

CANADA
DEPARTMENT OF MINES AND RESOURCES

HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES AND GEOLOGY BRANCH

JOHN McLEISH, DIRECTOR

BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

PRELIMINARY REPORT

FALLENTIMBER MAP-AREA, ALBERTA

BY

B. R. MacKay

Paper 38-23

OTTAWA

1938

This document was produced
by scanning the original publication.

Ce document est le produit d'une
numérisation par balayage
de la publication originale.

CANADA
DEPARTMENT OF MINES AND RESOURCES
MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

FALLEN TIMBER MAP-AREA, ALBERTA

By

B.R. MacKAY

PAPER 38-23

JULY 1938

CONTENTS

	Page
Introduction	1
Stratigraphy	3
Oil and gas possibilities	10
Coal	17

Illustrations

Preliminary geological map Fallentimbor Map-area.

Geological cross-sections Fallentimbor Map-area.

FALLETIMBER MAP-AREA, ALBERTA

By B.R. MacKay

INTRODUCTION

Fallentimber map-area is bounded by latitudes $51^{\circ}30'$ and $51^{\circ}45'$ and longitudes $114^{\circ}30'$ and $115^{\circ}00'$. The centre of this rectangular block of 370 square miles lies 55 miles northwest of Calgary. It embraces the northern third of township 29, all of townships 30 and 31, and the southern half of township 32, extending across the western half of range 4, all of ranges 5, 6, and 7, and the eastern border of range 8, all west of the 5th meridian.

The topography of the Fallentimber area is largely controlled by the character and structure of the underlying bedrock formations. The lowest elevations, less than 3,500 feet above sea-level, occur in the northeastern corner of the map-area, and the highest summit is in the southwestern corner, with an elevation of over 5,450 feet. The area may be roughly divided into three topographic units that trend in a general northwesterly direction. The northeastern unit covers a width of 15 miles and extends to the crest of the line of summits that runs from Red Deer River at the northern boundary southeasterly to the junction of Little Red Deer River and Silver Creek. This area is underlain by flat-lying and gently eastward-dipping beds, and the elevation ranges from 3,500 to 4,240 feet.

The central unit is approximately 10 miles in width, and is a dissected plateau the elevation of which ranges from 4,240 feet on the east to 4,850 feet on the west. Its western boundary crosses the northern border of the map-area near the northwest corner and extends southeasterly to cross the southern boundary at the eastern border of range 7. It is underlain by folded and faulted strata.

The western unit occupies a maximum width of 7 miles in the southwestern part of the map-area. It is characterized by a series of narrow, northwesterly trending and westerly dipping fault-block ridges that rise to elevations of 4,750 to 5,250 feet. These are separated by flat-bottomed valleys, which lie, on an average, 250 feet below the crest of the ridges, and are floored with muskeg and greasewood.

Fallentimber map-area lies 15 miles west of the Calgary, Red Deer, and Edmonton Branch of the Canadian Pacific Railway and

25 miles north of the Calgary-Banff highway and main line of the Canadian Pacific Railway. Most of the area has been subdivided, but only the eastern part is suitable for farming, and only a fraction of the remaining territory is suitable for ranch land. Consequently, the area is very thinly settled, and even where road allowances have been opened up the poor condition of the roads during much of the year makes travel on them by motor truck impossible. Supplies are largely obtained by the residents from either Sundre, located just beyond the northern boundary of the area near the junction of Red Deer River and Fallentimber Creek, or Cremona, located near the southeastern corner of the area at the end of a 32-mile railway spur-line from Crossfield, on the Calgary, Red Deer, and Edmonton Railway.

Two small coal mines have been opened up and are worked spasmodically as occasion demands, one on Silver Creek near the northwest corner of sec. 30, tp. 29, range 5, and the other on the north side of Red Deer River at the northwest corner of sec. 5, tp. 32, range 4, W. 5th mer. Sawmills are being operated spasmodically on Red Deer River, Nitchi Creek and Turnbull Creek.

Good motor roads run west into the map-area from Olds, Didsbury, and Carstairs, stations on the Calgary, Red Deer, and Edmonton branch line. Of these, the road from Olds, which runs through Sundre 24 miles distant, is the longest and the one most widely travelled. It continues beyond Sundre for a distance of 4 miles, where it turns southward and enters the map-area on the west side of Red Deer River, thence it runs southwest and west along the northern bank of Red Deer River past the abandoned Monarch and Carter-Majestic wells, and continues 25 miles farther upstream to the Hunter Valley Oil Company well, 65 miles distant by road from Olds.

The southern part of the area is served by roads that run west from Carstairs and Cremona or north from Cochrane on the Calgary-Banff highway. A road, barely usable by motors during wet seasons, leads up Fallentimber Creek, which is forded six times. The road becomes impassable for cars a short distance within the Forest Reserve, but may be traversed by wagon to near the western border of the map-area. Another motor road follows up the valleys of Little Red Deer River and Silver Creek to Turnbull's mill, beyond which it continues westerly and northerly as a lumber road to join the road that runs along Fallentimber Creek.

