South Dakota
Geological and Natural History Survey
Freeman Ward, State Geologist

CIRCULAR 10

The Possibilities of Oil in Northern Dewey County

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EXPLANATION

The Survey issues two series of publications as follows:

BULLETINS.—Some subjects have been investigated a longer time, full data have been gathered, such preparatory or experimental work as was necessary has been entirely or nearly finished. In other words, the study of the subject is actually completed or so nearly so that the results can be relied on and published with a degree of confidence as to their value; and the treatment is full and thorough. In such a case the matter is published as a bulletin.

CIRCULARS.—But often during the progress of the work enough information is at hand to be of value to those interested, yet not enough for a complete treatise. A part of a county or a part of a certain subject may be finished, perhaps, and publication waiting for the complete investigation of the whole county or the whole subject. There may be a demand for statistical matter, or lists of references, or current information, etc., which would hardly do for a formal bulletin. Such partial reports, summary reports, reports of progress, lists, or unit fragments of larger subjects, etc., are handled in circulars.

It is planned to publish the circulars frequently and the bulletins at longer intervals. With this arrangement much information will reach the public with a minimum of delay.

Inquiries may be addressed to the State Geologist, Vermillion, S. D.

INTRODUCTION

During the field season of 1921 the writer made a reconnaissance study of parts of western South Dakota to determine as thoroughly as the time, scope and methods of work would permit the geologic features bearing upon the possibilities of oil in this general part of the State. The results of this study are incorporated in Bulletin 10 of the State Geological and Natural History Survey.

The reconnaissance studies indicated that the strata over the plains region of the State are but slightly folded. The work also showed that little reliance could be placed upon local dip readings, inasmuch as the major portion of such dips were found to represent structures of local or surficial origin. Such structures bear little if any relation to the regional folding.

In view of these facts the accurate determination of detailed structural features in the plains region of the State is possible only by running carefully determined elevations upon some recognizable and sufficiently widespread stratum or horizon with reference to sea level and hence the character of the folding in which it is involved. Structural mapping by this method would, of necessity, be confined to those regions where satisfactory key beds were developed. This factor has determined the location of the areas which the State Geological Survey is now mapping.

LOCATION AND AREA OF THE DISTRICT

The area included in this report lies in the northern part of Dewey County. (See index map, figure 1.) It embraces all of the following townships: Tps. 15, 16, 17, 18, 19 N., R. 24, 25, 26 E.

Timber Lake, the county seat of Dewey County, is located near the center of the district on a branch line of the Chicago, Milwaukee and Saint Paul Railway, connecting with the main line at Mobridge.

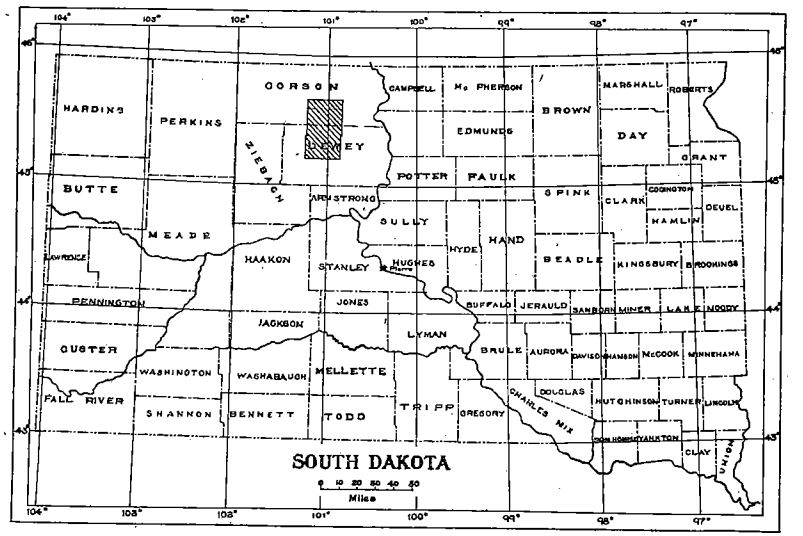

Fig. 1. Index Map
Shaded Portion Shows Area Covered by this Report.

