OKLAHOMA GEOLOGICAL SURVEY
Chas. N. Gould, Director

Bulletin No. 40-P

OIL AND GAS IN OKLAHOMA

STRUCTURAL TRENDS IN SOUTHERN OKLAHOMA

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NORMAN
JULY, 1927

CONTENTS

ILLUSTRATIONS

FOREWORD

In 1917 the Oklahoma Geological Survey issued Bulletin 19 part 2 entitled, "Petroleum and Natural Gas in Oklahoma." This volume was so popular that the supply was soon exhausted, and for several years copies have not been obtainable.

The present director has seen the need of a revision of this bulletin. On account of lack of appropriations he has not been able to employ sufficient help to compile the data, and has called on some twenty representative geologists throughout the state to aid in the preparation of reports on separate counties. These gentlemen, all busy men, have contributed freely of their time and information in the preparation of these reports.

It will be understood that the facts as set forth in the various reports represent the observation and opinion of the different men. The Oklahoma Geological Survey has every confidence in judgment of the various authors, but at the same time the Survey does not stand sponsor for all statements made or for all conclusions drawn. Reports of this kind are, at best, progress reports, representing the best information obtainable as of the date issued and doubtless new data will cause many changes in our present ideas.

Mr. LaVerne Decker, the author of this report, has spent several years in the geology of the fields in south-central Oklahoma, and is familiar with the general structural conditions in that part of the State. This report, with the accompanying map, gives in a brief, concise way, the peculiar structural conditions of southern Oklahoma.

CHAS. N. GOULD
Director

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By

LaVerne Decker

INTRODUCTION

AREA AND TREATMENT

The term "southern Oklahoma" as used in this paper is that part of the State lying south of the South Canadian River and between the ninety-sixth and one-hundredth meridians. The northern tier of Texas counties included between those meridians also will be treated.

This paper is neither analytical nor deductive. The effort here is to show the positions of structural trends and not to draw conclusions from their positions relative to each other and to the master structures of the area.

The complexity of structural conditions and the ambiguity of subsurface data renders confusion inevitable. No doubt my colleagues have in their offices map of trends which vary considerably from those on the map accompanying this paper. To further illustrate the point the writer has seen about eight structure contour maps of the Sholom Alechem field, all of them made by competent men and all differing rather strikingly in detail.

It is hoped that this paper will represent to the profession an interpretation of the available data reasonable enough to form the framework for further and more detailed research.

LITERATURE

The writer regrets that a shortage of time and an incomplete library prevented the compilation and careful examination of a complete bibliography and he accepts this opportunity to apologize for the resulting inaccuracies.

Some of the early opinions concerning certain trends have been disproven by the drill. That fact does not mean that the work was poor. On the contrary, early work in the district was uniformly good and the inaccuracies mentioned resulted from the intricacies of a problem which is by no means fully understood at present.

ACKNOWLEDGMENTS

The writer is especially indebted to C. W. Tomlinson for his kind assistance and advice. As a matter of fact the paper could not have been

produced by the writer without that aid. To Chas. N. Gould, and C. L. Cooper of the Oklahoma Geological Survey, and to R. A. Birk credit is due for assistance and criticism.

It will be impossible to give credit where it is due in many cases and it is desired at this time to acknowledge indebtedness to the writer's good friends and fellow geologists who have contributed essential portions of the data included in the following pages.

REGIONAL GEOLOGY

Gould and Lewis,[1] McCoy,[2] Gouin,[3] Dott,[4] Moore,[5] Taff[6] and others have given the regional geology of the area such thorough and competent consideration as to render a comprehensive treatment of the subject neither necessary nor desirable for the purpose of this paper.

The correlation and description of the formations of this area have been given by Gould.[7]

TREATMENT

To facilitate reference from text to map the various trend structures have been numbered. An unsuccessful attempt was made to apply numbers to show relationship so the numbers as shown bear no essential relation to each other.

Where possible the controlling structural features will be discussed as groups of smaller structures and as unit master structures. The major individual features will be treated separately. In all cases where it is possible to do so and avoid confusion the structures will be treated in groups.

When this paper was first discussed there was some idea of accompanying it with a contour map of the pre-Permian surface. There is a distinct relationship between that surface and the commercial production in the district, attention to which was drawn by Burton.[8] The writer regrets that a lack of time prevents further work along that line.