The areas lying between Red Deer River, Fallentimber Creek, and Little Red Deer River are traversed by a few poorly travelled pack-trails used by hunters, trappers, and Indians. The most important of these is the Morely or Graham trail, which extends north from the Morely Indian Reserve on Bow River, located 25 miles south of the southern boundary of the area. This trail enters the map-area on the west side of Grease Creek in the NW¹/₄, sec. 24, tp. 29, range 7, continues northwesterly along it and on to cross Fallentimber Creek in sec. 28, tp. 30, range 7, near the eastern border of the Forest Reserve. It then swings around the eastern base of the hill and along the south bank of Stormy Creek which it follows northwesterly, thence across the divide into the valley of Red Deer River. This it crosses and follows to the junction of Williams Creek, then leads up Williams Creek and passes out of the map-area near its northwestern corner. A number of very poor and seldom travelled trails follow along many of the inter-ridge valleys and up the more important streams, such as Grease Creek, Silver Creek, Helmer Creek, and Nitchi Creek, and an occasional trail may be encountered leading across the intervening ridges and uplands from one main travel route to another.

STRATIGRAPHY

General Statement

The formations exposed within Fallentimber map-area, with the character and thickness of each, are given in the accompanying table of formations.

Table of Formations

Age	Formation	Character of beds	Thickness, feet
Recent		Stream gravels, sands, and silts	0 - 10
Glacial		Boulder clay, fluvio- glacial gravels	0 - 100
Tertiary	Paskapoo	Sandstones and shales with conglomerate lenses, fresh water	5,300 -
Upper Cretaceous	Edmonton	Massive sandstones, green and dark shales, carbona- ceous shales, bentonite beds, and coal seams, fresh water	3,000
	Belly River	Sandstones, shales, con- glomerate lenses, bentonite beds, and thin coal seams, fresh water	3,600
	Wapiabi (Upper Alberta)	Marine shales with iron stone beds and nodules and thin fossiliferous lime- stone beds	1,750

The lowest exposed horizon lies near the base of the Wapiabi formation. This formation is the equivalent of the Upper Alberta formation of Wildcat Hills and areas farther south. The boundary separating the Wapiabi marine shales from the fresh water sandstones of the overlying Belly River formation corresponds to the Wapiabi-Brazeau contact of the Bighorn coal basin and Brazeau River area. In some sections there appears to be a transition zone of approximately 100 feet separating the shales and sandstones, but in others the boundary is more sharply defined.

The great thickness of sediments that overlie the Wapiabi formation consist essentially of sandstones, sandy shales, and shales, with an occasional lens of conglomerate, and at several horizons volcanic ash beds and coal seams. The series has an approximate thickness of 12,000 feet, and embraces the equivalents

of several formations. In that part of the foothills south of Bow River the division of this group of sediments into several formations has been facilitated by the extension westward into the foothills of the marine Boarpaw shales, which separate the underlying Belly River sandstones from the overlying Edmonton sandstones. North of Bow River the Boarpaw formation is absent and the division between the Belly River sandstones and the overlying Edmonton beds is more difficult to make. An attempt has been made to subdivide the series into the Belly River, Edmonton, and Paskapoo formations, as has been done in the Wildcat Hills, Jumpingpound, and Bragg Creek areas to the south.

Wapiabi Formation

The Wapiabi (Upper Alberta) formation consists essentially of thin-bedded, fissile, and blocky marine shales. It outcrops only in the western part of the map-area, where it is the lowermost exposed formation in a number of northwesterly trending and westerly dipping fault blocks and in the centre of two anticlinal folds. No complete section of the formation is obtainable within the map-area, but from sections measured to the north and south of the field it is estimated to have a thickness of 1,750 feet. The greater part of this thickness is involved in several of the fault blocks in the area, but on those the actual exposures that exist cover only small parts of the formation. The maximum continuous exposure observed covered approximately 600 feet of the upper part of the formation.

The uppermost part of the Wapiabi formation within the map-area consists of greenish, sandy shales containing numerous bands of sandstone, and of ironstone generally less than an inch thick. A marine fauna including *Baculites ovatus* was collected from two exposures on Red Deer River, located in the SE. $\frac{1}{4}$, sec. 27, and in the NW. $\frac{1}{4}$, sec. 29, tp. 31, range 7, W. 5th mer., and at an exposure on Fallentimber Creek in the NW. $\frac{1}{4}$, sec. 25, tp. 30, range 7, W. 5th mer. On Red Deer River and Fallentimber Creek the contact between the Wapiabi shales and the overlying, massive, Belly River sandstone is clearly marked, but on Little Red Deer River there is a transition zone approximately 100 feet thick, in which massive shale beds are interbedded with freshwater sandstones. Here the boundary between the Wapiabi and the overlying Belly River formation was drawn at the base of the lowest massive sandstone bed.

