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**MINES AND GEOLOGY BRANCH**  
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**GEOLOGICAL SURVEY**

**PRELIMINARY REPORT**

**DEL BONITA AREA,**  
**SOUTHERN ALBERTA**

**BY**

**L. S. Russell**

**Paper 37-10**

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# GEOLOGY OF THE DEL BONITA AREA, SOUTHERN ALBERTA

By Loris S. Russell

## INTRODUCTION

Recent drilling near Del Bonita post office, 43 miles south of Lethbridge, Alberta, has aroused interest in the oil and gas possibilities of the district. During the field season of 1936 the writer made a detailed geological survey of the area, as part of a general revision of the geology of the southern Alberta plains. Later, the available records from the numerous borings in the vicinity were studied, and the results obtained were incorporated with the field data to form the basis of the present report.

The writer is indebted to Mr. J.S. Irwin, of Calgary, for valuable information supplied during the course of the field work and subsequently. The Petroleum and Natural Gas Division, Department of Lands and Mines, Alberta, also assisted in various ways.

## PHYSICAL FEATURES

There are no natural boundaries to mark the limits of what is here called the Del Bonita area; the accompanying map includes parts of tps. 1 and 2, ranges 21 and 22, W. 4th mer. Del Bonita is situated 43 miles south of Lethbridge and 39 miles west of Milk River. To the south lies the state of Montana. Access to the area is by the Boundary trail, either west from Milk River, or east from Cardston. This road is joined by another from the north, giving access from Lethbridge, via Magrath. These are well-graded dirt roads. In addition, most of the road allowances and parts of the prairie can be traversed by car. The nearest railway station is Whisky Gap, 11 miles west.



The area is traversed from west to east by the North branch of Milk river, which carries irrigation water during the summer months, and is fordable with difficulty at that time. The river valley is not more than 150 feet deep in most places, but the land rises to the north toward Milk River ridge, and to the south toward the International Boundary, so that the surface varies in elevation from 3,900 to 4,400 feet above sea-level. South of the river, and parallel to it, is Shanks coulee, which drains into Shanks lake, a large body of water without direct outlet. In the southeastern corner of the area there is a large valley draining southward into Montana. The surface of the area is open prairie.

Outcrops occur abundantly along parts of Milk River valley, but are scarce in other parts of the valley, especially where the underlying formation is the Bearpaw. Outside of the valley there are only a few outcrops, as in the upper part of Shanks coulee, and in the southeastern corner of the area.

#### STRATIGRAPHY

The following notes on the geological formations are intended to apply particularly to the Del Bonita area, unless otherwise stated.

Madison. The Palaeozoic limestone was penetrated by both of the deep wells drilled in the area. The top of the formation was encountered at about 5,020 feet in the Terminal well, and at about 5,210 feet in the Sunshine well. In the Terminal well the samples from the Madison consist of very pale grey limestone, with some dark, slightly calcareous shale. Those from the Sunshine well are pale grey, cherty limestone and chert, with abundant dark grey shale, probably cavings from above.

Summary of Stratigraphical Succession in the Del Bonita Area

Age	Formation	Description
Upper Cretaceous	St. Mary River	Alternating sandstone and shale; freshwater fossils; 1,000 feet or more in thickness.
	Blood Reserve	Massive, buff sandstone, 135 to 160 feet thick.
	Bearpaw	Dark grey shale, with bentonite bands; marine fossils; 616 feet or more in thickness.
	Belly River	Carbonaceous at top; upper part light greenish grey sandstone and clay; lower beds sombre, with carbonaceous zones; probably about 1,200 feet thick.
	Pakowki	Dark grey shale, with some sandstone; probably 130 feet or less in thickness.
	Milk River	Sandstone and shale; probably about 650 feet thick.
Lower Cretaceous	Alberta	Dark grey shale, with some sandstone in lower part; about 1,800 feet thick.
	Blairmore and (?) Kootenay	Dark grey, greenish, and reddish shale, with some sandstone, especially in lower part; 600 feet or less in thickness.
Jurassic	Ellis	Dark grey shale, in part calcareous, with occasional sandstone; about 200 feet thick.
Carboniferous	Madison	Light grey limestone and chert, with some calcareous shale; thickness not determined.

Ellis. In the Sunshine well the section from 4,986 to 5,210 feet, that is, 224 feet of beds, is assigned to the Ellis. The samples from this interval consist of dark grey shale, in part calcareous. From 5,065 to 5,176 feet there is a large amount of pale grey, chalk-like, calcareous shale. The remaining 34 feet in the lower part of the Ellis is mostly non-calcareous. The samples from the Terminal well are difficult to interpret. Mr. R.M.S. Owen,<sup>1</sup> formerly of the Petroleum and Natural Gas Division, Department of Lands and Mines, Alberta, placed the top of the Ellis at 4,840 feet, which would give a thickness of 180 feet for the formation. The writer can neither confirm this interpretation nor offer a better one.

