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OIL AND GAS IN OKLAHOMA

GEOLOGY OF PAYNE COUNTY

By
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ILLUSTRATIONS

FOREWORD

In 1917 the Oklahoma Geological Survey issued Bulletin 19, Part II, 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 the 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 the 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.

The information on the geology of this county has been assembled and written by Prof. A. H. Koschmann, of the Oklahoma Agriculture and Mechanical College at Stillwater. Since there has been no extensive drilling, except in a few places, in the county, the data on the subsurface conditions over the entire county is insufficient for a complete discussion of this phase of the report.

CHAS. N. GOULD,
Director

January, 1928.

PAYNE COUNTY

By

A. H. Koschmann

ACKNOWLEDGMENTS

In the preparation of this chapter the writer has availed himself of information in Bulletin 19, Part II, of the Geological Survey. L. L. Foley, of the Mid-Kansas Oil Co., kindly correlated the formations in the well logs shown in Plate I and A. F. Truex, of the Twin State Oil Co., furnished the surface and core drill structure maps of the Ripley field, and well logs of this field with the important formations correlated. W. J. Allen, of the Shaffer Oil and Refining Co., furnished the structure map of the Mehan field. C. G. Carlson, of the Peerless Oil and Gas Co., kindly read the manuscript and offered many valuable suggestions, which the writer gratefully acknowledges.

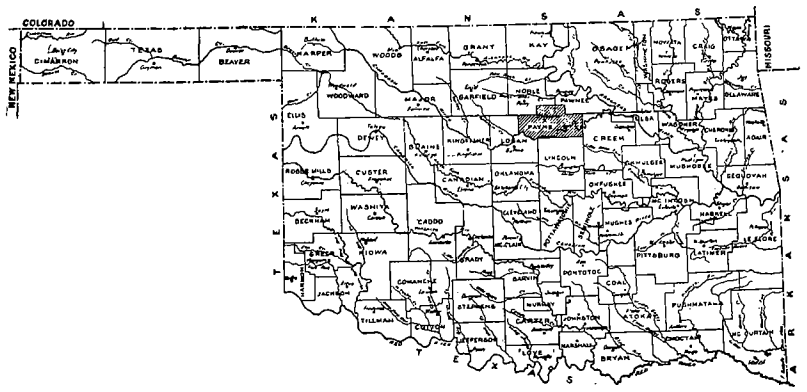


Figure 1. Map of Oklahoma showing location of Payne County.

LOCATION

Payne County is located in the north-central part of the State, extending from R. 6 E., to R. 1 W., and from T. 17 N., to T. 20 N. It is bounded on the north by Pawnee and Noble counties, on the east by Creek County, on the south by Lincoln and Logan counties, and on the west by Logan and Noble counties. It includes an area of approximately 716 square miles. Stillwater, with a population of 6,000, is the county seat.

TOPOGRAPHY

Payne County has a general surface slope to the southeast, with a range in elevation from 1,140 feet in the western part, to 800 feet in the valley of the Cimarron River in the eastern part. This river is the chief drainage channel of the county, and Stillwater Creek its chief tributary. The county is well drained by the tributaries of these two streams.

The well developed drainage has carved the topography into a rolling plain; however, the western part is in general of greater relief than the eastern, as the streams are here more deeply incised. Payne County lies with the Sandstone Hills region, excepting the extreme western part, which is in the Red Beds Plains. In the eastern part of the county several limestone ledges form small escarpments. Twin Mounds, limestone capped hills, 10 miles east of Ingalls, form the most striking topographic feature of the county.

GEOLOGY

Stratigraphy

Surface Formations

The surface rocks of Payne County are basal Permian (Stillwater and Wellington) and upper Pennsylvanian (Neva to Buck Creek). These formations represent the transition between the marine, non-red Pennsylvanian and the non-marine, red Permian. The color change does not follow the strike of the beds but transgresses the strike at an angle, which results in both red and non-red Pennsylvanian and Permian beds. The contact is here assumed to be the base of the Cottonwood limestone, following Prosser.[1] The Cottonwood limestone thins out at the north line of the county, but its equivalent horizon is found just west of the Neva limestone outcrop running almost north-south through R. 4 E. As a result Permian rocks cover about two-thirds of the area of the county, while the eastern one-third is occupied by Pennsylvanian beds.

