CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

PAPER 41-10

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(Summary Account)

BY

J. S. Stewart

OTTAWA
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PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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Steveville Oil and Gas Field, Alberta

The Steveville oil and gas field, which has been discovered only recently, lies in the Brooks map-area, which embraces the region between latitudes 50 and 51 degrees and longitudes 111 and 112 degrees. The most vigorous development at present (May 1941) is in the southeast part of tp. 20, rge. 12, W. 4th mer., and some 20 to 25 miles northeast of the town of Brooks.

Wells in which gas in quantity has been discovered are, however, scattered over such a wide area that it is difficult to predict what the limits of the field will be, and whether gas or oil will be the main product of the wells.

The region is mostly a flat prairie country cut by shallow valleys. South Saskatchewan and Red Deer Rivers, however, flow in parts of their courses through deep, narrow valleys and have deep, canyon-like, tributary coulées cutting back a short distance from the main streams. This type of canyon-like valley is particularly conspicuous along Red Deer River near Steveville where the dry climate, thin soil cover, and poorly cemented nature of the bedrock have combined to produce badlands over an area of about 100 square miles. In this area there is little vegetation, the bedrock is completely exposed, and steep-sided, deep drainage channels are numerous.

The accompanying map shows the surface distribution of the bedrock formations. As much of the region is prairie and exposures of bedrock few and far apart, the formation boundaries are in many places located by projection from known outcrops. This projection is based on knowledge of the elevation of the surface and the regional dip of the strata as determined from outcrops and the records of deep wells.

The oldest strata exposed belong to the Foremost formation. This formation is composed of fresh and brackish water deposits. The lower part consists of brown to grey sandstone and sandy shale with ironstone bands and several oyster beds. The uppermost 100 feet includes much carbonaceous shale and many thin coal seams. One seam of workable thickness is mined at several places to supply a local market. The base of the formation is not exposed, but the Foremost formation is not less than 250 feet thick. The uppermost carbonaceous shale above the coal seams is taken as the top of the formation, but it is thought that these beds are of very local distribution and the top of the formation is probably a different bed in different places. At its base, the Foremost grades into a formation that consists mainly of marine shale and probably corresponds to the Pakowki of areas to the south. The following section illustrates the lithology of the Foremost formation as seen in outcrops on the east bank of south Saskatchewan River in SW. ¼ sec. 27, tp. 12, rge. 10, W. 4th mer.

Lithology	Thickness Feet
Covered by wash and till to prairie level	30·0
Buff sandstone with thin bands of ironstone	20·0
Brown, carbonaceous shale with coal fragments	0·3
Light grey sandstone	8·9
Clay shale and sandy shale	1·6
Buff sandstone, some shale	6·8
Light grey sandstone with vertebrate bones at the base	13·0
Grey, sandy shale	2·0
Base of Oldman formation	
Top of Foremost formation	
Coal	0·8
Shale, brown, carbonaceous, with coal fragments	3·9
Shale, light grey	1·8
Sandstone, light grey	9·0
Shale, brown, carbonaceous, with coal fragments	1·1
Shale, grey, sandy	2·7
Sandstone, pale buff, well cemented	7·0
Shale, brown, carbonaceous	0·7
Coal	1·8
Shale, coaly, carbonaceous	2·7
Sandstone, light buff	2·9
Shale, grey	2·6
Shale, sandy, carbonaceous, with fragments of vertebrate bones	0·8
Shale and ironstone	6·6
Shale, carbonaceous, with some coal, and numerous oyster shell fragments at top	1·2
Shale, grey to brown	0·9
Sandstone, brown	2·0
Shale, dark chocolate-brown, with fragments of oysters and gasteropods.	1·8
Shale, grey-buff	6·6
Sandstone, buff, hard, well cemented	1·5
Sandstone, grey, with ironstone at top	6·0
Coal (this seam is mined)	3·4
Shale, coaly	1·2
Coal	1·1
Shale, brown, carbonaceous	1·1
Shale, grey-brown	1·1
Sandstone, brown and grey, evenly bedded	2·6
Shale, sandy, carbonaceous	1·0
Shale, brown, carbonaceous	1·2
Coal, and coaly shale	0·7
Shale, brown, carbonaceous	1·9
Sandstone, fine, silty, brown, poorly cemented	1·0
Shale, dark brown, crumbly	2·1
Sandstone, light brown, poorly cemented	1·9
Sandstone, grey, thin ironstone band near base	6·0
Coal	0·5
Shale, carbonaceous	0·8
Shale, grey, sandy	3·7
Ironstone	0·5
Shale, grey, banded	1·8
Coal	1·7
Shale, brown, carbonaceous	2·4
Sandstone, shaly, light grey	2·0
Shale, dark grey	1·8
Shale, coaly	0·9
Shale, light grey, carbonaceous near the top	2·8
Sandstone, grey, fine grained	1·8
Shale, brown, carbonaceous	1·0

Top of Foremost formation—*Concluded*	Thickness Feet
Shale, grey, crumbly	1·4
Shale, grey, sandy	4·7
Sandstone, light grey	12·6
Shale, grey, sandy at the top	3·0
Ironstone, with shell fragments	1·0
Shale, brown, with vertebrate bones at the bottom	4·0
Sandstone, light grey	24·0
Shale, brown, with shell fragments	2·5
Sandstone, with ironstone and shaly streaks	8·1
Shale, grey, sandy	5·2
Shale, brown, carbonaceous	0·5
Shale, with sandy streaks, shell fragments at the bottom	3·5
Shale, brown, carbonaceous	2·4
Shale, chocolate-brown	2·2
Shale	1·0
Sandstone, some shale	4·0
Sandstone, brownish, fine grained	3·8
Oyster bed	0·2
Sandstone, light grey	11·0
Sandstone, with oyster shells, hard, crossbedded	1·0
Sandstone, light grey	3·3
Sandstone, light buff, with a thin band of oyster shells at the top	1·1
Oyster bed	0·5
Sandstone, light grey	12·4
Covered to river level	24·5

NOTE: On the opposite side of the river the lower 24·5 feet is seen to be mainly sandstone.