FIELD WORK AND ACKNOWLEDGMENTS

The main purpose of the work was to determine the structural features of the region. Structural mapping was carried on by the plane table method. A hard sandstone stratum which lies near the top of the Fox Hills formation and caps the buttes of the district was used as a key bed. The horizontal control or location of the outcrops was determined by intersection and resection upon section corners. The vertical control or elevation of the outcrops above sea level was determined by barometric readings, with frequent checks upon established bench marks, previously determined by flying levels.

During the field work, transportation, board, and lodging were provided by Mr. C. R. Munson and Mr. Guy C. Long of Timber Lake. Acknowledgment is here given for the unfailing courtesy and cooperation of these men in aiding the writer to carry on the studies.

TOPOGRAPHY

The region is characterized by rolling prairie, over which buttes are irregularly scattered. The buttes are largely confined to the northern part. They are capped by a hard sandstone stratum, which was once continuous over the entire region but which has been removed from the intervening areas during a period of erosion.

The present prairie surface is developed in a soft, friable sandstone that underlies the more resistant stratum capping the buttes. Masses of iron-stained sandstone are irregularly interstratified throughout this horizon and, owing to their greater resistance to erosion, have formed mounds and ridges of irregular height and distribution.

The valleys are generally broad and shallow, but in the northern and southern parts of the region they are more deeply incised into the prairie, where they have adjusted their drainage to the deeper valleys of the Grand and Moreau rivers. The more pronounced valley of Firesteel Creek has also caused a similar deepening of its tributaries in the northwestern part of the area.

A ridge covered with glacial gravel and boulders trends in a general northwest-southeast direction through the northern part of the area. This ridge is especially well developed in the southern part of Tp. 19 N., R. 24 E., where it constitutes a conspicuous feature of the topography.

THE FORMATIONS

Three formations are exposed in this district—the Pierre shale, Fox Hills sandstone, and Lance formation. The position of these formations in the stratigraphic column is shown in the appended table (figure 3).

Pierre Shale.—This outcrops in the deeper valleys of the northeastern and southern parts of the area. About 75 feet of the top part of the formation is exposed. The outcrops consist of dark, fissile shale, somewhat sandy.

Fox Hills.—This formation covers nearly all of the area under consideration and the structural features were determined entirely from a study of its outcrops. A hard, fine to medium grained sandstone with a salt and pepper color forms the upper part of this formation. This sandstone caps the buttes over many square miles in this part of the State. The average thickness of this butte-capping sandstone is about 15 to 20 feet. In the northwestern part of the area about 15 feet of yellowish shaly sandstone lies between the hard sandstone and the Lance outlier described below.

The middle part of the Fox Hills formation is essentially a loose, coarse textured sandstone which readily breaks down under weathering and now forms much of the prairie surface. The color varies from a light yellow to a deep brown. Harder masses of sandstone are irregularly interstratified. The thickness of this middle member averages about 100 feet.

The lower part of the formation is composed of thin bedded sandy shale, representing a transition from the typical Fox Hills sandstone above to the dark bluish gray Pierre shale below. Thin beds of light gray sandstone are interstratified. Several horizons of fossiliferous nodules are present in this member.

The field studies indicate an average thickness of about 250 feet for the Fox Hills formation in this area.

Lance Formation.—This formation occurs as a small, local outlier on a high ridge in the northwestern part of the area. It is represented by a few feet of carbonaceous shale and gray sandstone.