1. Gould, C. N., and Lewis, Frank E., The Permian of western Oklahoma and the Panhandle of Texas: Oklahoma Geol. Survey, Cir. No. 13, 1926.
2. McCoy, A. W., Experimental petroleum geology: Bull. Amer. Assoc. Pet. Geol. Vol. V, No. 5, p. 466, 1921.
3. Gouin, Frank, Geology of the oil and gas fields of Stephens County, Oklahoma: Oklahoma Geol. Survey, Bull. No. 40-E, 1926.
4. Dott, Robert H., Pennsylvanian paleogeography; with special reference to south-central Oklahoma: Oklahoma Geol. Survey, Bull. No. 40-J, 1927.
5. Moore, R. C., The relation of mountain folding to the oil and gas fields of southern Oklahoma: Bull. Amer. Assoc. Pet. Geol., Vol. V, No. 1, p. 32, 1921.
6. Taff, Joseph A., U. S. Geol. Survey, Geologic Atlas, Tishomingo Folio (No. 98), 1903.
7. Gould, Chas. N., Oklahoma Geol. Survey Bull. No. 35, Correlation table, 1925.
8. Burton, George E., Relation of the base of the red beds to the oil pools in a portion of southern Oklahoma: Bull. Amer. Assoc. Pet. Geol., Vol. V. pp. 173-326, 1921.

STRUCTURAL TRENDS

MASTER STRUCTURES

The Wichita Mountains, the Arbuckle Mountains, the Criner Hills, the Anadarko basin, the Palo Duro basin, the Amarillo Mountains, the Red River basin and arch, and the Hunton arch are the master structures of the region. There is some evidence that the Ellenberger high plunging north from the Llano-Burnett uplift of central Texas may bear some relationship to the northern Texas structures and trends.

The Wichita Mountains and the Arbuckle Mountains are the most important of the master structures when considering the trend of the southern Oklahoma districts.

The Anadarko basin is reasonably assumed by Becker[9] to be the result of the settling of Permian sediments off the edge of the Wichita Mountains. Thus it can be considered a part of the larger structural province.

Gould[10] has done much toward a classification and correlation of the master structures of the Mid-Continent field. To him is attributed the names Amarillo Mountains and Palo Duro basin. The former feature he suggests may be an extension of the Wichita-Arbuckle axis or it may be *en echelon* and parallel to that axis.

His views relating to the Palo Duro basin are quoted verbatim:

> As studies have been carried forward on the geology of the southern part of the Great Plains during the past few years, it has become evident that there is a great structural trough lying south of the Arbuckle-Wichita-Amarillo Mountain uplift. Neither the exact location nor the extent of this great syncline or basin is now definitely known.
>
> In 1922 Howell[11] described a syncline which he called the Red River syncline, passing east and west in Jefferson, Cotton, and Tillman counties, Oklahoma. In 1925 Hoots[12] described a great basin in western Texas. This may or may not be a part of the same structural low as that described by Howell. On the colored geological map of Oklahoma, by Miser, a syncline is shown in western Harmon County at about the point indicated by Hoots on his map of Texas. In shape and outline this latter basin, as it occurs in the Panhandle of Texas, appears to differ from the Anadarko Basin in that it is probably shallower and more nearly circular in outline. The dips from the axes of the Wichita and Amarillo mountains northward to the axis of the Anadarko Basin at most places are relatively steep; while dips south from the mountains are more gentle.

9. Becker, Clyde M., Geology of Caddo and Grady counties, Oklahoma: Oklahoma Geol. Survey Bull. No. 40-I, 1927.
10. Op. cit.
11. Howell, J. V., Some structural factors in the accumulation of oil in southwestern Oklahoma: Econ. Geol., Vol. 17, No. 1, pp. 15-33, 1922.
12. Hoots, H. W., Geology of a part of western Texas and southeastern New Mexico: U. S. Geol. Survey, Bull. 780-b, page 113, Pls. III and VIII, 1925.

For this structural low which lies south of the Amarillo Mountains, the authors propose the Palo Duro Basin. The name is from Palo Duro Canyon, the deepest gash cut by nature on the Great Plains, which is located in Briscoe, Armstrong and Randall counties, Texas, which are in the northern part of the basin.

Dott[13] describes the Hunton arch as the initial movement in the Arbuckle System. He places its time of folding as the close of the first period in the Pennsylvanian.

The map (pocket) shows the master structures conspicuously labeled.

WICHITA MOUNTAIN REGION

The numbered trends, 1 to 7 inclusive, are strictly within the Wichita Mountain area. They are based on the outcrops of the older rocks as indicated on the colored geological map by Miser.[14] An attempt was made to about center the uplifts and the axes are established in that way.

