

South Dakota
Geological and Natural History Survey

Freeman Ward, State Geologist

CIRCULAR 25

The Structure
of
Western South Dakota

By
Freeman Ward

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PREVIOUS MAPS

The standard structure map of South Dakota has for years been the one by N. H. Darton.¹ This was reissued in much the same form ten years later.² The geologic structure of Perkins and Harding counties was shown by Winchester and others³ by contours drawn on the lower part of the Lance. With but few modifications, these served as a basis for a map prepared by R. A. Wilson.⁴

All of these maps (except Winchester's smaller area) are alike in representing the structures by contours drawn on the Dakota sandstone.

It is believed that these maps are inaccurate in many respects for the following reasons:

(1) The Dakota sandstone is not easily accessible. As a result there are too few observations on this horizon in the western part of the State. The Dakota sandstone outcrops along the outer edge of the Black Hills, from there dipping down and underlying the adjacent plains region. The only direct measurement, therefore, that can be made on this bed is by means of deep wells. Reference to the accompanying map shows (by means of black squares) that such wells have been put down only in the eastern part of the area or in the Black Hills region. To this should be added the well at Nowlin (Haakon County), the Rosebud well in Todd County, and two more in the southwestern part of the State (Shannon County). This leaves a wide section of the region in which there is no actual observation of the Dakota. The size of this section can be better realized by stating that a rectangle 195 miles north and south by 90 miles east and west has in it no well to the Dakota. Adding the territory immediately adjacent and adjoining, makes a total of some 25,000 square miles (one third the area of the State) barren of any evidence of a direct kind, bearing on the position of the reference bed chosen.

(2) The Dakota sandstone is probably not as definite a horizon as it has so long been assumed to be. Of course it has been known that there is more than one water-bearing sandstone in the Dakota. The record of the wells in the eastern part of the State has shown this. But that the Dakota may be a series of overlapping lenses plus some continuous beds is a more recent conception. Russell's work (not yet published) suggests that this is the case. It is quite possible that the first water-producing horizon in one locality may actually be equivalent to the second producing horizon in a well twenty miles distant, etc. The error in interpreting the top of the Dakota sandstone may therefore be as much as 100 or even 200 feet, particularly in the western part of the State.

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 completed. 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 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.

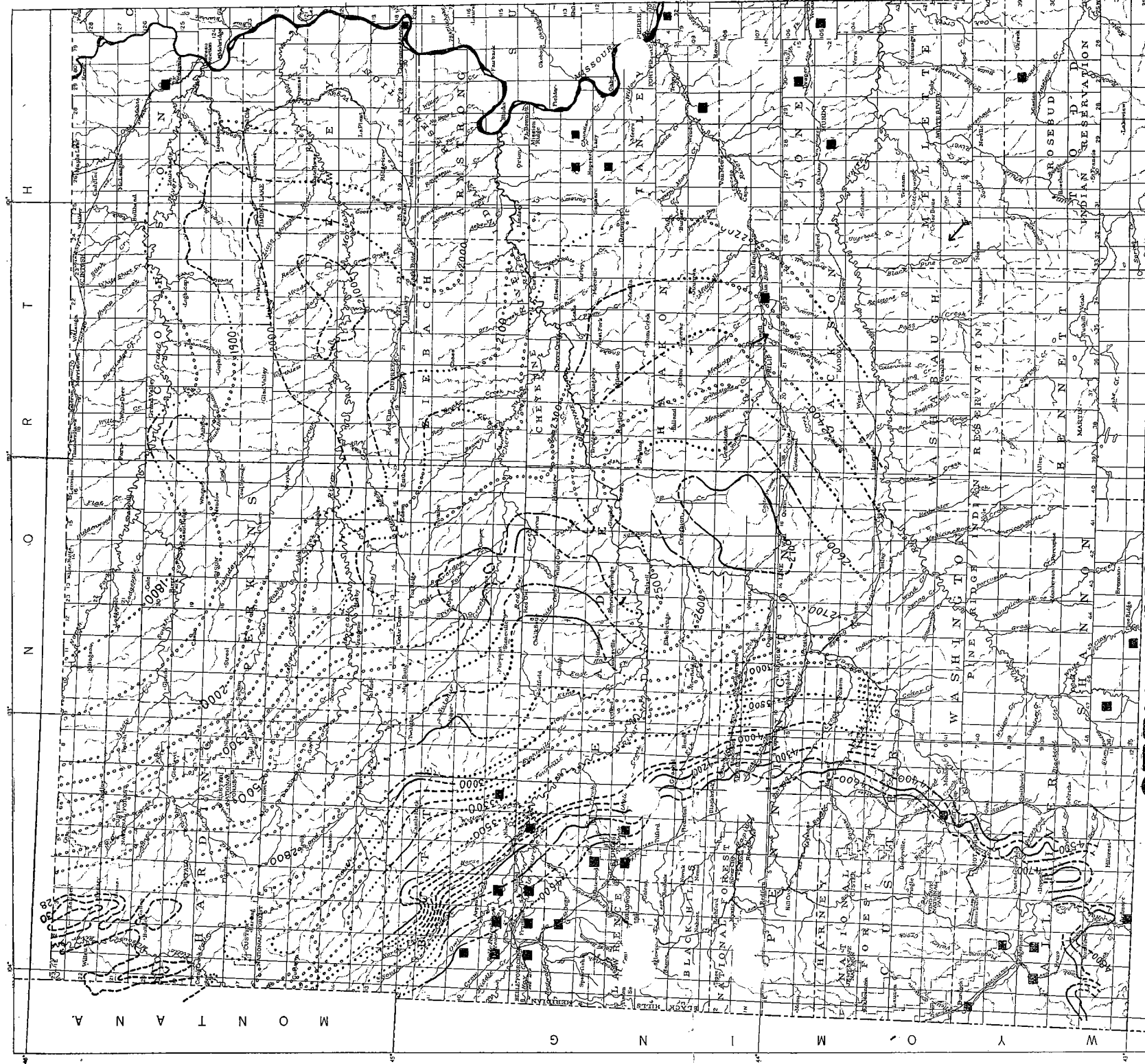
Inquiries may be addressed to the State Geologist, Vermillion, S. D.

