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Geologic conditions affecting the accumulation of oil and gas in the Beggs District, Oklahoma

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Department:

GEOLOGIC CONDITIONS AFFECTING THE ACCUMULATION OF OIL AND GAS IN THE BEGGS DISTRICT, OKLAHOMA

BY

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A

THESIS

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LOCATION

The area discussed in the following pages embraces parts of Townships 14 and 15 North, Range 10 East, Creek County, Oklahoma, and lies to the west of the present productive area of the Beggs Field, in a region in which little prospecting has yet been done.

The roads in this vicinity are generally poor and many of the section line roads are closed or in such a state that travel over them in a car is impossible. This condition limited to some extent the scope of this reconnaissance survey. A new road, however, is under construction in Creek County for use between Beggs and Bristow. The town of Bristow is situated about seven miles north and three miles west of the area shown on the accompanying map. The town of Beggs lies about fifteen miles to the east.

TOPOGRAPHY.

All of this area lies within the physiographic province known as the Sandstone Hills Region. The southern part of this territory, principally the east

half of Township 14 North, Range 10 East, is a rather flat sandy prairie broken occasionally by the steep banks of tributaties of the Little Deep Fork of the Canadian River which flows southeastward across the county. The west half appears to be more broken and was not covered at this time. Toward the northern boundary of this township and northward into Township 15 North, Range 10 East, there are several parallel ranges of hills which trend in a general north-south direction. Nearly all these hills are covered with timber which obscures the outcrops and retards progress of the survey.

The topographic profile section shown on the accompanying map is along the township line between Townships 14 and 15 North.

A significant topographic feature is noted in the vicinity of observation number 19, elevation 895. There are two similar hills south of this line in sections 1 and 2, Township 14 North, Range 9 East. The most gradual slopes on all three of these hills have an east component which can readily be seen from a distance. Hills west of this point have the steepest slopes on the east side, thus verifying the west dips observed in the vicinity.

STRATIGRAPHY.

The surface outcrops are of Pennsylvanian age and consist of a thick succession of fossiliferous sandstones and shales. The State Survey has mapped the formations in this territory in part, but has not named them. Owing to the fossiliferous character of a number of sandstones and the presence of a very thin limestone, the writer has placed these beds in the Wewoka Formation. About three miles east of the area mapped there is evidence of a conglomerate and this may be the same which is said to exist near the base of the Wewoka. The limestone is a thin, sandy bed containing crinoids, bryozoans and brachiopods in abundance. Some of the sandstones contain plant remains and occasional molds of polecypods and crinoids. The sandstones are thin-bedded to massive, cross-bedded, friable beds varying in iron content. The massive beds are usually white, the thin beds are often red.

A massive white sandstone about forty-two feet below the limestone was used as a key bed. The limestone is only three inches thick and readily disintegrates. It was observed at three points and was used to correlate the sandstones. This massive bed outcrops over a large

part of the area and it was followed as much as possible. Difficulty is encountered when it is necessary to correlate these beds across a valley in the absence of fossils, lithologic characteristics, or the limestone horizon marker. In such cases the writer was obliged to assume that the dip on one side continued to the other side of the valley and to project the bed across to that which appeared to be the same on that side. The outcrops are shown in dotted lines on the map.

CORRELATION OF SANDS. The accompanying columnar section shows the thicknesses of formations as given in the State Bulletins. The intervals and thicknesses of producing sands were taken from well logs in the Beggs District. Information concerning formations below the Pennsylvanian unconformity, i.e., below the Morrow formation, is lacking and the correlation here given is chiefly that of the Ozark region as shown on the Correlation Chart of the Oklahoma Geological Survey, with minor changes from sources mentioned later.

A recent circular of this Survey shows the Red Fork, Glen, Bartlesville and Dutcher sands as probably lying within the stratigraphic equivalents of the Boggy, Savannah, McAlester, Hartsborne, and Atoka forma-

tions of the southern part of the Sandstone Hills region, which in turn are the equivalents of the Cherokee and Winslow formations of Northeastern Oklahoma. There is much controversy over the age of the Wilcox sand. The writer understands that the majority contend that this sand is pre-Mississippian.

Using the depth to the Glen, 2440 feet, obtained from the driller of the Atlantic Petroleum Company's well in Section 31-15-10 and estimating that this well started near the upper third and fossiliferous portion of the Wewoka formation the Glen sand would lie near the middle of the Winslow formation. This, of course, is dependent on the accuracy of the correlation of the sandstone beds as Wewoka members in the area mapped, and upon the thicknesses given in the State Bulletins. In Volume 111, American Association of Petroleum Geologists, page 266, Bloesch correlates the Glen as near the top of the Winslow formation. The discrepancy might be accounted for by a thickening of formations to the southwest. In this same volume the statement is made that the Glen sand of the Glen Pool, the Salt sand of the Okmulgee district, and the Bartlesville sand of the Cushing field are identical or not so very far apart.

