

# A RECONNAISSANCE IN PALO PINTO COUNTY, TEXAS, WITH SPECIAL REFERENCE TO OIL AND GAS.

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## INTRODUCTION.

The presence of oil and gas in Palo Pinto County, Tex., has been known for a number of years. Wells drilled for water at Mineral Wells, on the east border of the county, encountered "showings" of oil and gas. Several gas seeps were known to ranchers north of Palo Pinto, in the central part of the county, and a small gas field was discovered several years ago on lands held by the Texas & Pacific Coal Co., near the towns of Strawn and Thurber, in the southwestern part.

The reconnaissance here reported was undertaken by the United States Geological Survey in the fall of 1914, in order to determine whether anticlines which might have influenced the accumulation of oil were present in the region and to point out, if possible, areas in which drilling might be successful.

The author was assisted both in the field and in the office by Mr. Ralph W. Howell, of whose careful work he desires to express his appreciation. Thanks are due to many residents of the district who have supplied valuable information.

In the time available for the work it was impossible to make an examination of the whole county, and therefore an area was chosen in which, from the nature of the outcrops and the character of the country, geologic work could be carried on most rapidly and in which also there were indications of gas. This area (see fig. 4) lies in the north-central part of the county and includes the prominent escarpment that trends northeastward about 4 miles northwest of the town of Palo Pinto. This escarpment is capped by thick beds of limestone, and a well-known point along it is a high butte south of Brazos River known as Kyle Mountain. The group of limestone beds constitutes stratigraphically and structurally one of the best horizon markers in the field.

## HISTORY OF DEVELOPMENT AND DESCRIPTION OF GAS SEEPS.

At the time of the examination the only important oil or gas development in the region was that of the small gas field southwest of Strawn, in the extreme southwestern part of the county. This field had been developed by the Texas & Pacific Coal Co., operating at Thurber, and contained nine or ten gas wells ranging in capacity

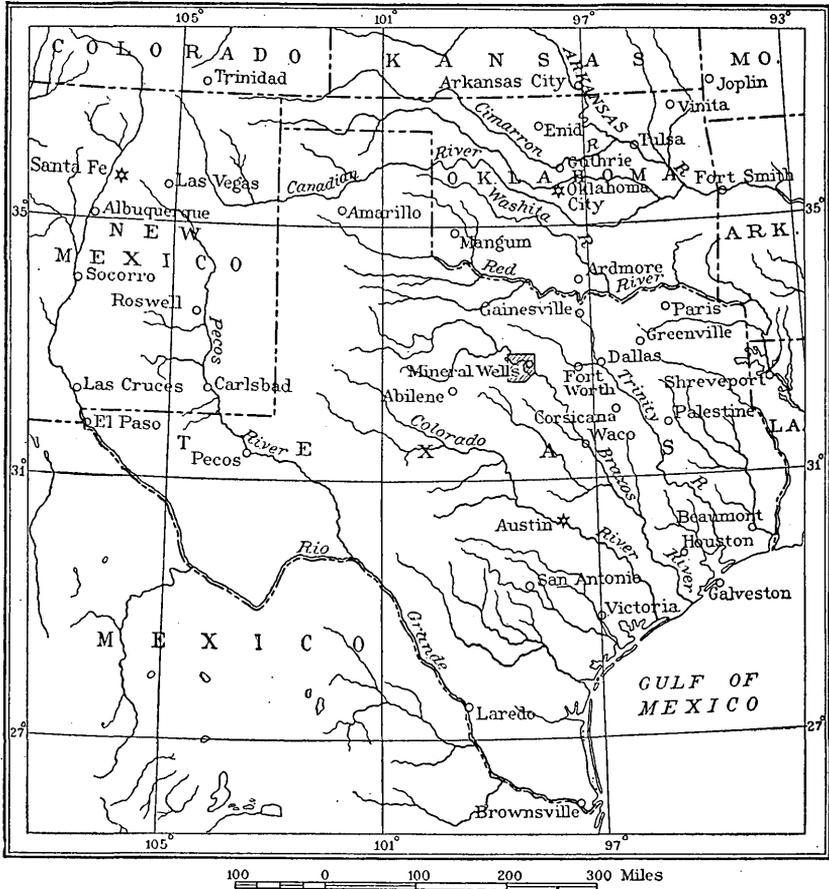


FIGURE 4.—Index map of Texas showing area examined in Palo Pinto County.

from 273,000 to a little over 2,000,000 cubic feet a day. The daily production of the entire field was estimated at about 8,700,000 cubic feet. The gas was obtained at about 400 to 600 feet below the surface, the depth depending on the position of the well with reference to a small local dome which appears to have controlled the accumulation.

Since this examination was made an oil field has been discovered about 3 miles northwest of the gas field and northwest of the town

of Strawn, and drilling is being actively carried on, not only in the vicinity of the new field but throughout the area.

In the town of Mineral Wells, at the east side of the county, small showings of oil have been encountered at a depth of about 100 feet in wells drilled for mineral water. The strata here dip at a low angle to the northwest, and on the W. W. Johnson place,  $1\frac{3}{4}$  miles north of the town, a small amount of heavy oil was encountered in this same sand at a depth of 350 feet. About  $1\frac{1}{2}$  miles northwest of the town, in the Crenshaw well, several gallons of oil was encountered at a depth of 520 feet, in a sand about 300 feet below that which carries the mineral water at Mineral Wells.