Blairmore and (?) Kootenay. The identification of Lower Cretaceous strata in the well logs from southern Alberta is usually based upon the presence of reddish and greenish shale. In the samples from rotary wells, unfortunately, this is liable to be masked by inclusion of material from above. Thus, in the Sunshine samples, red shale does not become conspicuous until about 4,750 feet. This would leave only 236 feet of Lower Cretaceous beds, apparently an inadequate figure. From 4,750 to 4,922 feet the predominant material in the samples is dark grey shale; from 4,922 to 4,943 feet red shale is very abundant; from 4,943 to 4,978 feet a light grey shale predominates; from 4,978 to 4,986 feet there is a medium-grained, "pepper-and-salt" sandstone, evidently the basal or "Sunburst" sand, as it is followed below by darker shale of the Ellis type.

In the Terminal samples the limits of the Lower Cretaceous beds are even more difficult to establish. Owen<sup>1</sup> assigned the strata from 4,230 to 4,840 feet to the Blairmore and Kootenay giving a thickness of 610 feet, which agrees well

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<sup>1</sup> Unpublished log, Petrol. and Nat. Gas Div., Dept. of Lands and Mines, Alberta.

with the thickness obtained in wells adjacent to the Del Bonita district.

Alberta ("Benton", "Colorado"). This formation consists predominantly of dark grey shale, with some sandstone, especially in the lower part (Blackleaf member). Owen<sup>1</sup> has recorded the occurrence of a zone of shale with rusty specks about 480 feet above the base. In the Terminal well the top of this formation lies at about 2,400 feet, and the base, according to Owen, at 4,230 feet, giving an approximate thickness of 1,830 feet. The Sunshine well encountered the red speck zone at 4,100 feet, and if this is the same horizon as in the Terminal well, the top of the Alberta should be about 2,750 feet, and the base about 4,580 feet. The samples examined by the writer do not show important lithological changes near either of these depths. In wells adjacent to the Del Bonita area the Alberta shale ranges from 1,867 feet (Spring Coulee) to 1,780 feet (Twin River No. 2) in thickness.

Milk River. The formations between the Alberta shale and the Bearpaw would be difficult to differentiate in this district, even in good sections, as the marine Pakowki beds disappear a short distance west of here. In the Terminal well the writer would assign the beds from 1,750 to 2,400 feet to the Milk River formation, giving it a thickness of 650 feet. These beds consist of sandstones and shales, with no conspicuous basal sandstone that could be identified as the Lower Milk River. In the Spring Coulee well 530 feet of sandstone and shale are placed in the Milk River formation.<sup>2</sup>

Pakowki. In the Terminal well section there are 130 feet of beds, between 1,620 and 1,750 feet in depth, which consist principally of dark grey shale. These may be the local equivalent of the Pakowki. In the Spring Coulee well<sup>2</sup> only 40 feet of

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<sup>1</sup> Unpublished logs.

<sup>2</sup> Hume, G.S.: Geol. Surv., Canada, Ec. Geol. Ser. No. 5, 2nd ed., p. 176 (1933).

carbonaceous shale were assigned to this formation. In the Twin River well No. 1<sup>1</sup> some 70 feet of grey shale were classified as Pakowki.

Belly River. As shown by the two Del Bonita well logs, this formation consists of pale grey, clayey sandstone, commonly with black specks, and light grey and greenish grey shale. Dark, carbonaceous shale, and coal, occur at intervals. In the Terminal well section the beds from 1,420 to 1,620 feet carry a large proportion of carbonaceous shale, and may represent the Foremost member. At the surface, outcrops of "Pale" beds, or upper Belly River, may be seen in Milk River valley from sec. 3, tp. 2, range 21, W. 4th mer., to some distance east of the Del Bonita area. The beds are principally light greenish grey clays and sandstones. Toward the top of the formation lenticular beds of hard, massive, buff and grey-buff sandstone appear, forming conspicuous ledges. In ls. 14, sec. 3, tp. 2, range 21, the Lethbridge coal zone is well exposed. As this is the most important key horizon in the district, the section exposed here is given in detail.

Section at Bearpaw-Belly River contact, Left Side Milk River, ls. 14, sec. 3, tp. 2, range 21, W. 4th mer.

	<u>Feet</u>
Shale, dark grey, rusty weathering, friable .....	5.4
Bearpaw-Belly River contact	
Clay-ironstone, moderately hard, rusty brown .....	0.9
Shale, sandy, dark grey-brown, coarsely friable .....	2.2
Shale, with beds of crushed fossils; <u>Corbicula</u> sp. ....	0.8
Shale, dark grey, rusty weathering, friable .....	11.6
Sandstone, fine grained, hard .....	0.2
Shale, dark grey, hard, friable .....	1.0

<sup>1</sup> Hume, G.S.: op. cit., p. 182.