No Dutcher sand was reported in the aforesaid well but taking the average interval, 575 feet, obtained from well logs in the Beggs Fields, the writer calculates that the Dutcher would lie near the base of the Morrow, occupying the same horizon as the Hale sandstone of the Ozark region.

The average interval to the Wilcox, 460 feet, places this sand near the base of the Mississippian or top of the Devonian, equivalent to the Sylamore sandstone. This correlation places unconformities above the Glen, between the Glen and the Dutcher and between the Dutcher and the Wilcox. The entire thickness of strata probably contains four or more unconformities.

If the Wilcox is considered pre-Mississippian, the stratigraphic hiatus in the Beggs field must be larger than it is in the southern Sandstone Hills region. In Bulletin 27, Oklahoma Geological Survey, pages 64 and 69, the thickness of the Mississippian in the Ouchita region is given as 1600 feet and in the Arbuckle about 1800 feet. This, however, is dependent on the correlation of the Caney Shale as Mississippian. Taff and Ulrich in the section given in the Correlation Chart assign this to the Pennsyl-

vanian. In Bulletin 691-C, U.S.Geological Survey, page 75, the statement is made that the Boone limestone, Mississippian, thickens about seventy feet to the southwest over a distance of about seventy miles in southern Kansas, and is probably thicker in northeastern Oklahoma. In Bulletin 19, Oklahoma Geological Survey, page 92, a section by Taff shows about 300 feet of Mississippian in the Muskogee quadrangle which is about the same given for the Ozark region on page 128 of this bulletin. In the Tishomingo, or Arbuckle Mountain region, the thickness of the Mississippian is given as 500 feet.

In general these figures show that the Mississippian should be present across the Beggs Field and of the same or greater thickness than in the Muskogee quadrangle and Ozark region to the northeast. If the Caney shale does exist here below the Morrow Formation, it represents from 100 to 300 feet of strata.

In the issue of the Oil and Gas Journal, May 7, 1920, pages 54 and 56, F.C.Greene, former member of the Missouri State Survey and geologist for Cosden & Company, who has done considerable subsurface work in the State of Oklahoma, writes that "the Wilcox lies

somewhere near the unconformable contact of the Woodford and the underlying Devonian, Silurian, and older rocks, just as the Cylamore sandstone does on the western flanks of the Ozarks." The black and brown shale between the Dutcher and Wilcox is correlated as Chattanooga. Wells drilled below the Wilcox in the Beggs and Okmulgee Districts report two types of formations; in some wells 200-500 feet of sand with few or no breaks is reported, while in others a succession of red and green shales with a few thin limestones and sandstones is reported. Of the first type of rocks only the upper part, he states, is Wilcox or Sylamore, and the balance is part of the Burgen, a formation near the base of the Ordovician system. The other type of formations represents probably a part of the Tyner Formation which unconformably overlies the Burgen in the Ozark region. Mr. Greene has frequently noted these red and green shales in many wells in this section of the State and has correlated them by a closely connected series of logs from Tulsa, where he has definitely established their age, to the Beggs Field.

The Pennsylvanian also thickens southward and eastward toward the source of these sediments, and

sandstones and shales become thicker and replace the limestone. In the Independence, Kansas, quadrangle the interval is given as 450 feet between the Calvin Sandstone and the Mississippian, in the Coalgate Quadrangle, southern Oklahoma, this interval is said to be 9,000 feet. The Boggy is said to thicken southward from Henryetta, to attain a maximum thickness north of Weleetka, to decrease near the neighborhood of Wetumka, and increase considerably toward Holdenville. From this first point southward the lower Pennsylvanian, Pottsville, which is equivalent to part of the Winslow and all of the underlying Pennsylvanian sediments, is said to thicken very rapidly. In effect the Glen, Dutcher and Wilcox sands are believed to dove-tail into these deposits. This reveals the necessity of very deep drilling to reach the Wilcox sand in the southern part of the state if it is present there. A line from Henryetta in Okmulgee County, northeastward to the town of Billings, Noble County, is said to mark the southern limit of drillable depth to the Wilcox, owing to the presence of the thick deposits of Pottsville sediments mentioned above. The State Survey recently printed a lithobathic contour map made by correlating formations noted in well

logs over the western half of the state, which showed an increase in thickness of the red Pennsylvanian and Permian strata westward from the Sandstone Hills region. This, too, would contribute to increasing the depth to the Wilcox sand in the region west of the Henryetta-Billings line.