STRUCTURAL FEATURES

The necessity of mapping structure in this territory by running elevations upon satisfactory key beds has already been indicated. The hard sandstone stratum developed near the top of the Fox Hills formation, once continuous over the entire region but now capping the widely scattered buttes, was found to be the most satisfactory key horizon. The degree of accuracy with which structure can be mapped is naturally dependent upon the distribution and number of key bed outcrops. Although the above described sandstone stratum is now confined to the tops of the buttes, the low dips of the strata and the resulting broadness of the structures permitted fairly detailed determination of the rise and fall of the beds, even though the key bed outcrops were widely and irregularly distributed.

Structural mapping showed that the strata of the region are warped into broad, slight folds, with dips averaging 10 to 20 feet to the mile; dips in excess of this are rare. In one or two localities, however, the angle of dip is as great as 45 feet to the mile. The regional dip is northwest.

The folds of the region trend in two general directions, northeast-southwest and northwest-southeast. The former set of folds is the more pronounced. Structures with slight closure are apt to develop where upwarps with the above described variations in trend cross each other. The dominating structure of the south half of the field is a broad, northeasterly plunging anticline, which has its high point in the southwest corner of the area. Several slight folds with the previously described trends occur in the northern part of the field, and two closed structures have been developed in the general area where folds intersect. The location and form of these domes are indicated on the map (figure 2). The eastern dome, which has its high point near Saddle

Butte, has an approximate closure of 50 feet. The dome to the west of this has a closure of 45 feet.

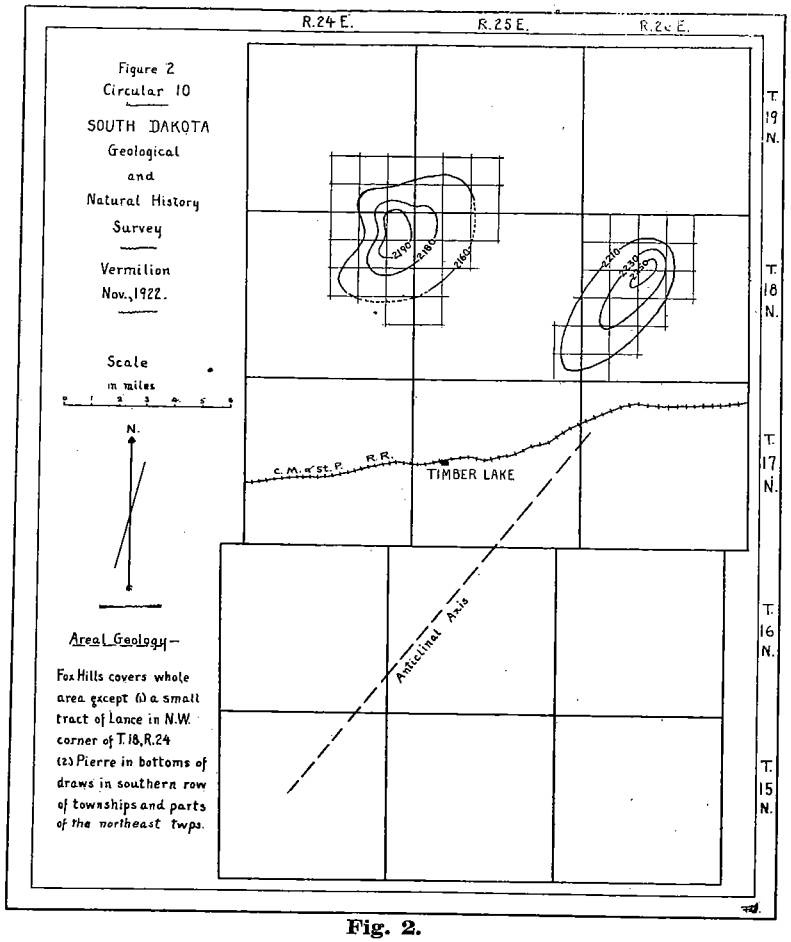

Fig. 2.

The Pierre shale exposed in the valley bottoms of the southern part of the area shows a considerable number of prominent dips and folds. These are largely of local origin and have little if any bearing upon the regional structure. The probable modes of origin of such folding in the Pierre shale has been discussed in Bulletin 10.

