

South Dakota
Geological and Natural History Survey

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CIRCULAR 9

The
Possibilities of Oil
in
Western Dewey County

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LOCATION

The area under discussion is located in western Dewey County, South Dakota. It includes four townships, viz., T. 15 and 16 N., R. 22 and 23 E.

The town of Isabel (population, 400), the terminal town on the branch line of the C. M. & St. P. R. R. running out from Moberg, is within one half mile of the northern border.

The index map (Fig. 1) shows the position of the area in reference to the State as a whole.

ACKNOWLEDGMENTS

The citizens of Isabel have been of decided help to the Survey in carrying on the work. They have very generously given the services of a car and driver for daily use. They have also furnished a helper when needed and have supplied noonday lunch almost continuously. Since the Survey is not financially able to own a car or hire one, except for occasional service, that part of the aid was especially appreciated. The work could not possibly have gone on successfully without this adequate transportation.

A unique characteristic of this community is their sane point of view. Their extreme interest in the possibilities of oil has been tempered by common sense. Nothing savoring of the spectacular has been tolerated. They have understood and appreciated what the Survey was trying to do, and the spirit of co-operation in the search for truth has always been maintained. Their thoughtfulness in regard to delivery of mail, doing errands, offering special trips on the side, etc., is worthy of comment.

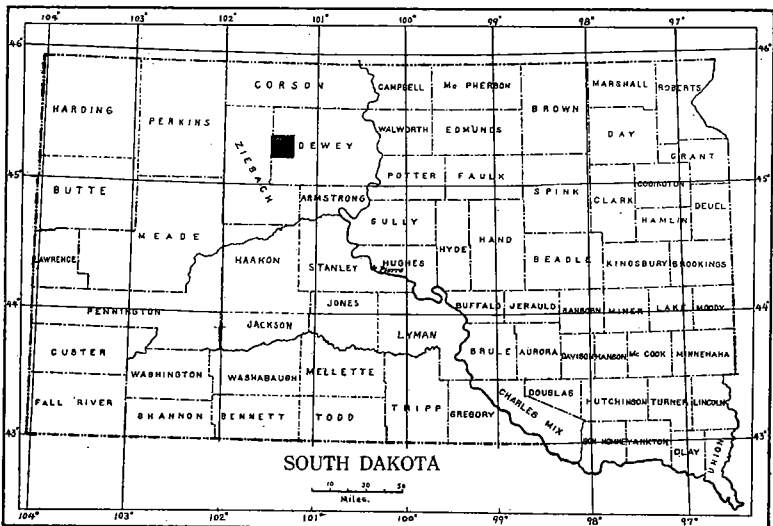


Fig. 1. Index Map
Black square shows location of area.

OIL POSSIBILITIES IN SOUTH DAKOTA

As a background for the discussion of the oil possibilities of this area it may be well to summarize the possibilities for the State as a whole, as follows:

South Dakota is an entirely new field; no commercial oil has thus far been discovered, and authentic oil showings in but a few places. Reconnaissance work and a critical study of the literature have rather definitely established the fact that no commercial oil can be expected in the eastern part of the State. The western part of the State, especially between the 101st meridian and the Black Hills proper, gives more promise. Thus far very few test holes have been put down and most of these have been placed in unfavorable localities. In order to prove South Dakota, holes must be put down on favorable structures and to depths of 2,500 to 4,500 feet depending on the locality. It should be distinctly understood that a "dome" or favorable structure does not *prove* oil, but until oil is proved to be lacking in the State such structures are logical places for trial. In the meantime the uncertainty is very high.

RELATION TO PREVIOUS WORK

The Survey issued last March a bulletin (No. 10) on the "Possibilities of Oil in South Dakota." This was written by the junior author after devoting some four months of field work to a rapid examination of the western part of the State, together with a searching study of all the literature bearing directly or indirectly on the problem. That bulletin is the basis for the statement in the preceding paragraph.

It should be emphasized that this work was a preliminary report. In the very nature of the case the field work could be only of a reconnaissance character. It serves as an admirable foundation for the later detailed work which must follow. One result of Mr. Wilson's reconnaissance investigation was the location of the areas which would merit closer inspection. The area under discussion is one of these selected areas.