STRUCTURE.

The structure, as determined by contours on the white massive sandstone, forty-two feet below the fossiliferous limestone member of the Wewoka, shows an irregularly folded dome with twenty feet and possibly as much as thirty feet of closure. The dip symbols show the inclination of the individual beds, and even if these contours are wholly incorrect, the dips on the several beds are strongly indicative of favorable structure. The contours are broken for the following reasons:

1. Lack of well-defined bedding in the sandstones,
2. Absence of continuous outcrops of these beds,
3. Lack of parallelism said to exist between surface and subsurface bed,
4. Absence of outcrops at critical points.

The first and third points enumerated will be dealt with in the general discussion of structural conditions which follows. The highest parts on this dome lie approximately in the Southwest Quarter of the Northeast Quarter of Section 1-14-9, the Northeast and the Northwest Quarter Section 12-14-9. The axes of these structural highs intersect at angles of about forty-five degrees, trending northwest-southeast and northeast-southwest. From subsurface maps in the territory to the east, the extent of productive territory seems to be limited to three ten-foot closures, i.e., not farther than thirty feet from the dip.

Near observation No. 175 in the Northeast Quarter of the Southwest Quarter of Section 1-14-9, the writer observed what appeared to be slickensides on a massive white sandstone outcrop in the bottom of a draw. There was not enough of the bed exposed to verify this and the lack of continuous outcrops north and south of this point also prevented further investigation. The trend of this fracture was a little east of north. If this is a normal fault, most of the acreage recommended would lie west of this fault plane and on the up-thrown side. The strong south or southwest dips

noted nearby to the east would not occur adjacent to a fault of this kind, if the down-throw were to the east. It has not been definitely established but some geologists think there are faults affecting the Wilcox sand in the Beggs Field which are not visible on the surface.

An anticlinal condition probably exists through sections 35 and 25, Township 15 North, Range 10 East, as evidenced by the development of a long nose in that vicinity. It appears worthy of further investigation.

FAVORABLE ACREAGE. Where cross-folding is present, the most favorable areas lie at the intersection of the anticlinal axes. Taking into consideration these several axes and judging from surface countours, the acreage of good prospective value is as follows:

The Southeast Quarter of the Northwest Quarter of Section 12-14-9;

The Southeast Quarter of the Northeast Quarter of Section 2-14-9;

FIRST CHOICE: The Northwest Quarter of the Southwest Quarter of Section 1-14-9;

The Northeast Quarter of the Northwest Quarter of Section 1-14-9;

The Southeast Quarter of the Northwest Quarter of Section 1-14-9;

SECOND CHOICE: Remaining acreage within the closure of the 830 foot contour.

DEVELOPMENT.

A dry hole was drilled by local interests in Section 4-14-9 to a depth of about 2700 feet. The Atlantic Petroleum Company in Section 31-15-10 was drilling at 3290 feet in a lime which the driller called "Mississippi lime". The Prairie Oil & Gas Company in Section 5-14-10 was drilling at 2340 feet in black shale with a hole full of water and caving. The former was probably nearing the Wilcox sand, and the latter was near the top of the Glen. Neither driller claims to have found much sand above these depths.

DRILLING DEPTHS.

Using the depth of the Glen sand obtained from the Atlantic Petroleum Company in Section 31, the writer calculated the approximate depths to the known sands as follows:

Glenn, - - - - - - - - - - - - - - - - 2440 feet

Booch, - - - - - - - - - - - - - - - - 2700 "

Dutcher, - - - - - - - - - - - - - - - - 2900 feet

Wilcox, - - - - - - - - - - - - - - - - 3300-3500 feet.

If the statement made by some geologists, regarding the presence of faults in the Wilcox which do not appear on the surface, is correct, then the depth to these sands may be less in faulted areas. The undesirable feature of the area mapped is the increased depth to Wilcox sand.

GENERAL DISCUSSION OF STRUCTURAL CONDITIONS AND THEORIES OF ACCUMULATION IN THE BEGGS FIELD.

It is generally accepted that there is lack of parallelism between surface and subsurface beds and between the productive sands in the Beggs District, a condition similar to that which obtains in the Cushing Field. The explanation of this condition as given on page 31, Bulletin 658, U.S.Geological Survey, is:

1. The difference in resistance to compression of the hard and soft beds of which the formations of the Cushing Field are composed;
2. The lenticular form of the Bartlesville sand (the equivalent of the Glen; Gas of Morris pool);

3. One or more unconformities between surface beds and the Bartlesville sand;
4. Folding during deposition;
5. Cross folding.

Other points will be given attention after the above are discussed.