OIL POSSIBILITIES

The possibilities that any region has for oil rest upon three general factors; a source for the oil, suitable reservoir rocks, and a suitable structure. The first and second factors must be determined largely from a study of underground conditions by means of well logs or exposures of formations. Owing to the slight amount of folding in this region, the formations have been exposed only to shallow depths, and a study of the deeper underground conditions must be based entirely upon well logs. No wells deep enough to penetrate possible oil horizons in this area have been drilled, so that our present conception of underground conditions must be based entirely upon the known facts relative to the regional geology.

The dark marine shales lying between the Dakota and Fox Hills sandstones are more or less petroliferous, but whether they would furnish commercial quantities of oil if suitable reservoir rocks were present is a problematical matter.

With regard to possible oil sands in this area the statement in Circular 9, "The Possibilities of Oil in Western Dewey County," will also hold true for this area:

"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 (figure 3) gives in a general way the most probable conditions:

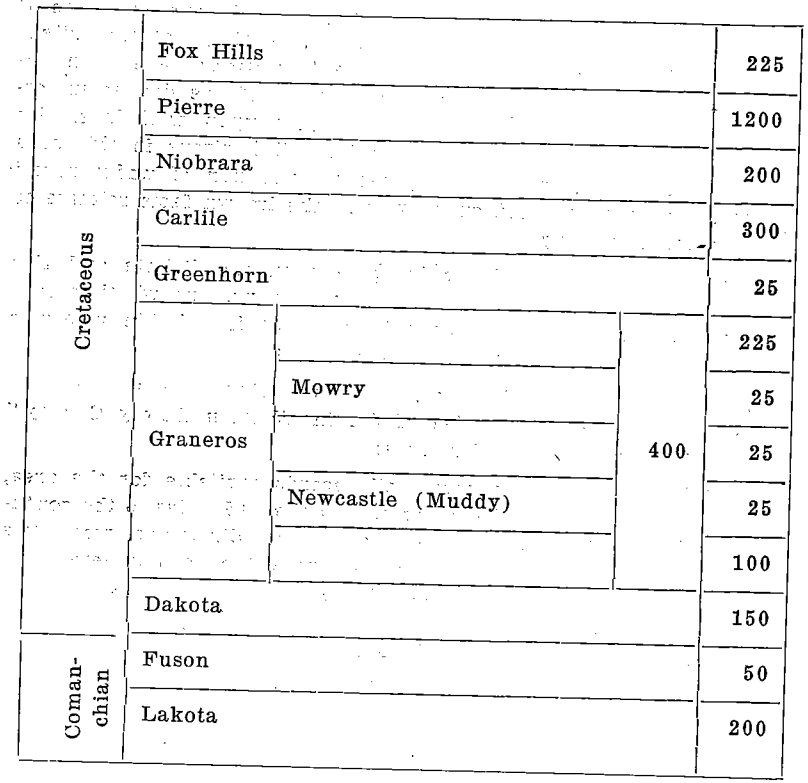

Fig. 3.

"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."

In the area under consideration two structures have been found which from the structural standpoint are considered to be worth testing.

DEPTH OF DRILLING

Wells put down on the high points of the above mentioned structures would have approximately 125 feet of Fox Hills to pass through. The depths to the various possible horizons as given in Circular 9 would also hold for this area. They are as follows: Mowry—2075, Newcastle—2020 to 2045, Dakota—2250, and Lakota—2450. In the light of present evidence these figures are only approximations.

SUMMARY

FAVORABLE FEATURES

(a) The area is in western rather than in eastern South Dakota

(b) Two structures of moderate closure and of sufficient size have been located.

(c) The depth of drilling necessary to test out possible oil horizons is not excessive.

(d) The structures are near the railroad.

(e) Roads are good, 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 and in the light of present geologic evidence unfavorable.