¹U. S. G. S., W-S. P. 227, Pl. XIII, 1908.

²U. S. G. S. Bull. 691 A. Pls., I, III, 1918.

³U. S. G. S. Bull. 627, Fig. 3, 1916.

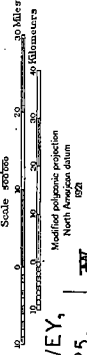
⁴S. D. Geol. and Nat. Hist. Surv.: Bull. 10, 1922.



STRUCTURE WESTERN SOUTH DAKOTA.

CONTOURS DRAWN ON THE TOP OF THE PIERRE SHALE.

- DATA WELL ESTABLISHED.
- - - REASONABLY ACCURATE.
- HIGHLY PROBABLE.
- INFERENCE LARGE.



S. DAK. GEOL. & NAT. HIST. SURVEY,
 Vermillion. CIRC. 25, OCT., 1925.

■ TOWNSHIPS IN WHICH WELLS HAVE REACHED THE REGIONAL DIP.
 ← DAKOTA.

In preparing these earlier maps it was natural to use the Dakota sandstone because it is such a widespread formation; also because in the eastern part of the State thousands of wells gave the desired information. Nevertheless, it seems to the writer that too much altogether has been taken for granted in attempting to represent the structure in the western part of the State.

THE PRESENT MAP

The map herein presented is an attempt to avoid the above mentioned difficulty in the use of the Dakota sandstone.

The top of the Pierre has been chosen as the index horizon. A preliminary attempt in the use of this horizon for part of the State was made by the writer in Circular 22 of the Survey.

The advantages of using the Pierre are as follows:

(1) This horizon is relatively accessible. The top of this formation can be seen in many different parts of the area considered. Where it cannot actually be seen, it can be readily estimated by adding a moderate figure to known index beds in the upper part of the Pierre, or by subtracting a moderate amount from index beds in the overlying Fox Hills. There is scarcely any appreciable error in these methods comparable to the necessary large error in estimating thickness (several thousand feet) of formations between the Dakota and the surface.

Since the Pierre is transitional into the Fox Hills the exact top of the Pierre is partly a matter of opinion and cannot be precise. But the determinations have been standardized. It is believed that most of the determinations are within 25 feet of correct and none of them more than fifty feet away from the truth. The error of horizon determination, then, is one half that encountered in the use of the Dakota, even where deep well holes are available for the latter.

(2) The Pierre is a widespread formation, so that it is equally valuable as the Dakota in this respect as far as western South Dakota is concerned.

Sources.—This map is in part a compilation. In studying the oil problems of the State, the Survey has for several seasons been working out local structures in detail. In all cases index beds either in the Fox Hills or Pierre were used. These beds had a known relation to the contact (top of Pierre). The members of the staff who have worked on these local structural problems are R. A. Wilson, G. F. Moulton, W. L. Russell, A. W. Voorhees and the writer. The data gathered for this first purpose have been reduced and integrated for the larger structure map.

Data have been secured from some eighty townships in western South Dakota outside of the Black Hills and in the region where the Dakota is not observable. The data have ranged from a single observation in a township to twenty-four observations in a section and as many as thirty-four sections in a township. In this latter case the records have been averaged for the larger map.

In northwestern Harding County the data have been taken from the U. S. G. S. press notice on the Cedar Creek anticline.

Along the eastern margin of the Black Hills, information has been secured from the U. S. G. S. folios—Belle Fourche, Newell, Black Hills, Oelrichs, Edgemont. In these publications, the elevation of the contact of the Pierre and Niobrara was determined for each section. To this was added the thickness of the Pierre as given in the respective folios. The Newell and Belle Fourche folios give the contact of the Pierre and Fox Hills exactly in a few localities.

In a few instances, where no other data were to be had, the regional dip was determined by running elevations on a local index bed. In addition, the writer has, during the past field season, made special studies for the particular purpose of the newer structural interpretation.

Special Features.—In preparing the map an effort has been made to evaluate the evidence used. The contours are drawn with four designs to show to what degree fact and assumption have controlled the representation of the structure.

It is evident that the simple basin-like structure as shown on the earlier maps is not a prominent feature of the present interpretation. In contrast, the striking character is the general northeast and southwest trend of large arches and terraces, except in the extreme northwest part of the State, where the trend is northwest and southeast. Another feature is the divergent lobate habit, illustrated by what may be named the White Owl terrace in eastern Meade County. This diverges into two lobes, one extending due northeast, the other north-northeast. This suggests some control by the pre-Paleozoic topography.

The most prominent single dome is in eastern Pennington County (east of the Cheyenne River) and the adjoining Haakon and Jackson counties. This can well be named the Wall dome since the crest is not many miles north of the town of Wall. This dome also is divergently lobate. The domal character would be still more striking if a 50 foot contour interval were used.

There are many gaps in the record. The Chadron anticline is not drawn in at all, no evidence of a newer quality having yet been secured in the extreme south portion of the area. As indicated by the type of contour used, there are many places where the inference is large. Especially is this true in Perkins and Harding counties. These doubtful and unexplored areas will be further examined as opportunity is offered.

It is hoped that this map, however incomplete it is, will stimulate and direct future field work done by others in western South Dakota.