DIFFERENCE OF HARD AND SOFT BEDS IN RESISTANCE TO COMPRESSION. The hypotheses enumerated might be applicable to the Beggs District. In a recent bulletin of the American Association of Petroleum Geologists, Volume IV, 1920, No.1, page 92, practically the same idea is incorporated under the caption of "Uneven Condensation of Deposits". According to this hypothesis, the mud and silt (shale) would settle more than clean sand or calcareous reef rock (limestone). The irregular settling of such deposits on a hilly foundation is given as one explanation of the origin of the Cushing, El Dorado, and Agusta Domes.

A glance at the columnar section will show the large amount of shales and shaly sandstones between the Glen and the surface beds. The Boggy shale, for example, contains irregularly distributed thin-bedded sandstones. The formations between the surface beds

and the Devonian unconformity may have been deposited on an old Silurian land surface with two or more interruptions of sedimentation. If such is the case, it might be expected that the structural features of the Wilcox will not show any definite alignment unless the old Devonian topography possessed regular systems or ranges of hills. The thickness of the Glen and the amount of lime between it and the Dutcher, the amount of lime between the Dutcher and the Wilcox nullify the effect of differential settling, although it may be a contributing factor to the structural irregularities. It is known that the dip of surface beds in this area are not as great as on the producing sands, in other words the folding appears to increase with depth. This fact may be accounted for by the relatively small amount of strata between the old Silurian hills and the Glen and Dutcher sands which may be expected to have a greater initial dip. Mr. Greene states that the Glen-Wilcox interval increases from the crests of the folds toward the flanks. This is further evidence in support of this hypothesis.

Hence, the lack of parallelism between the surface beds and the Glen, therefore, between the sur-

face formations and the Wilcox may be due to uneven condensation of the intervening strata, the resultant surface structure being in part an expression of Silurian topography.

LENTICULAR FORM OF SANDS. This feature may be neglected with reference to the Glen sand which is usually reported 120 - 140 feet in thickness more or less, according to well logs, and non-productive.

There is reason to believe, however, that the Dutcher sand is lenticular because of the greater variation of thickness reported, the stratic occurence of gas in northeast Beggs Field on the flanks of folds with little or no oil, the large amount of oil in the southwest Beggs country obtained from it, and its apparent absence fifteen miles west of Beggs in the Atlantic Petroleum Company's well Section 31-15-10. Some of these occurrences, however, may be due to other causes. If the Dutcher occupies the horizon representing a resumption of sedimentation after the Pennsylvanian-Mississippian unconformity, it might be expected that the sand would vary in thickness and texture from place to place and be entirely absent in certain localities not submerged at the time.

As stated previously, the texture of the Wilcox sand suggests that it is a shoal-water deposit, and if such is the case it may be expected to vary in texture and thickness depending on the character and amount of material carried out from shore. Irregularities of the sea floor or continental shelf would be reflected in corresponding variations in thickness of the Wilcox. If well logs can be relied upon there is also a variation in thickness of the lime overlying it. It is the opinion of the writer that this factor, lensing, is of minor importance in the Wilcox in this vicinity, at least.

ONE OR MORE UNCONFORMITIES. That some such form of structure as this does exist is evinced by contours on the Glen, Dutcher, Wilcox and surface beds. Contours on these beds differ from each other locally although in places there may be a radical difference as shown by the subsurface maps. The correlation given in the columnar section shows unconformities above the Glen, below the Dutcher, and above and below the Wilcox. There is a possibility of an unconformity between the Glen and Dutcher; i.e.,within the Morrow formation since it is the equivalent of the Franks Conglomerate and the Glen Formation of the southern Sandstone Hills region between which there is an unconformity. This unconformity may be the chronolog-

ical equivalent of the Franks Conglomerate, thus making the Morrow Formation the stratigraphic equivalent of the Glenn Formation alone. In Blackwelder's book on the "Regional Geology of the United States", page 82, a generalized section of formations for the Tishomingo Region in southern Oklahoma, modified after Taff, shows an angular unconformity above the Glenn Formation and above the Franks Conglomerate, respectively. It is reasonable to assume that this disturbance had its counterpart in the Beggs Field, hence the writer ventures the opinion that an angular unconformity exists between the Glen Sand and the overlying strata. Whether the Wilcox is correlated as Mississippian or Devonian, the columnar section shows that unconformities exist above and below it.

FOLDING DURING DEPOSITION. The writer has not had access to enough data on these sands to make any definite assertion regarding evidence supporting this hypothesis. It is the writer's opinion that there was no marked folding during the deposition of the Glen sand. The only evidence favoring this statement is the uniform thickness of the Glen sand. If there was any great degree of folding during deposition, we

would expect the formation to thicken on the landward side of the hills or crests of anticlines, which would be the south or southeast side of the major structures.

