SOUTH DAKOTA

GEOLOGICAL AND NATURAL HISTORY SURVEY

E. P. Rothrock, State Geologist

PAMPHLET II

THE OIL POSSIBILITIES

OF

SOUTH DAKOTA

(Advance Notice)

By

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Introduction

The data bearing on the oil possibilities of the State which has been gathered by the writer during the past three years is to be published as a bulletin of the State Survey. As, however, it will take some time to print and publish this bulletin, it seems advisable to promote development by publishing some of the conclusions regarding the oil and gas possibilities in advance.

General Conditions

Five formations must be considered as possible horizons for oil and gas production in South Dakota. These are the Minnelusa (Carboniferous), Sundance (Jurassic), Lakota (Lower Cretaceous), the series of sandstone just below the base of the Graneros shale (Lower or Upper Cretaceous) and the sandstone in the Carlile shale (Upper Cretaceous). These formations all come to the surface in the Black Hills, but dip beneath the plains. The Minnelusa formation or its equivalents probably underlies nearly all of South Dakota west of the Missouri River and outside of the Black Hills. The Sundance formation apparently does not extend as far as the Missouri River. The sandstones in the Carlile shale are present only in the extreme western part of the state.

The Oil Possibilities of the Black Hills Region

Though a number of anticlines in the Black Hills region of South Dakota have been tested without success, it seems probable that the absence of production in these anticlines is due to the scarcity of source materials. There are still a number of untested anticlines in the Black Hills region of South Dakota, and if it could be shown that adequate source rocks were associated with the sandstones in these structures, they would still be worth testing in spite of the unfavorable nature of the development to date. The Carlile shales probably contain source materials, and if it could be shown that the sandstones in them are present in certain structures in sufficient thickness to produce oil, these structures would be worth testing. Until further investigation has been made it will not be possible to determine what structures should be tested. At present the Flint Hill anticline five miles east of Edgemont, mapped by Rubey*, is one of the most promising in this region. The Smithwick structure, located about four miles south of Smithwick, and the Piedmont anticline, located about nine miles north-northwest of Rapid City, also have possibilities for production, though the latter may be too close to the the outcrops. The sandstones in the Carlile shale should be encountered in the Smithwick structure at a depth of about 1500 feet, and the top of the Minnelusa should be found at a depth of 1100 to 1200 feet in the Piedmont anticline.

The Oil Possibilities of the Region between the Black Hills and the Missouri River

In the region between the Black Hills and the Missouri River the most promising formations for oil and gas production are the Minnelusa formation of Carboniferous age, and the so-called "Dakota" sandstones probably contain fresh water, and the prospects for production in this horizon in that area are, therefore, not so promising. In the northwestern part of the state, on the other hand, the "Dakota" sandstones contain hot salty water with numerous gas shows. In this region there is probably little or no artesian circulation such as might destroy the oil pools. It is quite likely, though by no means certain, that adequate source rocks are interbedded with the "Dakota" sandstones in this section and structures are known to be present.

Since in areas of gentle dips there is a pronounced tendency for the oil and gas pools to occur along the axes of regional arches, it is very important to locate these regional structures in western South Dakota. The accompanying map, Fig. 1, shows the regional structure of part of western South Dakota reduced to the horizon of the Ammonite bed (CAS), a zone of fossiliferous concretions in the middle portion of the Fox Hills formation in its type locality. It is evident that there are two east-west regional arches, the Fox Ridge Arch and the Hilland Arch, and another poorly defined anticline, the Dupree Anticline, which extends in a north-northeasterly direction. The prospects for oil and gas are much better along the axes of these folds, and particularly where they cross. Hence, from the standpoint of the regional
structure, the most favorable localities for oil and gas production are in T. 11 and 12 N., R. 20 E., and in T. 2 and 3 N., R. 17 E. The latter area has been in part mapped and described by the writer in Circular 28. It is likely that structures with 50 to 100 feet of closure are present in both of these areas, though this could not be determined definitely without further work.

In the portion of South Dakota between the Black Hills and the Missouri River there are two types of structures which may produce oil. One is large, with few faults and gentle dips. The other is small, steep and highly faulted. The large, gentle type is more likely to produce on the regional arches, but the small, steep type may produce off of them, for the production of steep structures is not so closely related to the regional arches as in the case of the gentle folds. It is quite possible that the largest and most promising of these steep faulted anticlines has not yet been found. The most promising at present known to the writer are the Irish Creek Structure 15 miles southwest of Isabel, now being tested, and the Red Elm Structure, four miles north of Red Elm, Described in Circular 20. These two structures, and the structures at the intersections of the regional arches, are located in the region in which the "Dakota" sandstones contain salty water, and in the belt in which they are believed to be interbedded with dark shales which are probably in part bituminous.
The estimated depths in feet of the Dakota and Minnelusa in these structures are as follows:

<table>
<thead>
<tr>
<th>Location of Structure</th>
<th>Depth of top of Dakota</th>
<th>Depth of top of Minnelusa</th>
<th>Depth of base of Minnelusa</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. 2-3 N., R. 17 E.</td>
<td>2400</td>
<td>3700</td>
<td>4300</td>
</tr>
<tr>
<td>T. 11 &amp; 12 N., R. 20 E.</td>
<td>2800</td>
<td>4000</td>
<td>4500</td>
</tr>
<tr>
<td>T. 13 N., R. 19 E.</td>
<td>3200</td>
<td>4100</td>
<td>4600</td>
</tr>
<tr>
<td>T. 15 E., R. 20 E.</td>
<td>3900</td>
<td>4100</td>
<td>4600</td>
</tr>
</tbody>
</table>

Conclusions

1. The unfavorable results of drilling for oil and gas in the Black Hills region are probably due to the absence of suitable source rocks. Until a detailed investigation of the distribution of the source rocks in the various formations has been made, it will be impossible to form a reliable idea of the oil possibilities of this region.

2. The prospects for production in the "Dakota" sandstones are most promising in a region in the northwestern and west-central part of the state in which they contain salty water and are probably interbedded with more or less bituminous shales.

3. The most promising structures known at present in the region between the Black Hills and the Missouri River appear to be in T. 2 and 3 N., R. 17 E., T. 11 and 13 N., R. 20 E., T. 15 N., R. 19 E., and T. 15 N., R. 20 E.
Oil and Gas Problems Recommended for future Investigation.

1. A study of the amount and distribution of source rocks in all of the Mesozoic and Paleozoic formations of the Black Hills region, particularly the Minnelusa, Sundance, and Morrison Formations and the lower part of the Graneros shale.

2. An examination of the outcrops of the Carlile shale in the Black Hills region to ascertain the thickness and distribution of the sandstones contained in it.

3. The investigation of the subsurface stratigraphy of the area between the Black Hills and the Missouri River by means of the samples from drilled wells.

4. The construction of a map showing the regional structure of the area between the Black Hills and the Missouri River.