This section shows a thickness of 250·3 feet of Foremost beds with the bottom of the formation not shown. The strata above belong to the overlying Oldman formation, also called the Pale beds in earlier reports.

There is no particular bed or unconformity that marks the base of the Oldman formation. The division is based on a decided change in lithology from dark, coaly shales to light grey sandstones without carbonaceous matter. The Oldman formation is of freshwater origin and is composed mainly of pale grey to buff sandstones and sandy shales with numerous ironstone bands. Thin coal seams and carbonaceous shales occur near the top. The formation is well exposed in the badlands along Red Deer River below Steveville. A complete section was measured at Rapid Narrows on South Saskatchewan River to the east of Brooks map-area in sec. 7, tp. 17, rge. 3, W. 4th mer. This section is described by Williams and Dyer in Memoir 163, but there is an error somewhere in the measurements. On page 19 the section at Rapid Narrows is described as consisting of 350 feet of Pale beds above 90 feet of Foremost and below 50 feet of Bearpaw shales. On page 25 a detailed section shows 274 feet of Bearpaw shale, 246 feet of Pale beds (Oldman), and 38 feet of Foremost. This section was measured by the writer starting at river level and continuing to the level of the prairie. The section showed 80 feet of Foremost formation topped by a coaly shale, and 305 feet of Pale beds (Oldman) overlain by 70 feet of dark grey shale somewhat slumped and mixed with glacial clays and gravels. Landslides involving beds of the Oldman formation may be seen at several places along Red Deer and South Saskatchewan Rivers.

The Bearpaw consists of dark grey shales of marine origin. It is the youngest in the region and has been eroded from much of the area. Marine

molluscan fossils are common and usually occur in calcareous concretions. The Bearpaw shales disintegrate readily into clay, and near the upland surface merge into the unconsolidated glacial deposits. On steep slopes large slumped masses of these shales commonly occur in landslides.

The structure of the bedrock is apparently a modified expression of the Sweetgrass arch uplift of northern Montana. In general it is a broad anticline plunging gently northward, the strata dipping only a few feet to the mile. Sufficient information is not available for structural details, but the amount of dip between widely separated points can be measured quite closely. Between South Saskatchewan and Red Deer Rivers along the western boundary of range 10 the strata dip about 400 feet towards the north in a distance of about 54 miles. On South Saskatchewan River, levels on a workable coal seam show an eastward dip of 180 feet in a distance of about 23 miles. To the northwest on Red Deer River, between Steveville and Hutton Ferry, the base of the Bearpaw shale shows a northwesterly dip of about 130 feet in a distance of about 21 miles. Much steeper dips can be measured in places over short distances, so that apparently the broad, anticlinal structure is somewhat undulatory with local steeps and flats.

During the last few years several deep wells have been drilled in the vicinity of Steveville, but mainly near the railway southeast of Steveville. Many of these wells struck gas in considerable quantity and a few got shows of oil. Early in 1941 the Standard Oil Company of British Columbia discovered petroleum in commercial quantity in their Princess No. 2 well and since then several new wells have been started and some completed in that vicinity.

The following information regarding wells was obtained from the Calgary office of the Petroleum and Natural Gas Division, Department of Lands and Mines of Alberta, and from the companies interested.

Anaconda, Steveville. Elevation 2,304 Feet

Location: l.s. 15, sec. 9, tp. 22, rge. 12, W. 4th mer.

Drilling suspended November 19, 1939, at 3,727 feet deep. The following figures refer to depth in feet. Water at 595, 815 to 820, 2,495, 2,590, 2,795, 3,695. Gas at 815 to 820, 2,126, 2,495, 2,771 to 2,795, 3,195. Oil show at 815 to 820, 2,795. Top of Palæozoic at 3,201.

Anglo Canadian, Steveville No. 1. Elevation 2,304 Feet

Location: l.s. 2, sec. 13, tp. 21, rge. 12, W. 4th mer.

Completed January 19, 1939. Total depth 3,199 feet. Oil show and 12,000 M cubic feet gas at 2,750 feet. Oil show at 3,136 to 3,138 feet. Top of Palæozoic 3,172 feet.

Standard of B.C. Princess No. 1. Elevation 2,438 Feet

Location: l.s. 13, sec. 22, tp. 20, rge. 12, W. 4th mer.

Completed May 8, 1940. Total depth 6,155 feet. Gas at 2,440, 3,160, 3,255, 3,408, 3,960, 4,410, and 4,530 feet. At 5,152 to 5,192 feet nitrogen gas with an estimated daily flow of 60,000 M cubic feet was encountered.