Since there is practically no surface indication (such as oil seeps, etc.) in western South Dakota, and since deep well records are almost nil, the problem for the present at least is largely one simply of structural geology; i. e., the detailed studies place the emphasis on a search for "domes."

FIELD WORK

Something over a month's time has been spent in this area. The area has been mapped section by section on a scale of two inches to the mile, the land survey corners being taken as horizontal control. A plane table and telescopic alidade were used continually, all important outcrops and boundaries being located and drawn in the field. All measurements were made by stadia.

Elevations were determined almost entirely by barometer. With the railroad stations at Firesteel and Isabel as bases flying barometric levels were run by automobile along the main roads: these were always checked by re-reading. From these base lines of levels shorter lines were run to the key beds. From time to time the work was checked by level lines run with a spirit level. It is believed that the maximum error in elevation is ten feet, with a probable error of only five feet.

Every quarter section was visited, and over much of the area every forty was examined. In a few localities it was necessary to spend an entire day on a single section.

THE FORMATIONS

The Pierre, Fox Hills and Lance formations, all of Cretaceous age, are the only ones exposed in the area. Only outline statements concerning these formations will be given, more complete descriptions being reserved for a later publication.

Pierre.—This is a uniform, blue-gray shale. It is practically identical with the typical Pierre which is so common in western South Dakota, though there were present some thin layers of very fine sand near the top. Only the upper 100 feet of this formation was seen and, since the Pierre and Fox Hills are transitional, this upper portion may be expected to be a trifle sandy.

Fox Hills.—The Fox Hills is essentially a sandy formation, the upper portion being more and the lower less so.

At the very top is ten to twenty feet of yellowish, weak, shaly sandstone. Below this is a very characteristic bed, viz., a rather heavy bedded sandstone. This, over much of the area, is a hard sandstone with a pepper-and-salt gray color, fifteen to twenty feet thick, which makes the capping of most of the buttes. In other parts of the area this sandstone is weaker, is yellowish in color and not so thick.

Below this distinctly marked sandstone, in the eastern part of the area, is a weak, massive, yellowish sandstone; in the western part of the area this thins out and a thin bedded sandy shale becomes prominent; this is light yellow to gray in color.

The lower half or more of the Fox Hills is a thin bedded sandy shale, light gray above and merging gradually into bluish gray below. Occasional horizons of concretionary nodules, many of them highly fossiliferous, are present.

The total thickness of the Fox Hills is 225 feet.

The contact of the Fox Hills and Pierre is wholly transitional; it is impossible to draw a sharp line between the two—the color is alike and the sandy shale of the Fox Hills gradually gives way to the typical fissile shale of the Pierre through some fifty feet of intermediate material.

Lance.—The Lance is marked by the irregularity of its material and bedding. Sandstone, sandy shale and true shale alternate freely, some of the beds being fairly persistent but most of

them plainly lense-like. Colors range from a light gray which is nearly white to dark, somber tints of the heavier shale. This irregularity of bedding is quite in contrast with the even bedded character of the Fox Hills.

One characteristic of the Lance is the presence of coal beds and carbonaceous shale, all of which occur in the lower fifty feet: maximum number of beds in the area is four. In some localities the coal has burned; this has resulted in the baking of the adjoining shales, such places being marked by brighter colors, much of which is brick red.