Sandstone, very argillaceous, concretionary at top, and with bentonite streak at base .....	1.8
Shale, dark grey, somewhat arenaceous, becoming progressively more carbonaceous below .....	1.9
Shale, very dark grey, very carbonaceous .....	2.0
Sand, bentonitic, grey-green .....	0.1
Sandstone, light grey and buff, streaked, argillaceous, partly massive, partly finely laminated .....	3.9
Shale, dark grey, arenaceous, fissile .....	2.6
Sandstone, light grey-buff, platy, argillaceous, with shaly and carbonaceous streaks .....	2.4
Shale, grey and dark grey, hard, fissile, arenaceous, with thin bands of sandstone .....	7.1
River-level.	

Bearpaw. Although this formation underlies much of the Del Bonita area, it is largely concealed. The basal beds have been described above. The top may be seen at several points along Milk river, in secs. 2, 3, and 4, tp. 2, range 22. An interesting outcrop occurs on the right side of the river, in ls. 7, sec. 3. Here typical Bearpaw beds are exposed, consisting of dark grey shale, with concretionary layers, and three bands of bentonite. These beds are near the top of the formation. The Bearpaw has been penetrated by most of the test holes drilled in the area, and is an important formation to the test driller. The following section, based on test hole records, is largely taken from the compilations of J.S. Irwin, as the actual samples are available to the writer only in part.

Composite Section of the Bearpaw Formation in the Del Bonita  
area, compiled from test hole records

	<u>Feet</u>
Shale, sandy, becoming progressively less so .....	15
Shale, dark grey, with concretions and occasional bentonite bands .....	±230
Shale, dark grey, slightly arenaceous, with numerous bentonite bands (identified by Irwin as the Kipp member) ..	43
Bentonite .....	±0.7
Shale, dark grey, with concretions and bentonite bands; slightly arenaceous in places .....	85
Bentonite .....	±0.1
Shale .....	±0.7
Bentonite .....	±0.1
Shale, with concretions and occasional bentonite bands .....	23
Shale, arenaceous, fossiliferous, with one or more bentonite beds near middle (identified by Irwin as the Magrath member) .....	±15
Shale, dark grey, slightly arenaceous, with occasional bentonite bands .....	160
Shale, dark grey, with several bentonite bands .....	14
Shale, dark grey, with bentonite band near base .....	31
Bearpaw-Belly River contact.	

Total thickness of the Bearpaw formation in the above section is approximately 616 feet. Irwin<sup>1</sup> has determined the thickness as 645 feet, the difference being due to a different, and possibly correct, interpretation of the horizons in the zone of the "Kipp" member. It may be possible to settle this matter by a study of the microfossils, which occur abundantly at certain horizons in the Bearpaw beds. In any case, there is no

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<sup>1</sup> Unpublished logs.

doubt that the formation is considerably thinner in the Del Bonita area than in the Lethbridge district.

Blood Reserve ("Fox Hills"). This formation is now known to be older than the true Fox Hills of the United States. In the Del Bonita area the Blood Reserve is well exposed along Milk River valley. It consists of massive sandstone, grey to yellowish in colour, with indurated masses of irregular distribution. The outcrops of this formation commonly weather into castellated forms. Toward the base the sandstone becomes less massive and more arenaceous, and passes over to the underlying Bearpaw by a zone of transitional beds. At the top there may or may not be an indurated layer. The thickness of the Blood Reserve may be measured in the southwest quarter of sec. 31, tp. 1, range 21, where the top and the approximate base are exposed. The writer's measurements here give a thickness of about 115 feet. Farther west, in ls. 10, sec. 2, tp. 2, range 22, the exact base and the probable top are exposed. Vertical distance between them is 135 feet. To the south a determination of the thickness may be obtained from Parco test hole No. A1, in ls. 3, sec. 14, tp. 1, range 22, where about 160 feet of the sandstone was penetrated. The formation continues to thicken southward, and in Glacier county, Montana, where it is known as the Horsethief sandstone, as much as 375 feet are recorded.<sup>1</sup>

St. Mary River. This formation, the youngest in the area, consists of alternating sandstone and shale; individual beds show great lateral variability. It is not important to the present discussion, as it is unlikely to be represented in well logs here. However, the basal zone is of interest, as it contains beds of lignite and fossil shells, which might serve as horizon markers.

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<sup>1</sup>Stebinger, E.: U.S. Geol. Surv., Bull. 621, p. 124 (1916).