Oil show 2,815 to 2,819, 3,405 feet. At 3,960 to 3,980 feet oil and water was struck having an estimated capacity of 100 barrels a day. Water occurs with the oil in every case.

The well was plugged back to the gas horizon at 3,160 feet. This hydrocarbon gas with an estimated capacity of 10,000 M cubic feet a day is being used to drill other wells.

The entire thickness of Palæozoic sediments was penetrated and quartz diorite, apparently Precambrian, was struck at a depth of 6,147 feet.

Standard of B.C. Princess No. 2. Elevation 2,442 Feet

Location: l.s. 3, sec. 13, tp. 20, rge. 12, W. 4th mer.

Completed January 1941. Total depth 4,250 feet. Chert zone at top of Palæozoic at 3,200 feet. After acid treatment this well was reported to have an initial daily capacity of 520 barrels of oil and 12,000 M cubic feet of gas. Oil production is said to come from a depth of 3,225 to 3,275 feet, although a show of oil was reported at 3,215 feet.

Anglo Canadian Steveville No. 2. Elevation 2,492 Feet

Location: l.s. 4, sec. 14, tp. 20, rge. 11, W. 4th mer.

Completed April 18, 1939. Total depth 3,262 feet. Top of Palæozoic limestone at 3,252 feet. Gas estimated at 500 M cubic feet at 2,543 to 2,546, water at 2,600 feet. Gas show at 2,800 to 2,807 feet. Water at 2,807 to 2,811 feet. Oil and gas show at 2,844 to 2,859 feet. Gas show at 2,988 to 3,021 feet. Oil and gas, good show at 3,262 feet estimated at 3,000,000 to 5,000,000 cubic feet a day with a showing of black oil.

Rainy Hills Syndicate No. 1. Elevation 2,600 Feet

Location: SW. ¼ sec. 34, tp. 19, rge. 10, W. 4th mer.

Completed September 8, 1939. Total depth 3,500 feet. Gas at 2,592 to 2,622 feet. Gas, oil, and water 2,622 to 2,625 feet. Show of gas, oil, and water 2,889 to 2,900 feet. Show of gas at 2,934 to 2,945, 3,024 to 3,033, 3,050 to 3,062 feet. Gas and water at 3,448 feet. Top of Palæozoic reported at 3,333 feet. Samples from 2,500 to 3,450 feet are missing from the Geological Survey collection.

Standard of B.C. Tide Lake. Elevation 2,508 Feet

Location: l.s. 9, sec. 19, tp. 18, rge. 9, W. 4th mer.

Completed September 1940. Total depth 4,250 feet. Top of Palæozoic at 3,256 feet. Salt water at 3,657 feet. Gas at 2,497, 3,128, 3,148, 3,167 feet. Oil-stained cores at 4,023, 4,026 to 4,028, 4,080 to 4,082 feet. No appreciable quantity of gas or oil was discovered and the well was abandoned.

With the exception of Anaconda Steveville, all of the aforementioned wells were bored by rotary drills and the rock samples derived from this system of drilling are unsatisfactory for purposes of correlation. It is difficult to separate soft shales from drilling mud, especially if the sample has dried and hardened before being washed.

Designation	Location W. 4th Mer.				Year	Elevation	Total depth	Depth to top of Foremost	Glauconite	Depth to base of Alberta shale	Top of Palæozoic
	L.s.	Sec.	Tp.	Rge.							
						Feet	Feet	Feet	Feet	Feet	Feet
Anaconda Steveville	15	9	22	12	1939	2,304	3,727	410		2,780	3,204
Anglo Can. Steveville 1	2	13	21	12	1939	2,304	3,198			2,761	3,176
Stan. of B.C.—Princess 1	13	22	20	12	1940	2,438	6,155	370	1,235	2,828	3,235
" " " 2	3	13	20	12	1941	2,442	4,250	.....	1,200	2,830	3,212
" " " 3	5	13	20	12	1941	2,427	3,260	.....	1,210	2,820	3,254
" " " 4	13	12	20	12	1941	2,471	3,300	.....	1,210	2,830	3,228
Anglo. Can. Steveville 3	5	18	20	11	1941	2,417	4,000	.....	.....	2,835	3,247
" " " 2	4	14	20	11	1939	2,492	4,243	.....	1,165?	2,853	3,252
Rainy Hills Synd. 1	SW.¼	34	19	10	1939	2,600	3,500	.....	1,320?	2,948	3,324
Stan. of B.C. Tide Lake	9	19	18	9	1940	2,508	4,250	310	1,220	2,816	3,256
Ontario-Alberta	15	4	17	8	1931	2,467	3,592	250	1,120	2,760	3,160
Roth No. 1	4	6	13	5	1926	2,330	3,940	150	810	2,525	2,935
Atlee	15	10	23	7	1939	2,053	1,305	.....	900	.....	.....
C.P.R. Brooks No. 1	7	32	18	14	1910	2,493	2,802	420	1,310	.....	.....
C.W.N.G. Brooks No. 5	4	33	18	14	1932	2,471	1,297	410	.....	.....	.....
Tilley No. 1	13	19	17	12	1940	2,466	1,230	.....	1,080	.....	.....
Stan. of B.C. Rainy Hills	1	23	18	11	1941	2,509	3,405	.....	1,170	2,825	3,300
Anaconda Patricia	9	31	20	12	1941	2,366	4,089	.....	.....	2,860	3,300
Stan. of B.C. McD. S. No. 1	3	11	20	12	1941	2,504	4,077	.....	1,280	2,900	3,304

The preceding table gives a list of the deeper wells and the depth to various horizons as determined by the writer from available samples. Core samples of the strata immediately above the Palæozoic limestone show a transition series of interbedded sandstones, shales, and detrital chert with loose, fragmentary, cherty limestone at the base. This zone is as much as 30 feet thick in some wells and the detrital chert contains Mississippian fossils, showing its derivation from the upper Palæozoic cherty limestone. When this material is mixed as in the cuttings from a rotary drill the placing of the upper Palæozoic contact is difficult.