WELLINGTON FORMATION

The Wellington formation, according to Aurin, Officer, and Gould[2] is composed of gray to blue drab shales with numerous thin beds of gray "mudstone" to red sandstones and shales as the color-change line between the red and non-red sediments is crossed. This color change area is a zone or belt several miles wide running in a northwest-southeast direction across Payne County from Glencoe to Cushing.

The formation, which outcrops in the western part of the county, is approximately 600 feet thick. The Besdor, Tonkawa and Blackwell sand horizons of the fields to the north of Payne County are found in

1. Prosser, C. S., Jour. Geol., vol. 10, p. 709, 1902.
2. Aurin, F. L., Officer, H. G., and Gould, Chas. N., The subdivision of the Enid formation: Bull. Am. Assoc. Pet. Geol., vol. 10, no. 8, pp. 793-794, 1926.

the lower half of the Wellington. The formation in Oklahoma is equivalent to the Wellington shale and the Marion formation of the Kansas section.

STILLWATER FORMATION

The next oldest formation, the Stillwater, is the basal Permian formation in the classification used in north-central Oklahoma. Like the Wellington, this formation is found in the area of change of color of the sediments. North of the county the formation contains many prominent limestone members, which, with a few exceptions, thin out and disappear southward. The highest of the persistent members which are found in this area, the Fort Riley limestone, is found approximately in the center of the formation. It can be traced across the county to the Cimarron River just east of Perkins. The limestone has not been mapped south of this point. The Cottonwood limestone, which marks the base of the Stillwater, has been traced across western Pawnee County, south to the Payne County line. Here the horizon of the Cottonwood is made up of drab and red shales and shaly limestones, so that the limestone as described farther north is not found in this area.

ESKRIDGE SHALE

Following the classification of the U. S. Geological Survey and the Kansas Geological Survey, the Eskridge is the highest Pennsylvanian formation, lying just below the Cottonwood limestone. In this area the Eskridge, like other associated formations, changes in color and character from gray, green and brown shales to red sandstones and shales as the beds are traced southward.

NEVA LIMESTONE

Immediately below the Eskridge shale is a series of thin limestones and limy shales, aggregating 10 to 15 feet in thickness in this area. In Payne County the Neva limestone is red to gray in color, with many chert concretions in the lower portion. The formation has been traced south to the county line, and a few miles into northern Lincoln County, but farther south it loses its identity, changing from limestone and shale into sandstone and shale south of the Cimarron River.

ELMDALE FORMATION

The Elmdale is composed of interbedded shales and thin limestones, the latter being usually less than three feet in thickness. The formation has been mapped only in the northeastern part of the county as it loses its identity to the south where it merges into undifferentiated red beds. The most prominent limestone, the Cushing member, occurs just below the middle of the formation and has been traced as far south as the North Canadian River in northern Pottawatomie County. The formation has an aggregate thickness of approximately 100 feet.

SAND CREEK FORMATION

The Sand Creek formation is made up of about 180 feet of limestone and shale, with some sandy shale near the center. The largest limestone bed, the Foraker member, approximates 100 feet in thickness and is found at the top of the formation. The base of the Sand Creek is marked by the thin Grayhorse limestone, four feet thick.

BUCK CREEK FORMATION

The oldest surface formation in Payne County, the Buck Creek, is a series of shales and limestones with two sandy zones near the top. Its aggregate thickness is about 175 feet, the limestones making up half of this amount. The top is marked by the base of the Grayhorse limestone and the base by the base of the Bird Creek limestone. The thickest member of the Buck Creek, the Stonebreaker limestone, is found just above the center of the formation and is about 20 feet thick.

Subsurface Formations

PENNSYLVANIAN

The remainder of the Pennsylvanian section, as revealed by well cuttings, is composed predominantly of shales with interbedded limestones and some sandstones. The base of the Pennsylvanian, as shown in wells drilled near the Pennsylvanian-Permian contact is about 3,600 feet deep. This places the Bartlesville sand at about 3,400 feet and the Layton sand at about 2,400 feet in depth. (See cross-section, Plate I).

MISSISSIPPIAN

The Mississippi lime lies immediately below the Cherokee shales and is, on the average, 85 feet in thickness.

Below the Mississippi lime and resting unconformably upon all older Paleozoic rocks, is the Chattanooga shale. The pre-Chattanooga period of uplift and erosion has resulted in the tilting and beveling of these older rocks so that the Chattanooga rests on successive older formations from Hunton to Sylvan. The Chattanooga is a black fissile shale averaging less than 40 feet in thickness in the county.