Lower down the formation consists of dark grey and black, massive shales, which contain only an occasional ironstone concretion or a few thin, yellowish grey, argillaceous limestone bands, some of which hold an *Ostrea* fauna. On Red Deer River, in the NW. $\frac{1}{4}$, sec. 29, tp. 31, range 7, W. 5th mer., at approximately 1,200 feet stratigraphically below the top of the Wapiabi formation, there is exposed an horizon containing *Scaphites ventricosus* and various *Inoceramus*.

Nowhere within the map-area was the base of the Wapiabi formation observed, but it is believed to underlie the muskeg at the northeast corner of sec. 23, tp. 27, range 7, W. 5th mer., at the southern border of the map-area. A half mile farther south-east along the strike a few small outcrops of the *Cardium* formation occur, and from here the formation has been traced by Hume southeasterly across the Wildcat Hills map-area. It consists of one or more bands of sandy shales with a few thin beds of sandstone capped by a thin conglomerate with small pebbles. The thickness of the *Cardium* formation in the map-area, as based on thickness obtained on Ram River to the north and Ghost River to the south, is 275 to 300 feet.

Belly River Formation

The Belly River formation consists largely of white, grey, and brown sandstones interbedded with light green to black shales, and an occasional lens of conglomerate composed of quartzite and chert pebbles embedded in a sandy matrix. Associated with these beds are thin beds of bentonite, bands of ironstone, and a few thin coal seams. The upper part of the formation is more bentonitic and contains more thin carbonaceous layers and coal seams than does the lower part and, consequently, is much softer. Due to the prevalence of faulting and the heavy overburden of glacial drift it is very difficult to obtain an unbroken section or an accurate determination of the thickness. The formation appears to increase in thickness from east to west. The thickness as determined by a number of structural sections on Red Deer River, Little Red Deer River, and its tributary Frozeman Creek, is 3,600 feet, whereas to the west on Fallentimber Creek and Grease Creek the thickness was determined to be at least 3,900 feet.

The division line between the Belly River formation and the overlying Edmonton formation is in some places difficult to draw. The boundary has been drawn in most places at the base of a bed of conglomerate that ranges up to $1\frac{1}{2}$ feet in thickness and is composed of pebbles of chert of various hues, quartz, and shale fragments. A similar conglomerate marks a basal bed of the Edmonton formation in the Wildcat Hills area. On Red Deer River slabs of silicified wood and bone fragments of a duck-bill dinosaur were found in the conglomerate. Beneath it occurs a 3-foot bed of blocky shale, followed by a 25-foot thick bed of soft shale, followed by soft, shaly sandstones, some beds of which are strongly bentonitic. In the Monarch well on Red Deer River, where the conglomerate bed appears to be missing, the boundary between the Belly River and Edmonton formations has been drawn at a depth of 750 feet, at the base of a hard, green sandstone that overlies a thick bed of dark shales with thin beds of light-coloured grit. There is a fault contact at the Silver Creek coal mine, and at the old Downio mine on Little Red Deer River.

Edmonton Formation

The Edmonton formation consists largely of light buff, grey, and brown sandstones interbedded with greenish and dark brown, sandy and blocky shales. Associated with these beds are a few thin beds of bentonite, a few of carbonaceous shale, at least two 3- to 6-foot thick coal seams, and a bed of conglomerate holding chert and quartzite pebbles. On Sawdust Creek, in sec. 29, tp. 29, range 6, W. 5th mer., in the lower part of the formation there is a fossil-bearing horizon carrying abundant well-preserved *Unio* and *Gastropods*. The total thickness of the formation is estimated at, roughly, 3,000 feet.

Nowhere in the map-area is a complete section of the formation obtainable, the outcrops that do occur being almost wholly confined to the immediate banks of Red Deer River, Fallentimber Creek, and Little Red Deer River and its tributary Silver Creek. The most complete sections of the formation obtained are on Red Deer River and Silver Creek. The lowermost horizon exposed in both these sections is a coal seam, which is being mined as occasion demands, on Red Deer River at the Ferguson mine, in the NW. $\frac{1}{4}$, sec. 5, tp. 32, range 6, W. 5th mer., and on Silver Creek at the Silver Creek mine, in the NW. $\frac{1}{4}$, sec. 30, tp. 29, range 5, W. 5th mer. On Red Deer River the base of the Edmonton formation has been drawn at this coal seam, which lies less than 100 feet stratigraphically above the highest bed in the Monarch well. The

greater part of the formation is exposed along Red Deer River west of the Monarch well, but the presence of several thrust faults makes the correlation of the beds and an accurate determination of the thickness of the formation impossible.