The figures in the table are based on the examination of samples by the writer and will be used as a basis for all calculations throughout the remainder of the report. In the following table the elevation of several horizons with regard to sea-level is given.

Well	Foremost	Glauconite	Palæozoic	Exshaw
	Feet	Feet	Feet	Feet
Anaconda Steveville	+1,994	Sample missing	−900	−1,321
Anglo Can. No. 1	.....	.....	−872	.....
Princess No. 1	+2,064	+1,199	−771	−1,177
" No. 2	.....	+1,242	−770	−1,173
" No. 3	.....	+1,217?	−827	.....
Anglo Can. No. 2	.....	+1,327?	−760	−1,202
Rainy Hills No. 1	.....	+1,280?	−724	.....
Tide Lake	+2,198	+1,288	−748	−1,232
Ontario-Alberta	+2,217	+1,347	−693	.....
Roth No. 1	+2,180	+1,520?	−605	−1,330
C.P.R. Brooks No. 1	+2,071	+1,181	.....	.....
Tilley	.....	+1,386	.....	.....
Atlee	.....	+1,153	.....	.....
Anglo Can. No. 3	.....	+1,207	−835	−1,225
Stan. of B.C. Rainy Hills	.....	+1,339	−791	.....
Anaconda Patricia	.....	.....	−934	−1,334
Stan. of B.C. McD.S. No. 1	.....	+1,224	−800	−1,210

A thin, dark grey to black shale overlain by sandy limestone and underlain by pale green shale is correlated with the Exshaw shale, uppermost Devonian of the foothills region near Banff. This shale is quite different in apearance from the beds above and below, but as it is very thin, probably 5 to 10 feet in the Steveville wells, it might be missed in sampling if samples were not carefully taken or if much diluted with material from higher horizons. The difference in slope of the Palæozoic surface to that of the Exshaw shale can be readily seen in the above table. The thickness of Palæozoic strata above the Exshaw is 284 feet less at the Anaconda Steveville well than at the Roth No. 1 well at Medicine Hat. This difference in thickness is probably in large part due to erosion at the end of the Palæozoic era.

In examining the well samples the top of the Foremost formation was placed by the writer where carbonaceous shales and coal first appear beneath light-coloured sandstone and shales of the Oldman formation. The

lower part of the Foremost formation grades into marine shales and there appears to be many alternations of marine and freshwater beds, judging from the contained plant remains and shell fragments. Marine shales, however, constitute the great bulk of the strata for a thickness of some 2,250 feet below the Foremost. The upper part of this assemblage corresponds to the Pakowki formation, beneath which lie beds equivalent in age to the sandstones of the Milk River formation typically developed in areas to the south. The lower 1,400 feet or so consists of dark grey shales and extends to the base of the Upper Cretaceous. These shales presumably correspond, in large part or entirely, to those of the Alberta formation, as defined in southernmost Alberta. The top of the Alberta shale has been drawn by some geologists at the glauconite zone, but no fossil evidence has been shown to support it. The glauconite is a convenient marker, however, and is present in the samples from many wells. It shows up strongly in Princess Nos. 1, 2, and 3, and in the wells of Brooks, Tilley, Atlee, Tide Lake, and the Ontario Alberta well. It was not found in the Anaconda well, but several samples are missing from the depth at which it might be expected. The glauconite was not found in Anglo Canadian No. 1. It is reported in Anglo Canadian No. 2 and Rainy Hills No. 1, but samples are missing from this horizon so its presence could not be confirmed. The depth at which the glauconite is reported in Anglo Canadian No. 2, 1,165 feet, seems out of harmony with other wells in that region. The reported depth of the glauconite zone in the Rainy Hills well might also be questioned. The glauconite observed in the samples from Roth No. 1 near Medicine Hat at 810 feet deep is very small in amount, suggesting that it is very thin. Although it is possible that the glauconite does not represent the same horizon in all the different wells its position in most of the wells suggests that it does.

The base of the Alberta formation is placed where the predominant dark grey shales give place to predominant sandstones. There is a change from dark grey shale to lighter coloured sandstone with a great increase in the amount of pyrite and considerable increase in coarseness of sand grains. Although some sands occur above this horizon interbedded with the shales, they are very minor in amount and very fine grained. The division is based mainly on lithology and the top of the Lower Cretaceous cannot be closely defined. Failing fossil evidence, comparison with outcrops would be highly speculative because exposures of the more deeply buried formations are so distant that the sediments representing the same horizon in the Steveville region may be quite different. The nearest outcrops of Alberta shales to the wells in the Steveville region are over 100 miles away. Between the base of the Alberta shale and the chert bed believed to be the top of the Palæozoic there is a series of sandstones and shales and some coal, which probably represents the Blairmore and Kootenay (Lower Cretaceous) and Fernie (Jurassic) formations of the foothills region. No separation of these formations has been made.