Evidence in support of folding during deposition of the Dutcher is questionable also. The sand is frequently reported as "broken" and this and its absence in one locality favor the assumption of folding or uplift at this time.

The writer has not done any surface work in producing area in this district, but from his observations in the vicinity of the McIntosh lease, Section 12-14-11, and in the neighborhood of the Tobe Jefferson lease previously mentioned, he believes that the surface beds are less folded than these sands. A map in Bull. 19, part II, Oklahoma Geological Survey shows this relation. Since the Wilcox is said to be more steeply folded than the Glen and the Dutcher, the folding must have taken place during the deposition of these sands and would, therefore, be more noticeable on a thin formation five hundred feet above it than on the Glen sand, a thick formation 1,000 feet above it. Granting that the surface beds are less steeply folded than the Glen

and Dutcher sands, it follows that folding was continuous with the deposition of the intervening beds. In Bulletin 3, American Association Petroleum Geologists, page 269, the statement is made that folding took place during "Boggy" time, and continued during deposition - probably, of all formations between this and the Seminole Conglomerate, 360 feet, above the Wewoka formation.

CROSS FOLDING. The surface map submitted herewith shows a cross-fold. That such folding does exist in the territory about twenty-four miles east of Beggs is known and the surface fold should have its counterpart in the producing sands. With the meagre amount of subsurface work done by the writer in this field, it is impossible for him to tell what system of folds exist on the Wilcox sand, except that they are small and indicative of much folding. With several periods of folding affecting the strata, it might be expected that cross-folding exists.

RELATION OF OIL AND GAS TO STRUCTURE.

In general the anticlinal theory might be applied to the accumulation of hydrocarbons in this field, but the writer is in doubt as to the origin of these anti-

clinal conditions. It is not beyond reason to state that in the case of the Glen and Dutcher sands the occurrence is due to other causes. Contours on the three sands exhibit irregularities in the structure of each; the general structural features agree.

THE GLEN SAND. Although this sand possesses the same general structural features of the Dutcher and Wilcox sand, it is not productive in this field. This condition is probably one of source of the hydrocarbons which will be discussed later.

THE DUTCHER SAND. The writer suggests that the occurrence of oil and gas in this sand is influenced by three equally important factors; namely, lensing, folding, and source. The influence of the first is more noticeable in the northeast Beggs field where the gas occurs very low on the structure with little relation to it. The thickening and thinnning of this sand as reported in well logs, its absence in one locality, and the variation in the quantity of lime and shale above it substantiate the claim of its being lenticular. Folding would intensity the effect of lensing, causing greater accumulation at the top of these lenses and further delimiting the productive area.

THE WILCOX SAND. Contours on this sand show its surface to be highly folded and the producing structures of small area, consequently a dry hole in this sand does not condemn very much territory. If contours were drawn at intervals of 100 feet on the Wilcox it would reveal several structural lobes. The productive areas are minor structural features on these major structures, and their alignment would agree with the axis of the lobe. Hence, the arrangement of these smaller structures over the entire district depends on the direction or bearing of the axis of the lobes. The thickness of this bed varies to some extent but it is the writer's opinion that the inclination of the strata is the chief factor influencing accumulation in this sand.

INFLUENCE OF SOURCE OF OIL AND GAS ON ACCUMULATION.

That this is an important point to consider is exemplified by the absence of commercial accumulation in the Glen sand in this district. The petroliferous constituents of the sands in this field seem to have originated from several sources. The absence of oil or gas in paying quantities in the Glen indicates that these products were obtained from formations below the Glen, representing the lower Coal Measures or Muskogee

Group, in part, which are known to be high in carbon content. The limestone a short distance below the Glen probably prevented much upward migration of oil and the shales above it were probably low in carbon and partly removed by the lower Boggy-Thurman period of erosion.

The hydrocarbons of the Dutcher might have had their origin in the Morrow formation, the Caney Shale, or some of the formations between it and the Boone chart. The gas in this district seems to have entered the reservoirs soon after its production as shown by the areas where gas is chiefly obtained from this sand. The explanation which may be given this occurrence is that the Dutcher lenses were so gas filled that the oil was spilled on up the dip. If it is contended that this is merely an advanced stage of devolatilization, the explanation does not account for the large oil content of the Dutcher west of Beggs. It is possible, however, that the organic deposits varied sufficiently in carbon content in this territory, and that due to progressive devolatilization, gas only might obtain in one locality whereas both gas and oil might result in another. The latter premise is untenable because such wide variation over small

areas is not likely to occur.

