
Con. Pacific Ry.
Top of Bank
Township 29
Township 28
Range 19
Range 20
Range 20
Range 21
ISSUED BY
THE SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA
HON. HERBERT GREENFIELD, CHAIRMAN.
1922.
GEOLOGICAL MAP
OF
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SHOWING
OUTCROPS OF COAL SEAMS AND LOCATION OF MINES.
To accompany Third Annual Report by J. A. Allan 1921.
Scale of Feet
Geology and Surveys by:-
John A. Allan, In Charge.
R. L. Rutherford, Field Geologist.
J. O. G. Sanderson, Asst. Geologist.
EDMONTON, ALTA.