The top of the Palæozoic in this map-area is commonly a bed of chert. There appears to be some sandstone and shale mixed with chert and limestone below the top chert bed, but crinoid stems and a small cup coral in samples of the highest chert bed suggest that it is Palæozoic in age. In some of the wells many core samples were taken, but these were not avail-

able for examination by the writer. The cores will of course give a true picture of the lithology, and it is possible that they yield more definite evidence of the age of some of the beds than is available in the small and mixed fragments that make up the rotary drill cuttings.[1]

The following well logs, given to illustrate the nature and thickness of the strata, were selected because the wells were drilled by standard percussion tools, which commonly yield better samples. The log of the Atlee well and the comments are the work of R. T. D. Wickenden of the Geological Survey staff.

Well name: Atlee, second hole, irrigation project.
Location: sec. 10, tp. 23, rge. 7, W. 4th mer.
Elevation: 2,053 feet.

Depth Feet	Lithology, etc.
0–80	Drift (according to driller)
10–90	Sand and gravel
90–120	Coal and shale
120–130	Shale and gravel (gravel probably washed in from above)
130–190	Shale, medium to dark grey
190–200	Sandy shale, medium grey
200–210	Shaly sand, medium to light grey
210–220	Shale, medium grey, sandy
220–310	Shale, medium grey (foraminifera)
310–320	Sand (foraminifera)
320–340	Shale, medium grey, somewhat sandy (foraminifera)
340–380	Sand
380–410	Shale, medium grey
410–420	Shale, medium to dark grey (foraminifera)
420–440	Sand and sandstone
440–490	Shale, medium grey (foraminifera)
490–520	Mostly ironstone concretion
520–550	Shale, medium grey (foraminifera)
550–560	Sandstone
[2]560–590	Shale, medium grey, some grey sandstone, some concretion fragments
590–630	Shale, medium grey, little sandstone, some concretion fragments (foraminifera at 600 feet)
630–640	Shale, medium grey, very little sand
640–650	Shale, medium grey, some fine sand
650–660	Shale, medium grey, very little sand
660–680	Mostly concretion fragments (foraminifera)
680–690	Shale, medium grey, some concretion fragments (foraminifera)
690–700	Shale, medium grey, very few concretion fragments (foraminifera)
700–720	Shale, medium grey (foraminifera)
720–740	Shale, medium grey, some fine sand (foraminifera)
740–900	Shale, medium grey, some fine sand, a little glauconite
900–940	Shale, medium grey, some fine sand, much glauconite (foraminifera)
940–1,000	Shale, medium grey, little fine sand, grey concretion fragments, little glauconite (foraminifera)
1,000–1,020	Shale, medium grey, some concretion fragments (foraminifera)
1,020–1,085	Shale, medium grey, few concretion fragments, few Inoceramus prisms at 1,040–1,085 (foraminifera)

[1] Since the foregoing was written core samples have been examined, and much of the chert thought to represent the top of the Palæozoic is seen to be detrital deposits of a later age derived from Palæozoic cherty limestones.

[2] Wickenden considers the base of the Foremost to be at 560 feet, and is of the opinion that the shales from 560 to 1,085 feet correspond to the Pakowki and Milk River formations of southernmost Alberta.

Depth Feet	*Alberta Formation*
1,085–1,185	Shale, medium grey, some specks of white, calcareous material (foraminifera)
1,190	Shale, dark grey with white specks, some grey sandstone and bentonite
1,195	Shale, dark grey with white specks, some sand
1,200	Shale, dark grey with white specks, some sand
1,205	Shale, dark grey with white specks, some sand
1,210	Shale, dark grey with white specks, very little sand
1,218	Shale, dark grey with white specks
1,220	Shale, dark grey with white specks, Inoceramus prisms
1,225	Shale, dark grey with white specks, Inoceramus prisms
1,230	Shale, dark grey with white specks, Inoceramus prisms
1,235	Shale, dark grey with white specks, Inoceramus prisms
1,240	Shale, dark grey with white specks, Inoceramus prisms
1,245	Shale, dark grey with white specks, Inoceramus prisms
1,250	Shale, dark grey with white specks, Inoceramus prisms
1,255	Shale, dark grey with very little speckeld shale
1,260	Shale, dark grey with very little speckled shale
1,265	Shale, dark grey with very little speckled shale
1,270	Shale, dark grey with some very fine-grained sand, very little speckled shale
1,285	As above
1,290	As above
1,295	As above
1,300	As above
	Water at 315 and 440 feet
	Gas at 895 feet, 30 M cubic feet initial flow
	Gas at 1,240 feet, 65 M cubic feet initial flow

It is probable that the various marine and non-marine beds down to 560 feet are the equivalent of the Foremost.

The beds between 560 and 1,085 feet represent the equivalents of the Pakowki and Milk River formations, but just where the contact is between them is uncertain. In other areas there is a slight change in sediments that occur where a microfauna characterized by *Epistonina caracolla* is first observed, but in the Atlee well there is no obvious change where this fauna is first noted at 840 feet. The speckled shale occurs 245 feet below this fauna, an interval that agrees very closely with that observed between the same zones in the Lloydminster area. The foraminifera found just above the speckled shale is the same as that found in the Lloydminster area, suggesting that this is the same zone in both places.