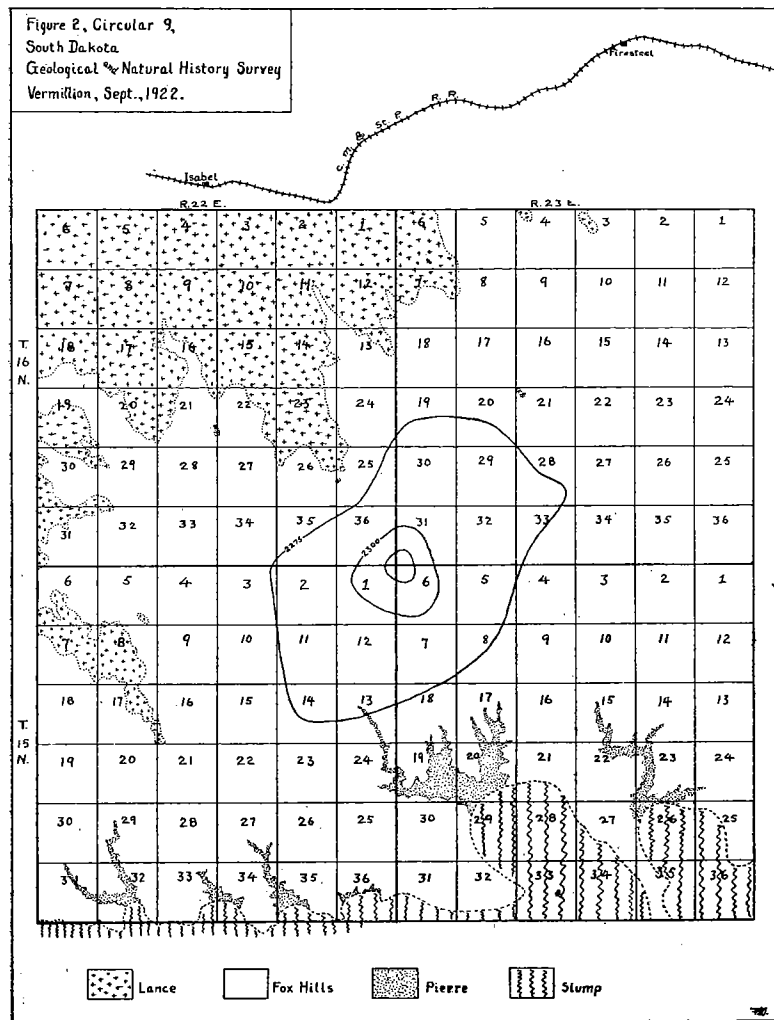


Fig. 2.

Maximum thickness of Lance exposed in the area is 75 feet.

The reasons for rating the Lance as Cretaceous are too lengthy to be given in this circular. One of the chief reasons,—and it is pertinent to the working out of the structure,—is the fact that the contact between the Lance and Fox Hills is transitional.

The distribution of these formations can be seen by reference to the geological map (Fig 2).

STRUCTURE

As stated in a previous paragraph, the chief aim in the detailed work has been to determine, if possible, whether any structures ("domes," etc.) suitable for oil accumulation could be found in the area.

Dips Not Trustworthy.—It has been determined by Mr. Wilson's reconnaissance work and since proved also by detailed observation that the recording of dips and strikes in separate outcrops gives no aid in working out the structure due to true regional deformation. The reasons for this are several, as follows:

(a) There is an abundance of slumping in the area, especially along the larger stream courses. The more recent cases are easily recognized and can be avoided, but the older ones are more obscure and may easily give unreliable evidence.

(b) Cross bedding, often on a large scale, is common in some of the formations, especially in the Lance.

(c) The Lance is very lense-like in its bedding, initial dip of several degrees may be due to this type of bedding.

(d) A large number of the rock outcrops are small, so that not enough is exposed to get the correct dip.

(e) In some cases a massive bed, such as the Fox Hills sandstone, may apparently give a dip of several degrees (ab, Fig. 3), whereas the bed may really be flat. This is due to uneven erosion. The bottom of the bed in such cases is usually obscured by an accumulation of talus blocks.

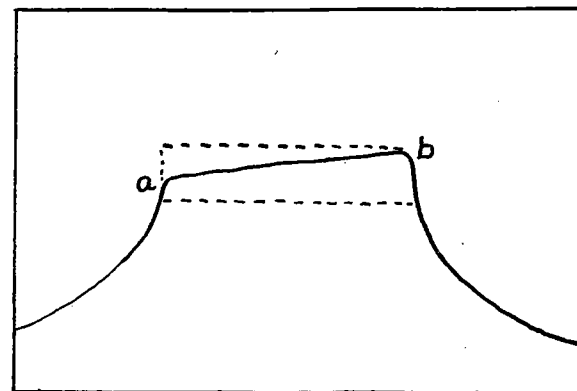


Fig. 3.

Key Beds Necessary.—Because of the unreliability of dip readings, it was imperative to find a key bed or beds which would be sufficiently recognizable and widespread to run levels on. Three such were found, as follows:

(a) The sandstone bed at the top of the Fox Hills. Where hard this makes the capping of many of the buttes; where soft the outcrops are less prominent but readily recognizable. This proved to be the most satisfactory of the key beds.