Paskapoo Formation

The Paskapoo formation consists of hard, light grey, buff, and yellow, brown-weathering sandstones, some of which are interbedded with light bluish grey to dark olive-green, sandy and blocky shales. There are also a few thin beds of bentonite and carbonaceous shale and an occasional thin coal seam. At several horizons there are shell beds, the invertebrate fauna of which are practically all of fresh-water origin. Fish scales and other fragmentary vertebrate remains were also obtained from these beds.

Outcrops of the formation are almost wholly confined to the channels of Red Deer River, Fallentimber Creek, Little Red Deer River, and the north side of Bear Valley, and Stony Creek. As the beds of this formation are considerably coarser and harder than those of the immediately underlying Edmonton formation, the basal Paskapoo beds, where they come to the surface, generally form an area of high relief. Within the map-area the actual base of the Paskapoo formation was observed at only two localities, one on Little Red Deer River, at the south border of the map-area, and the other a third of a mile north of Silver Creek, a tributary stream. At both these localities the Paskapoo formation overlies the Edmonton formation without any apparent unconformity.

On Little Red Deer River the lowermost beds consist of 115 feet of buff to brown-weathering sandstones, some of which are crossbedded. This horizon outcrops in a cliff approximately 100 feet high on the north side of the river. The beds strike 350 degrees and dip 30 degrees east, and overlie soft, carbonaceous shales and grey sandstones of the Edmonton formation. On Silver Creek this basal sandstone horizon is 188 feet thick, 140 feet of which contain large, hard, sandstone concretions and lenses. It strikes 340 degrees and dips 30 degrees east, and overlies, apparently conformably, the softer shales and sandstones of the Edmonton formation. The only other localities within the map-area at which beds occurring near the base of the Paskapoo formation are exposed is on Fallentimber Creek in the centre of the area and on Red Deer River at its northern boundary. On Red Deer River the section, in ascending order, consists of a 3-foot rubbly shale,

3-foot sandstone, 5-foot shalo, and a 30-foot bed of hard, massive, brown-weathering sandstone; the beds strike 345 degrees and dip 13 degrees east. These beds occur approximately 100 foot below a 240-foot thick section of Paskapoo beds exposed in the cliff on the river immediately north of the map boundary.

The maximum thickness of the formation within the map-area, as indicated by the isolated outcrops along Fallentimber Creek, Little Rod Deer River, and its tributary streams, is estimated at 5,300 foot.

Recent and Pleistocene

A blanket of glacial drift consisting of boulder clay and fluvioglacial gravels covers practically all of the interstream areas, whereas the valleys of the larger streams are floored by sand and silt of more recent stream origin. On the uplands the boulder clay is brownish, is composed largely of sandstone and quartzite boulders and rock flour of local origin, and is generally less than 3 feet thick. In the southwestern part of the map-area, where the ridges are higher, the boulder clay covering is thin and numerous exposures of rock occur along the ridges. In the lower-lying part of the map-area, and especially in the broad, pre-glacial valleys, the glacial drift blanket is much thicker, attaining in places a thickness of approximately 100 feet. In these localities the drift consists of an underlying blanket of boulder clay and an upper thick zone of gravel and sand of fluvioglacial origin.

Along most of the larger streams the glacial drift has been carved by the stream into a series of prominent terraces, some of which are over a mile wide and have a capping of more recent stream gravels, muskog, or black soil. The immediate channels of most of the streams are characterized throughout their length by bars of gravel, sand, or silt derived from the reworking of the unconsolidated drift.

OIL AND GAS POSSIBILITIES

Fallentimber map-area lies on the western flank of the Alberta geosyncline. A traverse across it reveals a change in structure, from east to west, from flat or gently eastwardly dipping strata, through folded and faulted beds, into a series of westerly dipping fault blocks. Assuming that the Mesozoic strata are underlain by Palaeozoic limestone, and that the limestones may carry oil in commercial quantities where favourable structures exist, four anticlinal structures merit discussion. These are the Monarch structure, the Red Deer River-Silver Creek structure, the Grease Creek structure, and the Red Deer River - Fallentimber Creek structure.

The depth to the Palaeozoic limestone is as yet a matter of inference, as no holes sufficiently deep to tap this formation have yet been drilled. The formations to be expected and their thicknesses should correspond fairly closely with those found along the strike of the strata in the Rain and Brazeau River areas to the north and in the Wildcat Hills and other areas to the south. The formations and their estimated thicknesses in the Fallentimber area are as follows:

	Feet
Wapiabi	1,750
Cardium	300
Blackstone (Lower Alberta)....	950
Blairmore	2,000
Kootenay	500
Fernie	150
	<hr/> 5,650

Taking into consideration the various structural factors believed to exist on each of the anticlinal structures, the minimum distance to the Palaeozoic limestone is estimated to be at least 7,500 feet. As in Turner Valley, there is a possibility of encountering accumulations of oil and gas in porous horizons in the overlying strata.