The occurrence of sand with the shale at 1,185 to 1,205 feet may be the equivalent of the Medicine Hat gas sand, although the gas in the Atlee well occurs at 1,240 feet, in a calcareous shale.

Log of Anaconda Steveville No. 1

Location: l.s. 15, sec. 9, tp. 22, rge. 12, W. 4th mer.

Lithology	Depth Feet
Glacial drift, etc.	0–130
Oldman formation (Pale beds)	
Mainly pale grey, silty sands.	130–410
Silty sands and carbonaceous shales with coal, top of Foremost formation	410–460
Silty sands and carbonaceous shales with coal	410–460
Sandstone, sandy shale, and ironstone	460–510

Lithology	Depth Feet
Sandstone, carbonaceous shale, and coal	510–520
Sandstone, sandy shale, and ironstone	520–550
Carbonaceous shale and coal	550–570
Sandy shale and ironstone	570–590
Sandy, carbonaceous shale with some oyster shells	590–610
Sandstone, shale, and ironstone	610–690
Sandy shale, ironstone, and coal	690–700
Grey sandstone, sandy shale, and bentonite	700–710
Coarse sandstone	710–720
Carbonaceous shale with coal	720–740
Mainly shale with coal and bentonite	740–800
Mainly sandstone with bentonite	800–840
Coaly shale and coal	840–860
Mainly shale with bentonite	860–900
Carbonaceous, sandy shale and coal	900–920
Dark grey, calcareous shale, some bentonite	920–950
Grey shale with coal	950–960
Carbonaceous shale, a little coal, sandstone, and bentonite	960–980
Mainly grey shale	980–1,010
Mainly grey shale with numerous fragments of shells and calcareous concretions	1,010–2,320
Mainly grey shale, becoming sandy	2,320–2,380
Mainly grey shale	2,380–2,500
Grey shale with small, black, chert pebbles	2,500–2,520
Mainly shale with pyrite and bentonite	2,520–2,570
Sandstone and sandy shale	2,570–2,590
Dark grey shale becoming sandy, with bentonite and pyrite	2,590–2,660
Dark, sandy shale, cherty sandstone, much pyrite, and some calcareous bands	2,660–2,670
Sandy shale, chert pebbles, and pyrite	2,670–2,710
Mainly dark grey shale with pyrite, base of Alberta formation	2,710–2,780
Mainly grey sandstone with pyrite, top of Lower Cretaceous and Jurassic	2,780–2,800
Sandstone, sandy shale, and pyrite	2,800–2,830
Dark grey shale with pyrite	2,830–2,840
Sandstone with pyrite	2,840–2,860
Mainly dark grey shale	2,860–2,870
No samples	2,870–2,945
Interbedded shale and sandstone	2,945–3,000
Carbonaceous shale with coal	3,000–3,025
Light grey and purple sandstone	3,025–3,040
Shale with much pyrite	3,040–3,050
Sandy shale, coal, and coaly shale	3,050–3,070
Light grey shale	3,070–3,080
Mainly grey sandstone	3,080–3,130
Sandstone, coaly shale, and coal	3,130–3,160
Grey shale and sandstone	3,160–3,170
White, angular chert and sandstone, crinoid stems, cherty limestone	3,170–3,182
Grey sandstone and shale, much pyrite	3,182–3,185
Mainly chert with small cup corals	3,185–3,197
Mainly shale	3,197–3,202
Shale, chert, and limestone, top of Palæozoic	3,202–3,204
Limestone	3,204–3,217
Cherty limestone with crinoid stems	3,217–3,265
Light grey limestone, numerous fossils	3,265–3,350
Dark grey limestone, dolomitic and cherty	3,350–3,380
Dolomitic limestone and red shale	3,380–3,387
Light grey limestone	3,387–3,400

Lithology	Depth Feet
Light grey limestone with a little red shale	3,400–3,408
Light grey limestone	3,408–3,424
Dark grey limestone, finely granular	3,424–3,455
Same as above with some chert	3,455–3,468
Shaly limestone with glauconite	3,468–3,471
Dark grey limestone, finely granular	3,471–3,495
Dark grey limestone, shaly and thin bedded	3,495–3,505
Light grey, granular limestone with pyrite	3,505–3,535
Calcareous sandstone	3,535–3,540
Calcareous shale	3,540–3,545
Shaly and sandy limestone	3,545–3,625
Dark grey to black shale	3,625–3,635
Shale and light grey limestone	3,635–3,645
Pale green shale and light grey limestone with brachiopods and crinoid stems	3,645–3,658
Pale greenish grey shale	3,658–3,680
Mainly pale greenish shale with some gypsum and anhydrite	3,680–3,717

Log of Roth No. 1 Well, Medicine Hat

Location: SW. ¼ sec. 6, tp. 13, rge. 5, W. 4th mer. Elevation 2,330 feet.