The oil in the Wilcox probably had its origin in the formations below the Boone. The Chattanooga is a carbonaceous shale below the Boone and may be the source of the Wilcox oil. The lithologic character of the Silurian and Ordovician formations obviates drilling into these sediments. An examination of the optical and chemical properties of these oils might determine the nature of their source.

GEOLOGIC HISTORY.

The sequence of events as suggested by the foregoing discussion may be stated as follows:

Shallow seas during the Ordovician, Silurian, and Devonian with frequent fluctuations of the land mass.

Erosion followed by submergence and deposition of the Sylamore (Wilcox) and Chattanooga - late Devonian,

Uplift and Erosion - Devono-Mississippian,

Submergence, deposition of Mayes - late middle Mississippian,

Emergence and erosion - upper Mississippian,

Submergence and deposition of Fayetteville and Pitkin - upper Mississippian,
Uplift and erosion - late Mississippian,
Submergence, deposition of Hale (Dutcher) with local emergences, deposition of remainder of Morrow - early Pennsylvanian - (Pottsville),
Uplift and erosion, development of angular unconformity in Arbuckles- (Pottsville),
Submergence and deposition of Winslow (including Glen sand) - (Pottsville-Allegheny),
Folding and development of lower Boggy-Thurman unconformity - (Allegheny),
Submergence and deposition of remainder of Muskogee and Tulsa group - (Allegheny),
Folding and erosion and formation of Seminole Conglomerate.

The geologic history of the region establishes the fact that there were at least two periods of folding which affected the producing strata in the Beggs field. A number of recessions of the sea took place and these may or may not have been accompanied by folding. No writer considers the possibliity of an angular unconformity above the Morrow in this district, as it is thought that deposition was continuous with folding. Some of the folding in the Beggs District was probably coeval with

the formation of the Ozark, Ouachita, Arbuckle, and Wichita Mountains. The time of this tectonic movement has not been definitely established in Oklahoma, but in the Arbuckles there is evidence that it took place before the deposition of the Franks Conglomerate of Pottsville age. This main period of folding was followed by others which may have resulted in cross-folds.

ECONOMIC VALUE OF THESE FACTORS.

Although much of the foregoing discussion is theoretical, the practical value of these factors can not be over estimated in the development of unprospected territory. The salient features of this discussion are:

1. Two periods of folding in the Beggs District which may have accentuated the folding or resulted in cross folds.
2. Lack of continuity of the Dutcher sand, therefore, dry holes in it do not show absence of structure or favorable territory nearby.
3. Structures on the Wilcox are small and

part of a major structural feature, hence dry holes in it do not condemn much acreage.

4. The probability of Wilcox structures being the result of deposition on old erosion forms with subsequent differential settling of formations. The size, shape and trend depend on like features of these former Silurian hills.

5. The probability of the Wilcox being beyond reach of the drill in the territory south of a line from Henryetta to Billings.

6. Subsurface structure will be reflected on surface beds to a moderate degree by nosing, flattening, and increase in the local dip. East dips may exist on the sand without any evidence of such on the surface.

7. Improbability of production below the Wilcox.

CONCLUSION.

The folding indicated by the contour map is undoubtedly an expression of deep seated folding, but it is impossible at present to determine the exact relation between surface and subsurface structure. In judging the value of surface indications due consideration must be given this variable relationship and the uncertainty thus introduced in geologic evidence before attempting leasing or development. With this in mind the writer has rather broadly outlined the prospective territory.

COLUMNAR SECTION

System	Equivalents		Formation	Character	Thick. Ft.	Interval Ft.
PENNSYLVANIAN (Pottsville)---------- (Allegheny)		Tulsa Group	Wewoka Formation	sandstone and shale with occassional lime, fossiliferous, upper & lower third	700 Surface	2440
			Wetumka Shale	gray and brown shales	120	
			Calvin Sandstone	chiefly s.s. at base + shale	140-240	
	CHEROKEE: Atoka, Hartshorne, McAlester, Savanna, and Bogey Equivalents of:	Muskogee Group by Gould, Chern, Hutchison, and others	Senora Formation	sandstones and interstratified shales	500-275	
			Stuart Shale	thin-bedded shaly sandstones and shales	100-275	
			Thurman Sandstone	coarse to fine sandstones and some shale and lime	80-275	
			Unconformity			
			Boggy Shale	shale and irregularly distributed thin-bedded sands		
			Winslow Formation includes:	shales and shaly sands	800 to 1000	
			Glen Sand (Bartlesville)	in upper part equivalent of Glen & Salt	120-140	300
			Booch (Taneha)	near middle	20	
			Unconformity			575
			Morrow Formation includes:	principally limestone with some sand. May be local unconformity near middle	0-210	
			Dutcher Sand	at base (probable equivalent of Hale Sandstone)	25-40	
			Caney Shale ??	black carbonaceous shales clay and lime segregations	100-300	1050
MISSISSIPPIAN	Osagian, Meramecian, Chesterian		Unconformity			
			Pitkin Limestone	thin light blue and brown layers interbedded with massive streaks	0-70	
			Fayetteville Shale	blue and black shales with thin lime lenses	0-160	460
			Mayes Limestone	dark gray to black lime	0-95	
			Unconformity			
			Boone Formation	limestone and chert	100-350	
			Unconformity			
DEVONIAN			Chattanooga Shale, includes:	black shale	0-40	
			Sylamore Sandstone (Wilcox Sand)	at base		
			Unconformity			
SILURIAN			St. Clair Marble		100	
			Unconformity (probable)			
ORDOVICIAN			Tyner Sandstone	sandstone, chert and limestone, and green shale	60-100	
			Burgen Sandstone	white, fine-grained sand		