Monarch Structure

The Monarch structure as displayed at the surface is in the Edmonton formation, and the crest of this fold crosses Red Deer River in the NW. $\frac{1}{4}$, sec. 5, tp. 32, range 6, and trends in a northwest-southeast direction (See section A-B). Owing to the soft nature of the bedrock and the thick overburden, the bedrock is

concealed except in the channel of the river and for less than a mile along a cliff on the north side of the valley. Even along the river channel no exposures occur for $1\frac{1}{2}$ miles east of the crest of the fold. The existing exposures are sufficient, however, to reveal that the fold has an unbroken, gently dipping eastern limb and a more steeply inclined and much faulted western limb. The crest of the fold is over 1,000 feet wide and is formed of beds in the lower part of the Edmonton formation. It is characterized by several minor anticlinal summits separated by shallow synclines. The eastern limb dips 22 degrees east near the crest, but the angle of dip is believed to become progressively lower eastward, until $1\frac{1}{2}$ miles downstream, near the Edmonton-Paskapoo contact, it is 13 degrees. The west limb near the crest dips 45 degrees west and 1,700 feet west from the crest this limb is cut by a fault zone in which there appears to be both easterly dipping and westerly dipping faults with slight displacements. Within the next 3,200 feet at least three other westerly dipping thrust faults occurs, each of which is accompanied by drag-folds. A mile west of the anticlinal crest there is a major, westerly dipping, low-angle fault plane along which beds belonging to the Belly River formation have been thrust eastward upon the Edmonton beds of the Monarch anticline.

No complete section of the Edmonton formation on Red Deer River can be had. The base of the formation is not exposed. In the log of the Monarch well, the uppermost 630 feet consists largely of greenish grey, sandy shales, grits, and sandstones, with a few thin beds of carbonaceous shale, and this assemblage is similar to the Edmonton beds exposed in the east and west limbs of the anticline. Below this depth the shales and sandstones are light grey and the beds become more massive, which features are characteristics of the Belly River beds exposed a mile west, up Red Deer River.

To date, the Monarch structure has been only partly tested by a 3,500-foot deep hole. This well was put down in 1914-15 by the Monarch Oil Company, Limited, on the north bank of Red Deer River at an elevation of 3,975 feet, near the apex of the main anticlinal structure in the NW. $\frac{1}{4}$, sec. 5, tp. 32, range 6, W. 5th mer. It began in the Edmonton formation at an horizon about 630 feet above its base and terminated at a depth of 3,560 feet in the lower part of the Belly River formation. A small seepage of olive-green to dark crude oil was reported to have been struck at a depth of 808 feet, and in several lower sandstone horizons there was encountered a number of other small seepages of oil and sufficient flows of gas to supply light,

heat, and power to the plant, the daily supply of the latter being estimated at 100,000 cubic feet.

Red Deer River-Silver Creek Structure

The Red Deer River-Silver Creek structure crosses the centre of the map-area in a northwesterly-southeasterly direction. The structure is not a simple anticline, but is one that has been considerably modified by a number of longitudinal faults and drag-folds produced by overthrusting from the southwest. It is bounded throughout its length on the east by a westerly dipping fault plane, along which soft Belly River beds have been thrust eastward over beds of the Edmonton formation. The structure can be observed in detail on Red Deer River and on Silver Creek, and the crest of the fold is exposed on Fallentimber Creek.

On Red Deer River the structure is wider and more modified by faulting than it is on Silver Creek. Along Red Deer River the Belly River beds cover a width of $2\frac{1}{2}$ miles and form one major and several minor anticlinal crests, accompanied by thrust faults of various dimensions (See section A-B). The main anticlinal crest crosses Red Deer River near the northeastern corner of tp. 31, range 7, W. 5th mer., and the major low-angle fault separating the soft beds of the upper part of the Belly River formation from the Edmonton beds crosses Red Deer River 3,000 feet downstream from this summit. The eastern limb near the crest dips 70 degrees east, and between the crest and the low-angle fault there are two other anticlinal crests separated by a fault. The western limb of the fold dips about 30 degrees west, but is cut by at least three faults, along which the displacement is to be measured in several hundreds of feet.

These faults are believed to continue downward into the Wapiabi formation, but may not extend to the major, low-angle, westerly dipping fault. The most prominent of these secondary thrust faults crosses Red Deer River 2,500 feet upstream from the main crest, and 2,000 feet farther upstream is located the well of the Cartier-Majestic, Limited.