Lithology	Thickness	Depth
	Feet	Feet
Glacial sand and gravel	30	30
Light buff sandstone, Oldman formation	90	120
Coarse sandstone with fragments of shells	30	150
Sandy shale, carbonaceous, with some coal, top of Foremost formation	10	160
Sandy shale, light buff	10	170
No sample	10	180
Sandstone, light grey	60	240
Sandy shale, with some coal	20	260
No sample	10	270
Sandy shale	10	280
Sandy shale with a little coal	30	310
No sample	10	320
Sandy shale with a little coal	10	330
Sandstone with a few shell fragments	10	340
No sample	10	350
Sandstone with some shell fragments	20	370
Sandy shale with coal	20	390
Sandy shale	20	410
Sandy shale with shell fragments	10	420
Sandstone and sandy shale with pyrite	10	430
Sandy shale with fragments of shells, also some rootlets replaced by pyrite	10	440
Sandy shale	30	470
No sample	10	480
Sandy shale	10	490
No sample	10	500
Sandy shale	10	510
No sample	10	520
Sandy shale	40	560
Sandy shale with shell fragments	10	570
Sandy shale	40	610

Lithology	Thickness	Depth
	Feet	Feet
No sample	10	620
Shale, dark grey	10	630
No sample	10	640
Shale, calcareous, with shell fragments	10	650
No sample	10	660
Shale with shell fragments and pyrite	10	670
No sample	10	680
Shale, dark grey	10	690
No sample	10	700
Shale, dark grey, with many foraminifera and dark brown mica	10	710
No sample	10	720
Shale, dark grey, with calcareous concretions	10	730
No sample	10	740
Shale with pyrite, shell fragments, and foraminifera	60	800
Shale, sandy, with a little glauconite	10	810
Shale, dark grey	30	840
No sample	10	850
Sandy shale with shell fragments	10	860
Shale, dark grey	20	880
Shale, dark grey	10	890
Shale with shell fragments and pyrite	20	910
Shale with a little coal and some calcareous concretions	10	920
Shale with shell fragments, foraminifera, and concretions	30	950
Same as above with much pyrite	10	960
Shale, grey, concretionary	30	990
Shale, mottled grey, and concretionary	20	1,010
Shale, dark grey, with numerous shell fragments	50	1,060
Sandy shale	10	1,070
Sandstone, very fine grained	10	1,080
Sandy shale	10	1,090
Sandy shale, some fish teeth	10	1,100
Mainly grey sandstone with calcarous cement, much dark brown mica	5	1,105
Fine, silty shale	35	1,140
No sample	10	1,150
Silty shale	30	1,180
Fine sandstone with dark brown mica	10	1,190
Grey shale with shell fragments common	110	1,300
No sample	10	1,310
Grey shale with a little sand	10	1,320
No sample	10	1,330
Grey shale, numerous shell fragments and pyrite	50	1,380
No sample	10	1,390
Grey shale	30	1,420
No sample	10	1,430
Grey shale	10	1,440
No sample	10	1,450
Grey shale, many shell fragments and pyrite	50	1,500
No sample	10	1,510
Grey shale	10	1,520
No sample	10	1,530
Grey shale	10	1,540
No sample	10	1,550
Grey shale	10	1,560
No sample	10	1,570
Grey shale, concretions and pyrite	10	1,580
No sample	10	1,590
Grey shale	30	1,620

Lithology	Thickness	Depth
	Feet	Feet
No sample	10	1,630
Grey shale, sandy	10	1,640
No sample	10	1,650
Grey shale, some sand	20	1,670
Grey shale	50	1,720
No sample	10	1,730
Grey shale with pyrite shells and many foraminifera	20	1,750
No sample	10	1,760
Grey shale with pyrite and thick shell fragments	20	1,780
Shale with a little sand	10	1,790
Shale	10	1,800
No sample	10	1,810
Shale, sandy, with pyrite	20	1,830
Shale, bentonitic, black mica crystals	10	1,840
Shale, bentonitic, black mica crystals	20	1,860
Shale, very thin bedded	30	1,890
Shale, bentonitic, with minute, dark, concretionary grains	10	1,900
Shale, bentonitic and sandy	100	2,000
Shale, somewhat sandy, with pyrite	10	2,010
No sample	10	2,020
Shale with a little sand and pyrite	30	2,050
Shale with bands of silt	90	2,140
Shale with bands of bentonite	90	2,230
Shale, sandy, with considerable pyrite	10	2,240
Shale with bands of bentonite and some black chert	70	2,310
No sample	10	2,320
Shale, sandy, with some white bentonite	60	2,380
No sample	10	2,390
Shale with dark, cherty grains and pyrite	60	2,450
Shale with numerous shell fragments	30	2,480
Shale with much pyrite and white bentonite	40	2,520
Shale, sandy, with black chert grains and some fish teeth	5	2,525
No sample	10	2,530
Sandy shale and sandstone, with black chert grains, top of Lower Cretaceous and Jurassic	65	2,595
Sandy shale, reddish	10	2,605
Sandstone, reddish	30	2,635
Grey sandstone with some reddish shale	10	2,645
Grey sandstone	10	2,655
No sample	10	2,665
Sandstone, brown	20	2,685
Sandstone, brown, with much pyrite and some coal	5	2,690
Sandy shale, grey and reddish	10	2,700
Sandstone, grey and reddish, with pyrite	10	2,710
Sandy shale, grey and red	10	2,720
Sandstone with pyrite and coal	20	2,740
Shaly sandstone, grey	10	2,750
Sandstone, light grey, some pyrite	10	2,760
Sandstone with pyrite and coal, many grains of black chert	20	2,780
Grey sandstone and shale	20	2,800
Shale, dark grey, calcareous	10	2,810
Shale, dark grey, much pyrite	20	2,830
Limstone, shaly	30	2,860
Sandstone, grey	30	2,890
Sandstone and shale	10	2,900
Sandstone, shale, and thin limestone	10	2,910
Sandstone, grey to brown	10	2,920