From Correlation Chart Oklahoma Geological Survey and other sources

PRODUCERS & REFINERS CORPORATION
GATES OIL COMPANY
and
E. L. Robinson

Northeast Beggs

RECORD OF WELL #6 on John Marshall farm - located in NW corner of SW¼ SW¼ Sec.16-15N-12E, Okmulgee County, Oklahoma.

Drilling commenced June 8,1920 - completed July 17,1920.

Production 50bbl. on pump.

	From	To	
Soil, brown, soft	0	2	
Hardpan,dark	2	14	
Shale,light,soft	14	180	
Sand,light, soft	180	190	- water
Shale, light, soft	190	480	
Sand, light, soft	480	500	- water
Shale, dark, soft	500	513	
Sand, light, soft	513	525	
Shale, light, soft	525	608	
Lime, light, hard	608	612	
Shale, light, soft	612	749	
Lime, light, hard	749	755	
Shale, light, soft	755	900	
Lime, light, hard	900	905	
Shale, light, soft	905	940	
Lime, light, hard	940	950	
Shale, dark, soft	950	970	
Lime, light, hard	970	980	
Shale, black, soft	980	985	
Sand, light, hard	985	995	
Shale, dark, soft	995	1040	
Sand, light, soft	1040	1045	- gas & water.
Shale, brown, soft	1045	1090	
Sand, light, hard	1090	1125	

Gates Oil Co

	From	To	
Shale, dark, soft	1125	1210	
Mud, black, soft	1210	1230	
Sand, light, soft	1230	1265	
Shale, brown, soft	1265	1350	
Sand, light, soft	1350	1372	
Shale, brown, soft	1372	1430	
Shale, light, soft	1430	1575	
Sand, Glen	1575	1730	- Water in bottom.
Shale, brown, soft	1730	1780	
Lime, light, hard	1780	1785	
Shale, light, soft	1785	1850	
Shale, brown, soft	1850	1920	
Lime, light, hard	1920	1927	
Mud, black, soft	1927	1950	
Shale, light, soft	1950	2000	
Shale, brown, soft	2000	2075	
Mud, black, soft	2075	2140	
Sand, light, soft	2140	2152	- Taneha gas sand
Shale, brown, soft	2152	2200	
Lime, white, hard	2200	2206	
Shale, brown, soft	2206	2300	- 7 M gas
Sand, light, hard	2300	2330	- Dutcher sand
Shale, black, soft	2330	2427	
Lime, black, hard	2427	2600	
Shale, brown, soft	2600	2656	
Lime, black, hard	2656	2666	
Lime, grey, hard	2666	2679	
Sand, brown, hard	2679	2688	- Wilcox sand
Total depth		2688	

CASING USED

10"	525'
8¼	1730'
6-5/8	2427'

PRODUCERS & REFINERS CORPORATION

Southwest Beggs

RECORD OF WELL #4 on Pink Hawkins lease - located 660' from South and 200' from West line of SW¼ NE¼ of Section 11-14-11E, Okmulgee County, Oklahoma.

Commenced drilling May 10, 1920 - completed June 21, 1920.

Production after 1st 60 qt. shot - 375 bbls; after 2nd 68 qt. 925 bbls.