## STRUCTURE

The structure of the Del Bonita area (See accompanying map) consists of an anticline and syncline, plunging to the northwest. The existence of such a structure can be demonstrated from the surface outcrops alone. Following the course of Milk river, the Blood Reserve sandstone first appears in the northwest quarter of sec. 28, tp. 1, range 22. The beds rise rapidly downstream, then assume an approximately uniform elevation to sec. 4, tp. 2, range 22. Here, as the river swings eastward, the westerly dip again becomes apparent, and Bearpaw shale appears near river-level. The northwesterly plunge is shown by lower elevations of horizons on the north bank than on the south. In sections 3 and 2 the river is following approximately along strike, as shown by elevations on the top and base of the Blood Reserve sandstone. The next group of abundant outcrops occurs in sec. 31, tp. 1, range 21, where the Blood Reserve beds are seen to be dipping to the northeast. North of here, on the north bank of the river, there is a small outcrop of upper Bearpaw beds, which occurrence gives some evidence on the northward plunge. No additional outcrops occur for some distance downstream, but in the northwest quarter of sec. 29, tp. 1, range 21, the basal Blood Reserve and upper Bearpaw beds are exposed in road cuttings. Between secs. 6 and 3, tp. 2, range 21, outcrops are absent, but the beds must be rising rapidly here, as the Bearpaw-Belly River contact is exposed in ls. 14, sec. 3, dipping to the southwest. From here the Belly River beds are exposed intermittently to beyond the margin of the area, and show persistent southwesterly dips.

Three small outcrops of Blood Reserve sandstone occur in Shanks coulée, southwest quarter of sec. 14, tp. 1, range 22. These show westerly dips. Test drilling here indicates that the exposed beds are near the top of the formation.

Numerous test holes in the area permit the structural pattern to be filled in with some detail. Nordon test holes Nos. 1, 2, and 3, in sec. 25, tp. 1, range 22, all begin in the Bearpaw, showing that the axis of the anticline passes through this vicinity. The westerly limb of the anticline may be plotted from the test holes along Shanks coulée, Parco A3, A7, A1, and A2. Comparison of this series with the Nordon holes gives the plunge of the structure north of Shanks coulée. To the southeast there is a series of test holes extending to the International Boundary. These give a good picture of the crest of the anticline. The fact that the key horizons maintain approximately the same elevations in Parco test holes A3, A4, A12, A5, and A6, indicates a terraco-like character for the crest of the anticline here. Close to the International Boundary the axis of the fold begins to rise rapidly again, as shown by test holes A9 and A11.

The details of the synclinal fold to the east are hypothetical, although there is no doubt of its existence. Test hole A8 is situated on its western limb. In ls. 15, sec. 9, tp. 1, range 21, a road cut exposes some Bearpaw beds which appear to include the transition zone to the Blood Reserve sandstone. If so, this outcrop must be very near the axis of the syncline.

#### OIL AND GAS POSSIBILITIES

The first well drilled in the area was the Terminal Oil Company Del Bonita No. 1, commonly called the Terminal well, which is situated in ls. 15, sec. 18, tp. 1, range 21, W. 4th mer., at an elevation of 4,190 feet. This well was begun in November 1934, and completed during 1936. The drilling reports record 500,000 cubic feet of gas, with some naphtha, at 5,025 to 5,030 feet. This is in the top of the Madison limestone. An attempt was made to tap the Sunburst sand by means of explosives, but satisfactory results were not obtained.



The second well, drilled by the Sunshine Oil Company, is located in ls. 10, sec. 19, tp. 1, range 21, W. 4th mer., or about one mile north of the Terminal well. Ground elevation here is 4,272 feet. This well was begun in June 1936, and had reached the Madison limestone by December. At the time of writing, a commercial production of oil from a depth of 5,252 feet is reported. According to the writer's determinations, this depth is about 42 feet below the top of the Madison limestone.

The writer<sup>1</sup> has recently pointed out that most of the folds beneath the southern Alberta plains plunge toward the north, and this is not favourable for the accumulation of petroleum, but there are other factors which may modify the effect of the plunge. The most important of these in the Del Bonita area is the terrace that apparently exists along the crest of the anticline in sections 5, 7, 8, and 18, and which may serve to retard the southward migration of oil and gas. It is known, for example, that oil occurs in a terrace structure without southern closure in the Red Coulée field.<sup>2</sup> Some knowledge of the southward extension of the Del Bonita fold into Montana would be valuable, but this probably could be obtained only by test drilling.

Taking into account the character of the Del Bonita anticline, as described above, as well as the reported success of the Sunshine well, it is recommended that further exploration for petroleum be conducted in the Del Bonita area.

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<sup>1</sup> Can. Min. and Met. Bull., No. 299, p. 194 (1937).

<sup>2</sup> Evans, C.S.: Geol. Surv., Canada, Sum. Rept. 1930, pt. B, pp. 22-24.