The Wichita movement in the opinion of Gouin[15] who cites Schuchert,[16] Plummer,[17] and Moore,[18] began in early Mississippian time. The same reasoning might allow its being assigned to early Pennsylvanian.

Gouin[19] further states that the Loco (14), Woolsey (13), Velma (22), Healdton (19), Hewitt (20), and probably Cruce (22) structures are of the same orogenic age.

The Wichita Mountains were again affected when the Arbuckle folding took place. That movement according to Moore[20] took place in mid-Pennsylvanian time. The Franks-Seminole conglomerate, representing a post-Arbuckle erosion period, bears out this position as well as does the angular unconformity of upper Pennsylvanian in contact with truncated Glenn beds to the north of the Arbuckle Mountains. Then too, he finds the Permian resting with apparent conformity on the upper Pennsylvanian to the north while the same beds rest unconformably on the Glenn to the south.

The Wichita Mountains were again subjected to orogenic movement during post-Permian times as evidenced by the surface folds in the region. Powers[21] draws attention to the early surface work in the Permian from which production has resulted in the district.

The production in Comanche, Cotton, southwestern and central Stephens and Jefferson counties is coming from structures undoubtedly

13. Op. cit.
14. Miser, Hugh D., U. S. Geol. Survey, Geologic Map of Oklahoma, 1926.
15. Op. cit.
16. Schuchert, Chas., and Prisson, L. V., Textbook of Geology, pt. 2, p. 343, 1924.
17, and 18. Plummer, F. B., and Moore, R. C., Stratigraphy of the Pennsylvanian formations of north-central Texas; Univ. of Texas, Bull. 2132, 1921.
19. Op. cit.
20. Op. cit.
21. Powers, Sidney, Petroleum Geology in Oklahoma: Oklahoma Geol. Survey Bull., No. 40-G, 1926.

trending with the axis of the Wichita Mountains. The 6-12 trend is considered the center of the mountain axis. The trend is productive on the Lawton, Nellie, North Duncan, Comanche, Baird, and Walters structures. The Addington terrace has been drilled, but no commercial production was encountered although some good shows were logged.

North of the Wichita trend and in reality a part of it, is the Nellie-north Duncan-Loco-Healdton trend. There is no absolute data which scientifically proves these structures to be *en echelon* folds on a controlling axis, however, their physical aspects suggest strongly that the assumption is justified as a theory upon which to base research.

There is not enough information at hand to suggest the relationship of axes in the Wichita Mountains with the Walters or Baird trends. To the southeast the Walters trend seems to align with the Addington terrace and the Grady anticline. The Baird trend seems to be in subalignment with the structure or structures at Clay pool.

The value of the axes shown in central Jefferson County (15) is a matter of doubt. The writer has no subsurface data to prove their existence and the surface work in the red beds at that particular point is of a doubtful nature. Nevertheless it is evident at the surface that there has been movement of some nature at that particular point.

Considered from another point of view, the Walters trend may include the Addington terrace, the Oscar anticline and from there to the Bulcher anticline. The Baird trend may include the Grady structure and extend from there to a position parallel to and bisecting the distance between the Marietta syncline and the Bulcher structure.

ARBUCKLE MOUNTAINS

Dott[22] divides the Arbuckle uplift into the Arbuckle anticline and the Hunton arch. He also states that the first period in Pennsylvanian time was closed by the Hunton arch and the Ozark arch. Dake[23] described the second great movement as the Ouachita overthrust. Dott[24] refers the formation of the Ouachitas to late Marmaton time.

The folding of the Arbuckle anticline took place at the close of Glenn time if not later. The beds of the Glenn conform in the structure with the anticline.

Moore's[25] discussion of the relationship of the Franks or Seminole conglomerate to the underlying Glenn definitely establishes the time of Arbuckle folding as post-Glenn—pre-Franks.

22. Op. cit.
23. Dake, C. L., Bull. Missouri Sch. Mines, Vol. VI, No. 1, 1921.
24. Op. cit.
25. Op. cit.

Some rather outstanding structures were developed as a part of the Arbuckle uplift and the more imposing ones will be discussed separately.

During the early work on the area the Criner Hills were considered a part of the Arbuckle orogeny. Tomlinson's[26] work on the stratigraphy of the Pennsylvanian system of the Ardmore Basin tends to remove much of the confusion which formerly clouded the subject. He draws attention to Goldston's[27] interpretation of the orogeny and stratigraphy in the area and to the differing opinion held by Girty and Roundy.[28] He gives structural evidence that the Criner Hills of Carter County are related to the Wichita uplift and not to the Arbuckle uplift.