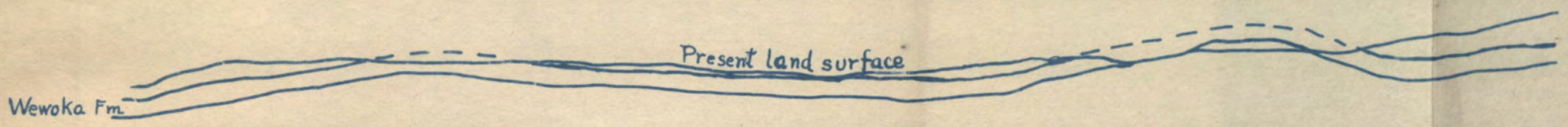
	From	To	
Soil, Sandy, soft	0	3	
Sandstone, soft	3	45	
Shale, blue	45	54	
Sand, yellow	54	76	
Shale, blue	76	525	
Shale, brown	525	585	
Lime, hard, white	585	589	
Shale, grey	589	625	
Lime, hard, white	625	629	
Shale, grey	629	1006	
Lime, hard, white	1006	1012	
Shale, grey	1012	1070	
Shale, brown	1070	1082	
Shale, grey	1082	1112	
Lime, hard, grey	1112	1132	
Shale, black	1132	1192	
Sand, grey, little gas	1192	1223	
Shale, white	1223	1430	
Sand, grey	1430	1440	
Shale, brown	1440	1595	
Sand, white, 3 blrs hour	1595	1646	
Shale, white	1646	1695	
Shale, black	1695	1734	
Sand, Glen, white	1734	1898	- (Showing of oil (Hole full water.

	From	To	
Shale, white	1898	2040	
Sand, Taneha, brown	2040	2080	- 1/4 M gas.
Shale, blue	2080	2110	
Sand, Taneha, white	2110	2290	- H.F.W.
Lime, grey	2290	2318	
Sand, brown, Dutcher	2318	2324	- Oil
Lime, hard, black	2324	2340	
Shale, black	2340	2360	
Lime, hard, black	2360	2375	
Shale, shelly	2375	2430	
Shale, black	2430	2510	
Lime, hard, black & grey	2510	2753	
Shale	2753	2805	
Lime, hard, white	2805	2822	
Sand, Wilcox	2822	2853	

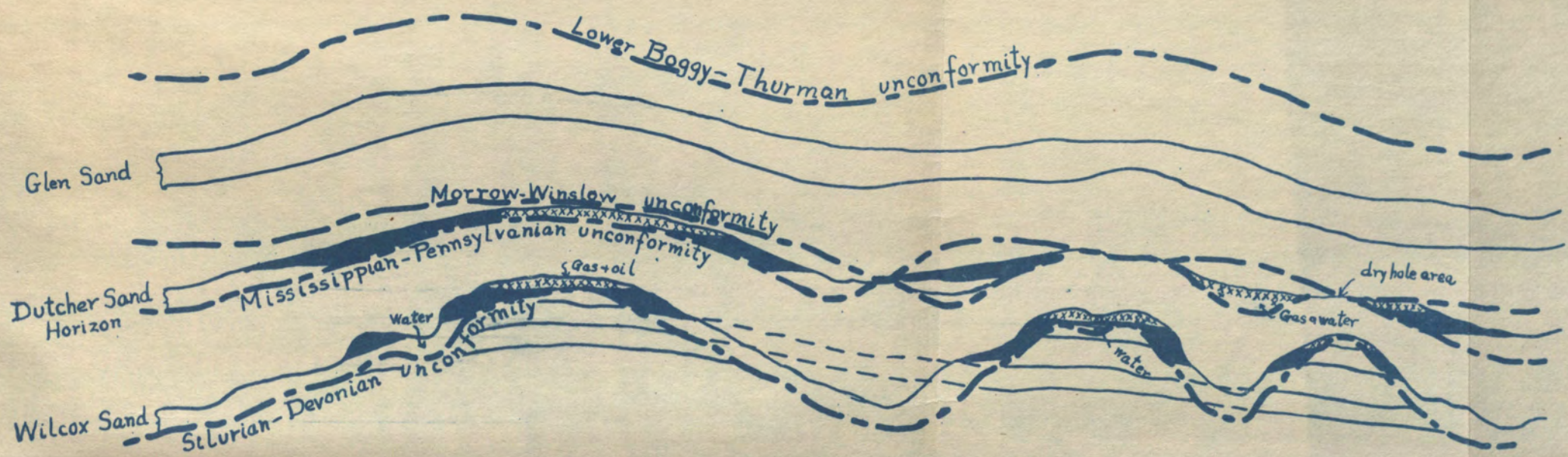
CASING USED

10"	80'
8¼	1905'
6-5/8	2328'
5-3/16	2811'

Ideal Section Showing Probable Relation Of Formations In Beggs District



(shales, sandstones, and shaly sandstones)



Note:- Pre-Devonain beds may or may not be "folded" as much as overlying beds.
Dip of Wilcox in part due to initial dip and in part to folding.

J.C.Miller