The Misener sand, where present, lies directly beneath the Chattanooga shale and forms one of the minor producing horizons of the county. Its occurrence[3] is "patchy", and drilling has not entirely defined its occurrences. Its thickness varies from 0 to 25 feet. The sand is very pure, the grains well sorted and rounded, very much resembling the Wilcox, from which it is believed to have been derived by wind action during the pre-Chattanooga period of erosion.

3. White, Luther H., Subsurface distribution and correlation of the pre-Chattanooga ("Wilcox" sand) series of northeastern Oklahoma: Oklahoma Geol. Survey, Bull. 40-B, 1926.

SILURO-DEVONIAN

The Hunton formation in this area consists of limestones and calcareous shales which are difficult to differentiate in well cuttings and so are logged as Hunton lime. It is present in the southwestern part of the county, but its exact limits have not been determined. The Twin State Oil Co.'s well in sec. 23, T. 18 N., R. 1 E., penetrated the Hunton at 4,798 feet. The formation has been encountered in several wells south of this area in Lincoln County.

ORDOVICIAN

The Sylvan shale is found over the greater part of the county, being absent only in the eastern and northeastern parts. This shale may be distinguished from the Chattanooga by its light color, usually greenish- or bluish-gray. Because of its uniform character it forms a good key bed. Its maximum thickness is 75 feet in the western part of the county which decreases to zero in the eastern part.

The Viola immediately underlies the Sylvan and is 35 to 75 feet thick in this area. In places where the Sylvan and Hunton have been eroded the Viola is found in contact with the Chattanooga.

The Simpson formation has an average thickness of 250 feet in the eastern part of the county. Post-Wilcox beds have been reported in the Cushing district where they are made up of brown or gray sandy dolomitic limestone interstratified with sandstone and green shale. The Wilcox here is typical of the Wilcox of other areas.

Only a few wells in the eastern part of the county have been drilled sufficiently deep to encounter the Arbuckle limestone (Siliceous lime). No wells have penetrated it entirely so its total thickness is not known. The upper part consists of beds of massive dolomitic limestone and occasional thin beds of sandstone.

STRUCTURE

The formations of this county have a monoclinal west-southwest dip of about 40 to 50 feet per mile (see Plate I) with occasional reverse dips, which form favorable structures for oil accumulation. The "nose" or plunging anticline type of structure is the more common in this territory. These are merely surface reflections of closed structures in depth and belong to the class of parallel folds formed at greater depths and the degree of folding therefore necessarily decreases upward in the vertical column. Fig. 2, showing the Ripley structure, shows the typical surface "nose", whereas Fig. 3, of the same field, shows this same structure on the subsurface Neva limestone obtained by core-drilling, showing a 20 foot closure. There is some shifting of the top of the structures at depth. This shifting is to the northwest and due to the unequal dips on the northwest and southeast sides of the field. The Mehan field, ig. 4, shows another subsurface structure, contoured on the Viola limestone.

The Cushing, Yale, and Ingals anticlines were the first structures to be developed in the county. They were outlined by the usual field methods, and are located east of the Neva limestone outcrop where there are reliable markers for surface mapping. The fact that all the structures have a general east-northeast trend is noteworthy.