On Silver Creek both limbs of the structure are faulted, with drag-folds developed adjacent to the major faults. The crest of the fold is near the middle of the Belly River formation, and this formation occupies a width of $1\frac{3}{4}$ miles. The crest of the fold is exposed on Silver Creek at a point 1,500 feet east of the west boundary, on sec. 25, tp. 29, range 6, W. 5th mer., where it

is observed to trend 15 degrees east of south and to plunge 8 degrees south. It lies 3,000 feet west of where the major, westerly dipping, low-angle fault comes to the surface, and is separated from it by a shallow syncline, a fault, and a secondary drag anticlinal fold that lies adjacent to the major fault.

Owing to the covering of boulder clay, gravel, muskog, or forest growth that conceals the bedrock over much of the surrounding area, the position of the crest of the anticline to the north of Silver Creek can for the most part only be inferred. One and a quarter miles north of Silver Creek the crest of the fold is not exposed, but from the outcropping beds on opposite limbs it is believed to lie 600 feet east of the southwest corner of sec. 1, tp. 30, range 7, and a few feet to the east of where the Spindletop well No. 1 is being drilled (See section G-H). Sandstone beds exposed in the derrick basement and on the ridges immediately west of the well location dip 40 degrees west, whereas the sandstone and conglomerate beds outcropping on the ridge 200 feet east of the well site dip 45 degrees east. The beds on the opposite limbs of the fold, where exposed, have approximately the same strike and could not be traced across the axis of the fold. If there is any southward plunge to the fold it is only a few degrees. Possibly the crest of the fold here is faulted.

Over the 12-mile stretch between the northernmost outcrops near Spindletop Oils, Limited, well No. 1, and the exposures along Red Deer River, the only rock outcrops occurs about midway along the channel of Fallentimber Creek, in secs. 33 and 34, tp. 30, range 6, W. 5th mer., for a distance of less than 1,000 feet. In this short exposure is displayed the apex of the anticline. The beds on the west flank dip 25 degrees west and those on the east dip 45 to 40 degrees east.

The three faults already referred to as cutting the west limb of this anticlinal structure on Red Deer River are believed to continue southeastward roughly parallel to the axis of the fold, and to be represented in the Silver Creek area by two faults. The fault nearest the axis is believed to cross Silver Creek highway 100 feet east of the road bridge in the northwest corner of sec. 25, tp. 29, range 6, where vertically dipping sandstone beds are exposed. The tops of these beds face north and are believed to form the eastern limb of a tightly compressed and faulted drag-fold developed along a major fault. The beds in the western limb of this drag-fold outcrop within 100 feet west of the bridge, where they dip 45 degrees west. The vertical displacement along this fault in the vicinity of Silver Creek is estimated to be several

thousand feet, bringing the Wapiabi (Upper Alberta) shale in the core of the drag-fold to within a few hundred feet of the surface.

The two other major faults of this structure observed on the Red Deer River section are interpreted as joining near the southeast corner of sec. 5, tp. 31, range 6, W. 5th mer., and continuing thence southeasterly as one fault across Fallentimber Creek and on to form the conspicuously straight course of Silver Creek Valley in secs. 15 and 10, tp. 30, range 6, W. 5th mer. This fault leaves Silver Creek Valley at the quarter-post on the east side of section 3, whence it continues in a less clearly defined southeasterly course along the slope of the ridge to cross Silver Creek highway roughly 3,500 feet to the west of the anticlinal crest. The vertical displacement along this fault is believed to be relatively small.

The oil and gas possibilities of the Red Deer River-Silver Creek anticlinal structure have not as yet been adequately tested, although test holes have been sunk at the northern end on Red Deer River, near the centre of the structure at a point a little to the north of Fallontimber Creek, and near its southern end near Silver Creek. None of these holes, however, reached below the basal part of the Belly River formation. A test well is at present being drilled by Spindletop Oils, Limited, on the crest of the anticline north of Silver Creek, and it is hoped that this well will be carried to a sufficient depth to satisfactorily prove the structure. The well has already reached the top of the Wapiabi (Upper Alberta) formation and although indications of gas and oil have been reported, no commercial supplies are to be expected until much deeper horizons are reached.

The first test hole put down on this structure was a diamond drill hole started on September 1, 1914, by the Sunbeam Oil Company in the SE. $\frac{1}{4}$, sec. 4, tp. 31, range 6, W. 5th mer., at a point 4,000 feet north of Fallentimber Creek. This location lies at or close to the axis of the anticline (See Section C-D). While this hole was being drilled the Sunbeam Oil Company was amalgamated with others under the name of the Union Pacific Consolidated Oils, Limited, and Sunbeam No. 1 well was renamed U.P. Consolidated No. 2 well. The hole was continued to a depth of 1,800 feet, when in June 1915 drilling was discontinued. Oil seepages were reported to have been encountered in soft, porous sands at depths of 1,380, 1,390, 1,393, 1,440, 1,590, and 1,680 feet, and a large showing of gas at a depth of 1,800 in what is probably the basal beds of the Belly River formation.