(b) A layer of fossil-bearing concretions about 125 feet below the top of the Fox Hills. This was not widespread but served locally.

(c) Coal beds in the basal Lance. These of course are lense-like, and no single one could be recognized or used continuously, nor could one of the four beds be distinguished from any of the others where seen separately. But all of them occurred in the lower 50 feet of the Lance. As a group, then, they could be rated as a key bed 50 feet thick. Considerable care and good judgment had to be exercised in using the beds in this manner but they supplemented very nicely the data derived from the other beds.

Results.—By running levels on these key beds a dome covering about fifteen square miles and having a closure of fifty feet was located near the center of the area. The structure contours on the map (Fig. 2) show the location and outlines of this dome. The crest is very close to the intersection of the four townships.

A few step faults were found. These are of small magnitude and should in no way interfere with the unity and value of the dome.

POSSIBLE OIL HORIZONS

Although a suitable oil structure has been located, the two other necessary conditions for commercial oil have not been proved to exist. If there is no source of oil below or reservoir rock in which the oil may accumulate, the dome has no value. Since there are no deep well records available for the area, nor, indeed, for any of the region nearer than 45 miles to the southeast and several times that distance in other directions, very little definite information is at hand concerning the deep underground conditions. But from a study of the nearest available evidence it is believed that the following table (Fig. 4) gives in a general way the most probable conditions.

Cretaceous	Lance		75	
	Fox Hills		225	
	Pierre		1200	
	Niobrara		200	
	Carlile		300	
	Greenhorn		25	
	Graneros	400		225
			Mowry	25
				25
			Newcastle (Muddy)	25
			100	
Dakota		150		
Comanchian	Fuson		50	
	Lakota		200	

Fig. 4

It is not believed that there are sands of any consequence in the Pierre.

The first possible horizon which may act as a reservoir rock is the Graneros. The Mowry member of that formation often contains a sandstone. The Newcastle, known also as the Thermopolis or Muddy, is another sandy member of the Graneros. Sometimes a water-bearing bed is encountered above the Mowry. Very little can be expected from any of these horizons.

The Dakota and Lakota are well developed sandstones and would be excellent reservoir rocks under suitable conditions. The latter has the most favorable prospects of the whole series.

The uncertainty concerning the formations below the Lakota is so great that it does not seem worth while to consider them.

While it may be disheartening yet it must be admitted that the expectation concerning the productivity of the several possible horizons of the State is on the whole rather low. This matter is discussed fully in Bulletin 10, to which the reader is referred. In

brief the reasons are as follows: The thickness, number and productivity of the oil sands diminish from central to eastern Wyoming and Montana. Many of these sands are completely absent in eastern and central South Dakota and no oil has been found in the thousands of artesian wells drilled in that part of the state. Western South Dakota is intermediate in position between the entire absence of production in eastern South Dakota and the moderate production of eastern Wyoming.

However, the matter can only be proved one way or the other by drilling on suitable structures.

DEPTH OF DRILLING

The depths to the several horizons listed above will vary, depending on the site chosen for the well. As is shown on the map (Fig. 2), there is no Lance at all along the crest of the dome. Furthermore, part of the Fox Hills has been worn away by erosion. If the well is put down near the base of the buttes on the crest of the structure it can safely be assumed that 100 feet of the Fox Hills has been removed.

On this basis the Mowry should be struck at 2,075, the Newcastle 25 to 50 feet deeper, the Dakota at 2,250, and the Lakota at 2,450.

It should be borne in mind that in the nature of the case the figures given cannot be exact; they are, however, the most reasonable estimates that can be made at the present time.

It would be unwise to drill deeper than 3,000 feet.

SUMMARY

FAVORABLE FEATURES

- (a) The area is in western rather than eastern South Dakota.
- (b) A well defined closed structure of good size has been located in the area.
- (c) The depth of drilling needed to prove the structure is not excessive.
- (d) The structure is near a railroad.
- (e) Roads are good, and fuel and water for operating are within easy reach.

UNFAVORABLE FEATURES

- (a) The South Dakota field as a whole is entirely unproved.
- (b) The deep underground conditions are extremely uncertain.