Lithology	Thickness	Depth
	Feet	Feet
Sandstone and shale with some pyrite	10	2,930
Sandstone, shale, and cherty limestone	10	2,940
Sandstone with some white limestone, top of Palæozoic	10	2,950
Sandstone and reddish shale with considerable white limestone	20	2,970
Mainly limestone	10	2,980
Cement samples only	70	3,050
Calcareous sandstone with dolomite crystals	20	3,070
Limestone, fine, granular	10	3,080
Cement samples only	40	3,120
Limestone, white, granular	10	3,130
Limestone, brown, finely granular	50	3,180
Limestone, buff, coarsely granular	70	3,250
Limestone, pale buff, very cherty	30	3,280
Limestone, crinoidal	10	3,290
Limestone, buff	20	3,310
Limestone, buff, with white chert	10	3,320
Limestone, light grey, granular	20	3,340
Limestone, reddish buff, cherty	40	3,380
Mainly pink chert	10	3,390
Limestone, cherty, granular	10	3,400
Limestone, pink and grey	30	3,430
No sample	10	3,440
Buff limestone and gypsum	40	3,480
Dark buff limestone	40	3,520
Buff, cherty limestone	10	3,530
Mainly dark grey chert with a little limestone	50	3,580
Crinoidal limestone and shale	10	3,590
Dark grey shale and limestone	10	3,600
Dark grey shale and limestone, much pyrite	20	3,620
Dark grey shale and limestone, fine sandstone	10	3,630
Fine sandstone with some limestone	10	3,640
No sample	10	3,650
Dark grey shale and calcareous sandstone	10	3,660
Dark, calcareous shale	10	3,670
Cement or drilling mud	20	3,690
Dark, greenish grey shale (bryozoa)	10	3,700
Dark, greenish grey shale	50	3,750
Cement or drilling mud	50	3,800
No sample	10	3,810
Cement or drilling mud	10	3,820
Dolomitic limestone	10	3,830
Drilling mud or cement	30	3,860
Mainly gypsum	60	3,920
Mainly gypsum with cherty limestone	20	3,940
Gypsum and calcareous shale with pyrite and cherty limestone	10	3,950
Limestone and calcareous shale	30	3,980
Mainly granular limestone	10	3,990
Limestone, calcareous shale, and a little chert	60	4,050

In the Atlee well a little glauconite appears in practically all the samples between depths of 740 and 940 feet, but the main glauconite horizon where it is quite plentiful is at 900 feet. This is to be correlated with the glauconite at 810 feet deep in the Roth No. 1 well. From a study of the microfaunas, Wickenden is of the opinion that the zone 180 to 200

feet below the glauconite zone corresponds to the zone at the top of the Alberta in southernmost Alberta. This places the glauconite at about the same horizon as the top of the Milk River sandstone of southern Alberta.

SUMMARY AND CONCLUSION

As exposures of bedrock are mainly confined to sections along Red Deer and South Saskatchewan Rivers and deep wells yielding subsurface information are few, details of rock structure are not available. The information available, however, tends to show that the general structure of the Upper Cretaceous strata is a broad anticline. This anticline plunges gently northeastward and is somewhat asymmetric, the dip of the western limb being steeper than that on the eastern. In the vicinity of latitude 50 degrees the axis appears to pass through range 14 and trending northeast it crosses Red Deer River somewhere in range 11. It is possible that small subsidiary folds occur on this broad anticlinal structure, but the general lack of outcrops of bedrock will make some kind of subsurface prospecting necessary to find them.

It should be understood that high points on the top of the Palæozoic limestone are not necessarily structural highs, but may simply represent topographic highs on the old Palæozoic surface.

As there is no market for gas in the vicinity of the Steveville field, the object of the drilling is petroleum. Although small amounts and shows of oil have been found at various horizons, the most promising appears to be at or near the top of the Palæozoic limestone and chert. In some wells oil apparently has beeen struck in sandy beds immediately above the limestone, but in others the main oil reservoir appears to be somewhere less than 50 feet below the top of the Palæozoic limestone and chert. It would seem, therefore, that the reservoirs are somewhat in the nature of stratigraphic traps; these may be local sand lenses immediately above the Palæozoic unconformity or the reservoirs may be porous zones developed in the limestone below the unconformity. These porous zones could readily be developed by weathering and ground water circulation at and immediately below the Palæozoic surface before Mesozoic sediments were deposited. The broad anticlinal structure would only be effective in causing accumulation of oil and gas if the reservoir beds were of widespread distribution. The results of drilling up to the present tend to show that the reservoirs are either sands of very local distribution or that the porosity in the limestone is not uniform.

The steeper west limb of the broad anticline appears to be the more favourable. It is possible that where the dip of the beds is very gentle or essentially flat, the contained fluids were not subject to movement, separation, and accumulation. The location of porous reservoirs at great depth cannot be predicted accurately and rock structure must be used in defining the more favourable places to drill for oil. The west limb of the anticlinal structure is probably more favourable because of its steeper dips and also because sediments tend to be coarser and more porous nearer their source, which was probably to the west and southwest.