CADDO ANTICLINE

The Caddo anticline is a striking structural feature in central Carter County. The exposed beds range in age from Springer to Hoxbar. The structure has not been thoroughly tested for commercial oil or gas but at the present time there is a test drilling on the anticline in sec. 22, T. 3 S., R. 1 E.

The beds exposed at the surface at the location are almost vertical. Cores taken as the drill went down show decreasing dips and at a depth of 2,000 feet the beds are almost flat. With the decreased dip allowing for accumulation there is a possibility for production if a reservoir bed is found below the Caney shale which has not been penetrated at the present depth of more than 3,100 feet.

OVERBROOK ANTICLINE

The Overbrook anticline extends from central Carter County in a southeasterly direction to Red River and possibly on into Texas. Tomlinson[29] says in part that the Overbrook anticline is " * * * an overturned fold with a structural height of at least 10,000 feet, which can be traced continuously for 15 miles through the belt of Pennsylvanian rocks which lies between Ardmore and the Criner Hills."

The structure is not productive. Some very good shows of oil have been found, especially in the Schemerhorn-Ardmore Company's well in sec. 24. T. 5 S., R. 1 E. The steep surface dips indicate a doubtful area of accumulation but the condition encountered in the Caddo anticline test tends to enhance the prospects for commercial production on the structure under discussion.

26. Tomlinson, C. W., Unpublished manuscript.
27. Goldston, W. L. Jr., Differentiation and structure of the Glenn formation: Bull. Amer. Assoc. Pet. Geol., Vol. VI, No. 5, 1922.
28. Girty, George H., and Roundy, P. V., Notes on the Glenn formation of Oklahoma, with consideration of new paleontologic evidence: Bull. Amer. Assoc. Pet. Geol., Vol. VIII, No. 4, 1923.
29. Op. cit.

MARSHALL COUNTY TRENDS

Hopkins, Powers and Robinson,[30] Bullard,[31] Taff,[32] Stephenson[33] and Tomlinson[34] have each contributed to a study of the geology of Marshall County. The structural axes shown on the accompanying map represents a combination of their work.

The Mansville-Madill anticline extends from the Carter-Johnson County line southeast across Marshall County and possibly into Bryan County. The structure is determinable in the Comanchean beds exposed at the surface. Tomlinson[35] has described an outcrop of Paleozoics exposed in Turkey Creek in the northwestern part of the county. The writer does not know of any other such exposure along the anticline or for that matter in the county.

It is difficult to determine the structural relationship of the Paleozoic rocks and the structures in the Comanchean rocks of the county but for the present purpose it is assumed that the positive areas overlie pre-Comanchean topographic highs.

The Madill sector of the anticline produces small, though commercial, quantities of high gravity oil from the Trinity sand at the base of the Comanchean. The producing horizon is called the Arbuckle sand and further work may prove it to belong to the Pontotoc instead of the Trinity.

The Oakland dome is located near the village of Oakland in the northwestern part of the county. It is not productive but it is being tested at the present time.

The Preston anticline extends from the south-central part of Marshall County southeast to the northeastern corner of Grayson County, Texas. It has long been a disappointment to geologists and oil operators. It is a well exposed, almost perfectly formed structure and easily worked in Comanchean beds. Although it has been extensively tested it has produced only small quantities of gas. At the present time there is a test being drilled on a nose extending south of the anticline near Pottsboro. A good but thin oil sand was encountered at the base of the Trinity at about 800 feet.

The Kingston syncline is a broad, shallow basin separating the two positive areas just discussed. The Cumberland syncline is a similar feature northeast of and parallel to the Mansville-Madill anticline and extends into Bryan County.

30. Hopkins, O. B., Powers, Sidney, and Robinson, H. M., U. S. Geol. Survey, Bull. 736, 1922.
31. Bullard Fred M., Geology of Marshall County, Oklahoma: Oklahoma Geol. Survey Bull. No. 39, 1926.
32. Op. cit.
33. Stephenson, L. W., U. S. Geol. Survey, Prof. Paper 120, 1918.
34. Tomlinson, C. W., Buried hills near Mannsville, Oklahoma: Bull. Amer. Assoc. Pet. Geol., Vol. X, No. 2, 1926.
35. Op. cit.