In May 1931, Cartier-Majestic Oils, Limited, started a well in L.S. 6, sec. 36, tp. 31, range 7, W. 5th mer., on the north bank of Red Deer River, at an elevation of 4,025 feet. This well is located 4,500 feet west of the axis of the anticline, and is separated from it by a fault along which there has been considerable vertical uplift of the beds on the west side. The horizon at which the hole was started is believed to be near the middle of the Belly River formation. The hole was sunk to a depth of 1,420 feet, and was still in the Belly River formation when in January 1935 drilling was discontinued. Oil and gas showings were reported as having been encountered at several horizons, but not in commercial quantities. The stratigraphic interval between the lowest horizon already reached and the Palaeozoic limestone is estimated to be about 5,700 feet.

The southern part of the Red Deer River-Silver Creek structure is being tested by Spindletop Oils, Limited, No. 1 well, located in sec. 1, tp. 30, range 6, W. 5th mer., near where Cremona No. 1 well had previously been started. It is located on the west limb of the anticline close to its crest, at an elevation of 4,440 feet above sea-level. Drilling was started here on April 15, 1937.

At a depth of 1,460 feet the hole entered shale that is believed to be the top of the Wapiabi formation and continued in these shales to a depth of 1,970 feet. Here it entered sandstones of the Belly River formation and drilling has been temporarily discontinued at a depth of 2,315 feet in an horizon believed to lie roughly 500 feet above the base of the formation. It is probable that the major low-angle fault was crossed at 1,970 feet, although no evidence of slickensiding was observable in the drill samples examined. On the other hand, the lower part of the Belly River formation as exposed in the heart of this fold on Little Red Deer River, 3 miles south of the well, contains a massive shale bed a short distance above the basal massive sandstones, and it may be that the shales penetrated in the lower part of the hole belong to this member of the Belly River formation.

Where the Silver Creek coal mine is located occurs the junction of two major faults. One is an easterly dipping fault that causes a duplication of the coal seam being mined and has thrown it into drag-folds produced by a thrust from the east. The other is a steep, westerly dipping fault that is believed to underlie the anticline. For a distance of 470 feet west of this fault there occur vertical beds that form the eastern limb of a large drag-fold resulting from a thrust from the west. It is believed that this fault decreases rapidly in depth and that the displacement along it is relatively small.

Grease Creek Structure

The Grease Creek anticline occurs in the northeastern part of tp. 29, and the southeastern part of tp. 30, range 7, W. 5th mer. The axis of this structure is believed to cross the southern boundary of Fallentimber map-area at Grease Creek and to trend in a direction north 17 degrees west, crossing the northern border of township 29, range 7, 6,000 feet west of its eastern border. Here the anticlinal form of the structure is most clearly defined by the prominent curve in the Belly River-Wapiabi contact and by the dip and strike of the Belly River outcrops. The axis of the fold could not be traced north of the recorded outcrops due to the heavy covering of glacial drift and forest growth that completely conceal the bedrock, but it is believed to continue northward and to be in alignment with the axis of the fold observed on Fallentimber Creek at the eastern boundary of sec. 27, tp. 30, range 7, W. 5th mer., which is cut off by the longitudinal fault $3\frac{1}{2}$ miles farther north. The form of this anticlinal structure at the north boundary of township 29 is shown by section E-F. The western limb has been modified by thrust faulting.

Red Deer River-Fallentimber Creek Structure

On Red Deer River, at the western border of the map-area, there occurs a prominent anticlinal fold in the Belly River formation, the unbroken crest of which is completely exposed in a 200-foot cliff on the north bank of the river. The axial plane dips steeply to the west. The fold is bounded on the east by a westerly dipping fault zone that crosses the river 2,500 to 3,000 feet east of the anticlinal axis, and along which the beds on the west have been thrust for 1,000 feet or more over those on the east. This fault zone, though steep at the outcrop, is believed to decrease in dip in depth, and to underlie the anticline at a depth of approximately one-half mile beneath the surface. The axis of the anticline where exposed on Red Deer River trends 23 degrees east of south, but owing to the covering of glacial drift, muskeg, and forest growth it was impossible to trace it either north of the river or southeasterly toward Fallentimber Creek.

A traverse along Fallentimber Creek reveals that the axis of this anticline lies close to the thrust fault in the NE. $\frac{1}{4}$, sec. 20, tp. 30, range 7. Here basal Belly River beds and the underlying shales of the Wapiabi formation may be observed to be tightly folded and thrust over Belly River beds. The crest of this fold occurs in the Wapiabi formation,

approximately 1,000 feet stratigraphically below the Belly River-Wapiabi contact. This contact crosses Fallentimber Creek 1,700 feet west of the fault, from where it may be observed to continue northward and eastward to circle over the axis of the anticline at approximately 4,000 feet north of Fallentimber Creek. To the south of Fallentimber Creek the fault and the Belly River-Wapiabi contact continue with an average trend of south 20 degrees east to beyond the southern boundary of the map-area, the structure being that of a westerly dipping fault block having an average dip of 45 to 50 degrees west.