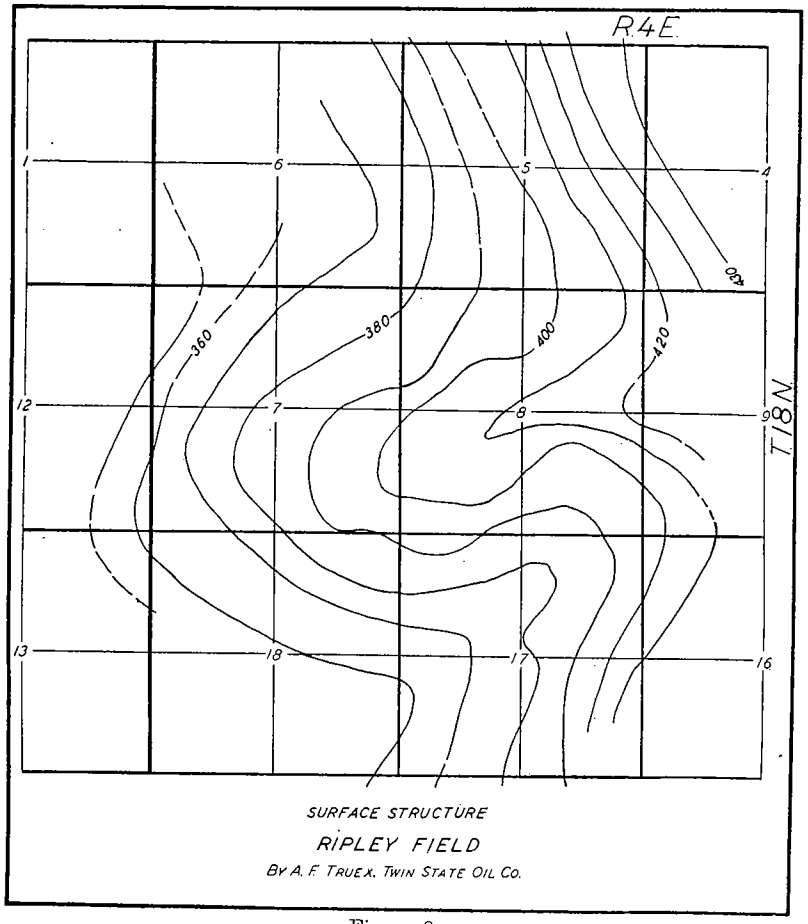


Figure 2.

PRODUCING SANDS

The Bartlesville and Wilcox sands are the two important producing horizons, and of these the latter is the most important. There is considerable Misener production in the county, although the pools are small because of the lenticular nature of the sand. The Misener sand

is producing in the Olean and Ingals fields, in T. 18 N., R. 5 E., and in the Tidal-Gardner well in the SE.¼ SE.¼ SW.¼ sec. 12, T. 19 N., R. 1 W.

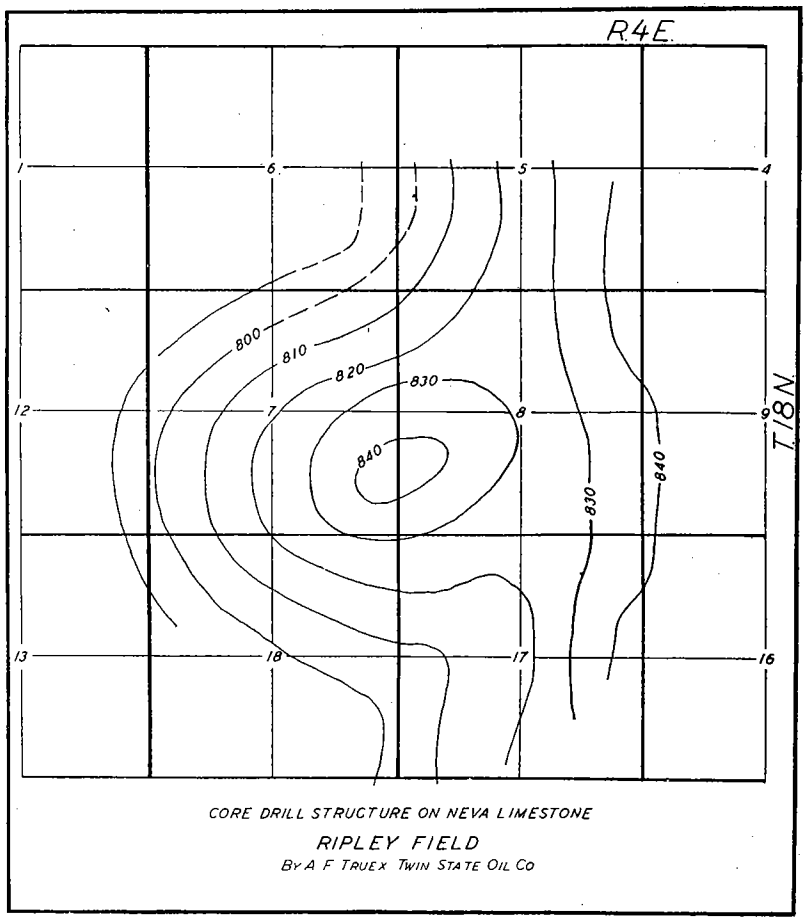


Figure 3.

FUTURE DEVELOPMENT

In the eastern part of the county, east of the Neva limestone, the folds and structures have been largely worked out and development progressed rapidly after the discovery of the Cushing field. In the western part the sediments change rapidly in lithology, both laterally and vertically, so that the surface structures are worked out with a great deal of difficulty, uncertainty and expense. Core-drilling has been re-

sorted to in most cases to check up on suspected structures determined by usual field methods. The Mehan and Ripley fields, the two latest to be developed in this county, were definitely determined by core-drilling and illustrate the importance and even necessity of core-drilling to corroborate surface work.