LOVE COUNTY

The surface structure of Love County does not lend itself easily to detailed investigation. It is, in the main, covered either by Trinity sand or Red River alluvium, thus precluding satisfactory surface work. Not enough wells have been drilled to permit complete subsurface work.

Bullard's[36] map shows the Marietta syncline as the most outstanding feature. Surface work farther northwest suggests that the Criner Hills may extend a considerable distance southeast under the Comanchean. Subsurface work indicates the possibility of an anticline with its axis roughly along the line between the villages of Burneyville and Pike. There is no commercial production in Love County although it has been rather extensively tested.

The Marietta syncline is of post-Comanchean age. As Bullard[37] says, it is quite reasonable to assume that the folding took place along a line of weakness established in an earlier period. The structures mentioned above are probably related to the Wichita orogeny.

NORTH TEXAS

The writer is only vaguely acquainted with the structures of northern Texas further than that they conform in a general way to those across the line to the north. In most cases the structure seems to conform to the general northwest-southeast trend. There is some reason to believe that the structures in the Wilbarger-Wichita-Archer area may be influenced slightly by the Ellenberger high or Bend Arch which plunges north from the Llano-Burnett uplift.

The Nacona folds in Montague County and the Bulcher and Muenster structures in Cooke County are undoubtedly true trend folds, probably a part of the Wichita orogeny. We do not know at present how far that influence will extend to the southeast. The Cooke County structures are weakly reflected in the Comanchean beds at the surface.

CADDO AND GRADY COUNTIES

Becker's[38] interpretation of the structure in Caddo and Grady counties is that shown with slight modification on the accompanying map.

The Anadarko Basin which traverses the two counties is the major structural feature. Greene,[39] and Gould and Lewis[40] have described that feature so thoroughly as to eliminate the necessity of discussing them.

The remaining structures of the two counties are quite probably related directly to the Arbuckle uplift. The writer is in thorough accord with Becker[41] in his interpretation of the Caddo County structure. However, by subsurface methods, he is unable to find the faults shown by Becker[42] in T. 3 N., R. 5 W. in Grady County. The writer's interpretation of the Kilgore trend (25) shows this feature extending from sec. 15, T. 5 N., R. 7 W., southeast to sec. 20, T. 2 N., R. 4 W. The statement is offered empirically inasmuch as it would require a paper longer than this to prove this point.

36. Bullard, Fred M., Geology of Love County, Oklahoma: Oklahoma Geol. Survey, Bull. No. 33, 1925.
37. Op. cit.
38. Op. cit.
39. Greene, Frank C., Oil and gas in Creek County, Oklahoma: Oklahoma Geol. Survey Bull. No. 40-C, 1926.
40. Op. cit.
41. Op. cit.

NORTHEASTERN STEPHENS AND NORTHWESTERN CARTER COUNTIES

This area is the most active in the southern Oklahoma district at the present time. With slight variations, the work of George and Bunn[43] still holds for the Fox and Graham structures. Later subsurface work shows their work to have been in error in detail but the general interpretation of the trend was correct.

The Cruce trend extends from sec. 2, T. 1 N., R. 6 W., in a general southeasternly direction to sec. 28, T. 2 S., R. 3 W. It cannot be stated with certainty just what the condition is between the south end of the Cruce anticline and the Graham structure. However, there is undoubtedly a number of small highs between the two and it is quite probable that there is a direct connection between the two structures.

In Tps. 1 N., 1 S., Rs. 3-4 W. there is considerable activity at present. The subsurface condition is not thoroughly known. The writer's work in the area shows that there is a distinct probability that the Doyle anticline is in direct trend with the Tussey structure and that this subsurface feature extends southeast into T. 1. S., R. 2 W. The Sholom Alechem trend, made up of a number of anticlines, manifests a tendency to extend northwest across T. 1 S., R. 4 W. The present development will soon prove the case.

SUMMARY

1. In general the structural axes in the southern Oklahoma district lie northwest and southeast.

2. The position of the axes is controlled by the Wichita and Arbuckle mountain systems.

3. The areas controlled by the two major orogenies can be roughly separated by a line extending N. 53° W. from a point midway between the Overbrook anticline and the Criner Hills.

4. Past experience indicates that future exploration for oil and gas will be found profitable along trend lines now well established.

42. Op. cit.
43. George, H. C., and Bunn, John R., Petroleum engineering in the Fox and Graham oil and gas fields: Bull. U. S. Bureau Mines, 1924.