In the vicinity of Red Deer River, the anticline, though here very pronounced, is believed to be a large drag-fold cut off at a comparatively shallow depth by a westerly dipping fault, below which the structure is interpreted as being a westerly dipping monocline similar to that occurring in the area to the east of the fault, as shown by sections A-B, C-D, and E-F. The western limb of the anticline is cut by several thrust faults, along which there is considerable displacement. The closest of these to the summit is estimated to cross Red Deer River one-half mile west of the anticlinal axis.

COAL

Several thin coal seams occur in the upper part of the Belly River formation, but none of them is sufficiently thick to warrant development. Coal seams thick enough to be commercially mineable are confined to the lower part of the Edmonton formation. Several seams of bright, banded, high volatile, sub-bituminous coal, averaging 3 to 4 feet in thickness, outcrop on Red Deer River, Silver Creek, and Little Red Deer River. Small mines were opened up at some of these locations a number of years ago, but were soon closed due to difficulties encountered. At present small amounts of coal are being extracted, as occasion demands, at the Red Bell mine, located on Red Deer River in L.S. 13, NW. $\frac{1}{4}$, sec. 5, tp. 32, range 6, W. 5th mer., and at the Silver Creek mine, located on Silver Creek in the NW. $\frac{1}{4}$, sec. 30, tp. 29, range 5, W. 5th mer.

The Red Bell mine on Red Deer River was opened in 1934 on a 2-foot 10-inch seam of blocky, bright coal that occurs 750 feet above the base of the Edmonton formation, and near the crest of the Monarch anticline. An adit 400 feet long has been driven along the seam, which strikes 325 degrees and dips 37 degrees east into a shallow syncline. The workings are carried up the pitch to the surface, a maximum of 100 feet. The seam repeated on the flanks of the several shallow folds that characterize the

crest of the Monarch anticline. The roof and the floor of the coal seam are shale. The thinness of the seam, the closeness of the folds, and the lack of overhead lift in the seam are the main difficulties to any large-scale development at this mine. The eastern flank of the Monarch anticline has a uniform dip of 22 degrees or less, but this inclination is too low to permit of a profitable extraction of coal in such a thin seam.

On Silver Creek, coal has been mined in a small way at two localities less than 1,500 feet apart, on the NW.¹/₄, sec. 30, tp. 29, range 6, W. 5th mer. A number of years ago a small operation under the name of the Bitumen coal mine was carried on and considerable coal extracted. This mine, located 1,500 feet east of the western boundary of section 30, has long been abandoned and the old workings have caved. The seam where exposed near the mine has a maximum thickness of 8 feet, but is very carbonaceous in its upper part and is badly crushed. It strikes 345 degrees and has an average dip of 45 degrees east. The seam occurs at an horizon 1,445 feet stratigraphically below the Edmonton-Paskapoo boundary.

A 3-foot 6-inch coal seam located 300 feet east of the western boundary of section 30 and 2,200 feet stratigraphically below the Edmonton-Paskapoo contact was mined a few years ago. In 1937 this mine was reopened and is being operated in a small way under the name of the Silver Creek Coal Mining Company. It supplies coal to Spindletop Oils, Limited, for drilling purposes, and to residents of nearby centres. A 400-foot adit has been driven north from Silver Creek along the seam, which strikes 345 degrees and dips 45 degrees east. At the end of the adit the seam is almost completely cut out by a fault, which appears to strike 350 degrees and dips 60 degrees east. Innumerable, small, asymmetrical drag-folds are observable in the coal seam, all indicating a thrust along this fault plane from the east. Followed down the dip, the seam departs from the fault plane and assumes a dip of 40 to 35 degrees east, conforming with the general dip of the overlying measures to the east. The coal seam with 50 feet of overlying beds is repeated 50 feet west of this fault, the approximate displacement of the coal seam along the fault plane being estimated at 125 feet. The western segment of the coal seam dips 50 degrees east and overlies beds that appear to form the core of a highly squeezed anticline. What appears to be the crest, however, is crumpled beds caused by a westerly dipping fault, along which vertical beds of the Belly River formation, with their tops to the east, have been thrust eastward upon the easterly dipping Edmonton beds. The western segment of

the coal seam is, therefore, not considered to have any commercial value, and large-scale development is dependent on the possibility of profitable extraction down the dip of the coal seam from the adit. Unfortunately, the old abandoned workings lie at or below stream level at the entry to the adit, which makes the entry into the undeveloped deep territory by a slope from the creek difficult.