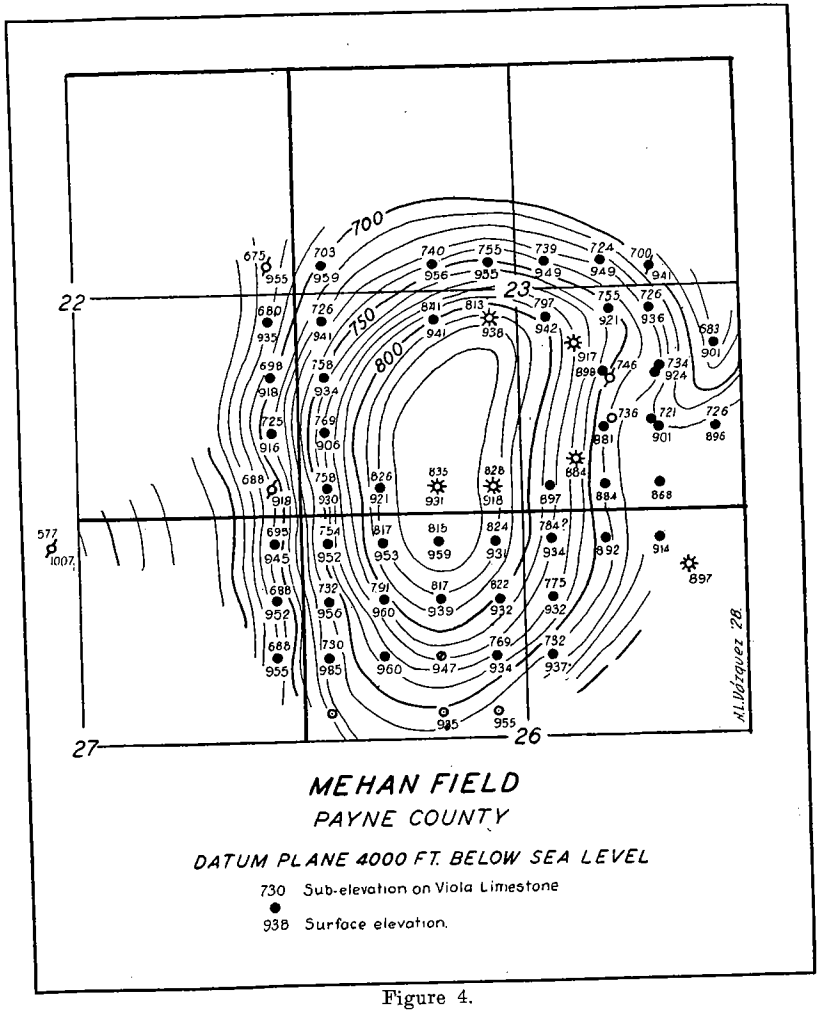


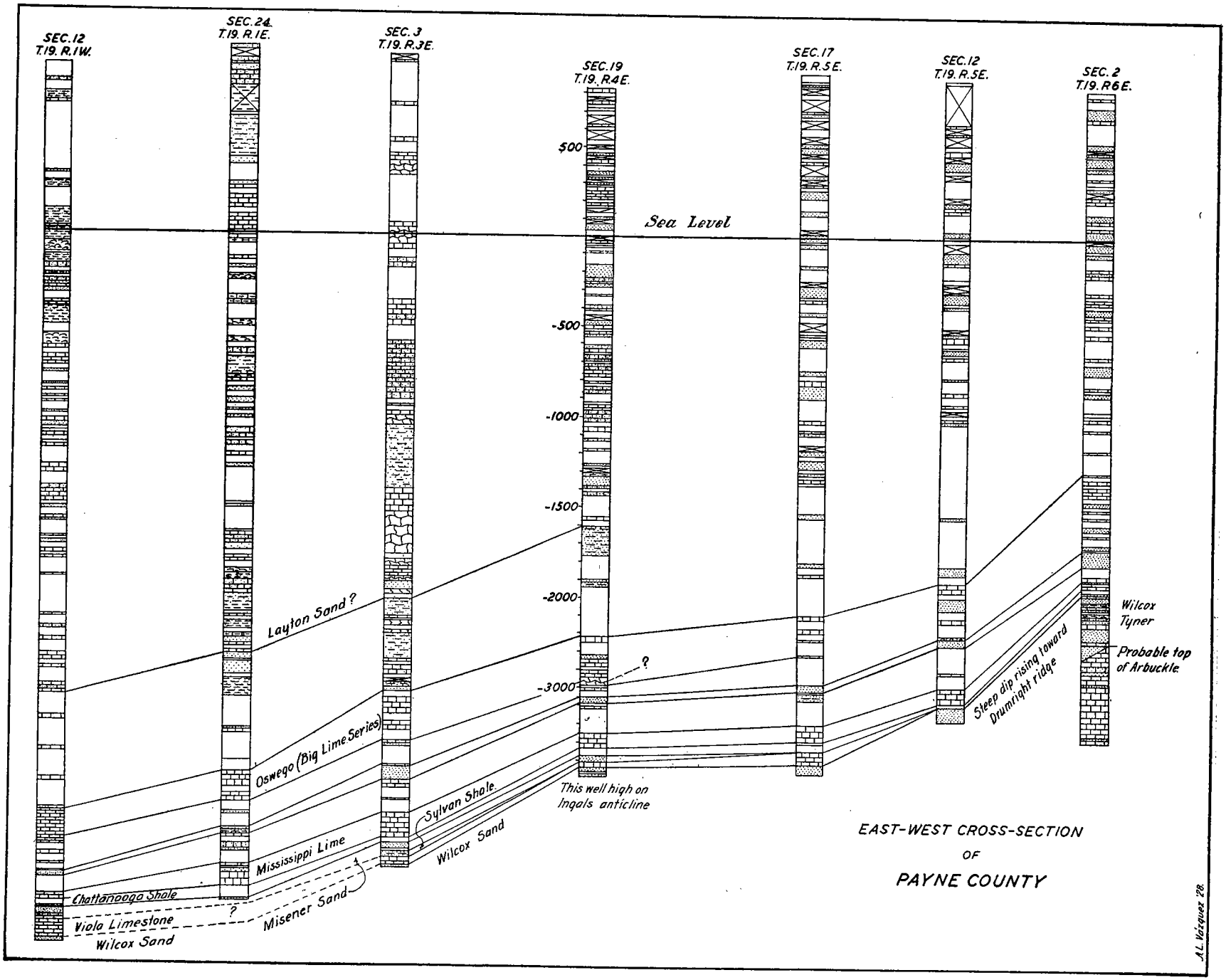
Figure 4.

Coupled with the uncertainty of determining structures by usual field methods and the expense of core-drilling is the problem of deep production in the western part of the county. The "Wilcox" is found

at about 3,800 feet in the eastern part of the county, but at 4,700 to 5,000 feet in the western part, as shown in Plate I.

The entire county may be considered prospective territory. The eastern part is proved territory and it is quite probable that some new fields will be discovered in the western part. The Mid-Continent well in NW.¼ NW.¼ SW.¼ sec. 3, T. 19 N., R. 3 E., the Amerada well in SE.¼ SE.¼ SE.¼ sec. 24, T. 19 N., R. 1 E., and the Tidal-Gardner well in SE.¼ SE.¼ SW.¼ sec. 12, T. 19 N., R. 1 W., have recently been drilled. The Tidal-Gardner well had an initial production of 140 barrels from the Misener sand and is still producing 50 barrels daily. It was drilled into the Wilcox but found water, so it was plugged back to the Misener.

In spite of these dry wells leasing in the county has been active, especially during the last year. Little land remains unleased at this writing, (December, 1927), which is certainly a good indication of the faith held by the oil fraternity in the future oil development of Payne County.


SEC. 12
T. 19. R. 1W.
SEC. 24
T. 19. R. 1E.
SEC. 3
T. 19. R. 3E.
SEC. 19
T. 19. R. 4E.
SEC. 17
T. 19. R. 5E.
SEC. 12
T. 19. R. 5E.
SEC. 2
T. 19. R. 6E.
500
Sea Level
-500
-1000
-1500
-2000
-3000
Layton Sand?
Oswego (Big Lime Series)
Mississippi Lime
Sylvan Shale
Wilcox Sand
Chattanooga Shale
Viola Limestone
Wilcox Sand
Misener Sand
?
?
This well high on Ingals anticline
Steep dip rising toward Drumright ridge
Wilcox
Tyner
Probable top of Arbuckle
EAST-WEST CROSS-SECTION
OF
PAYNE COUNTY
A.L. Velguth '28