In the north-central part of Palo Pinto County a gas seep occurs about a mile northwest of Kyle Mountain and half a mile east of Brazos River. Gas bubbles here rise in a pool of water in the bed of a small tributary of the Brazos. The bottom of the pool is limestone. On the Dalton ranch, about a quarter of a mile northeast of this gas seep, a well has been drilled which is said to have encountered a small flow of gas at 385 feet below the surface and a greater flow at 854 feet. It is reported that this gas, being lighted at the mouth of the casing, burned for almost a year. No odor of gas could be detected in this old well at the time of the writer's examination. Within a few rods of this well another test hole is at present being drilled by the Crazy Oil & Gas Co.

About 3 miles north and a little east of the last-named locality, on the west bank of Dark Valley Creek, 1 mile north of Brazos River, is a well which is said to have obtained a good showing of gas. The casing was open at the time of the examination and the odor of gasoline could be detected. A lighted paper dropped into the casing produced an explosion. Bubbles of gas were observed rising in the mud and water at the mouth of Dark Valley Creek, but the nature of the gas was not determined.

#### TOPOGRAPHY.

The region is one of considerable relief, some of the hills rising to heights of 500 feet above the valley floors. The ruggedness of the surface is produced by a series of escarpments which trend in a northeasterly direction and are formed by the outcropping edges of sandstone and limestone beds that dip at low angles to the northwest. The most prominent of these escarpments, about 200 feet above the adjacent plain, is that formed by the group of limestone beds which caps Kyle Mountain. Northwest of this escarpment the country is very rough and in part is heavily timbered. East of the escarpment is a belt of comparatively open country about 5 miles in width, the surface of which, formed by a limestone bed lower than

that which caps Kyle Mountain, is covered only by a growth of mesquite. The eroded edge of this lower limestone bed forms the crest of another escarpment, southeast of which are a series of timber-covered escarpments formed by sandstone strata.

The county is crossed from northwest to southeast by Brazos River, which flows in wide intrenched meanders, suggesting that its course was chosen when it flowed on a low-lying and featureless plain, which has since been uplifted and eroded. The present stream valley is comparatively narrow and is bordered by high bluffs.

### STRATIGRAPHY.

Palo Pinto County lies on the east side of the Carboniferous area which in Texas extends from Red River on the north to San Saba, McCulloch, and Concho counties on the south and in its widest part from Parker County on the east to Jones County on the west. Throughout most of this area the strata have a prevailing dip to the northwest. On the east the Carboniferous rocks are covered by Cretaceous deposits, which overlie them unconformably. On the west the Cisco, which is regarded as the uppermost formation of the Pennsylvanian, is overlain by the Permian "Red Beds."

In Palo Pinto County only two formations are exposed at the surface, both of which are of Pennsylvanian age but older than the Cisco, which is not present in the county. The older of these formations, the Strawn, is about 1,700 feet thick,<sup>1</sup> and the younger formation, the Canyon, about 750 feet thick. In the Strawn formation are included the Strawn and Millsap formations as originally named by Cummins,<sup>2</sup> who, however, later modified his definition of the Strawn to include the "Millsap."

The base of the Strawn formation is not exposed in this region, being covered by the Cretaceous deposits on the east. The formation consists mainly of alternating beds of dark shale, gray shale, sandstone, and conglomerate but includes several thin beds of limestone. Its upper limit is placed, according to Cummins, at the base of the heavy beds of limestone of the formation above. About 700 feet below the top of the Strawn formation is the coal bed mined at Thurber, Gordon, and Strawn, and formerly mined 4 miles east of Mineral Wells.

The Canyon formation overlies the Strawn and consists of thick beds of limestone, sandstone, and gray shale. To quote from Cummins: "This division is characterized by the heavy beds of lime-

<sup>1</sup> Gordon, G. H., *Geology and underground waters of the Wichita region, north-central Texas*: U. S. Geol. Survey Water-Supply Paper 317, p. 15, 1913.

<sup>2</sup> Cummins, W. F., *Report on the geology of northwestern Texas*: Texas Geol. Survey Second Ann. Rept., p. 374, 1890.

stone found in it and is easily recognized by this fact, the limestones in other divisions being much thinner bedded." He states also that limestones of this formation may be observed at Palo Pinto. This town is built on a limestone bed which is about 400 feet below that capping Kyle Mountain and which forms the escarpment crossed by the Mineral Wells road, 2 miles east of Palo Pinto. As there is no lower limestone bed of prominence exposed in this area, it is probable that the rock on which Palo Pinto is built was considered by Cummins as the basal bed of the Canyon formation, and it is so represented on the accompanying map (fig. 5, p. 56).

Of the several escarpments which cross Palo Pinto County from northeast to southwest and are formed by the outcropping edges of sandstone and limestone strata, three are particularly prominent—the one just described, formed by the basal limestone of the Canyon formation; a second, of which Kyle and Wolf mountains are a part and which is formed by a limestone bed 400 feet above the base of the Canyon formation; and a third, which lies north of the Texas & Pacific Railroad, between Brazos and Gordon, and is formed by a sandstone of the Strawn formation, a little above the Thurber coal bed. In tracing these three escarpments from northeast to southwest across the county they appear to converge, as if the dip of the rock strata increased slightly in that direction.

#### METHODS OF FIELD WORK.

Geologic observations to determine structure were confined in the present examination to the limestone bed which forms the second of the escarpments just mentioned and which is well exposed in Kyle Mountain, north of Palo Pinto. By a system of plane-table triangulation, together with vertical angles read with a telescopic alidade, numerous elevations were taken on the top of this limestone bed at intervals along the escarpment for a distance of 16 miles. From these observations it has been possible to make a structure-contour map of the surface of this limestone, showing the shape of the folds into which it has been thrown and the relations of these folds to the gas seeps and gas wells in the region.

#### INTERPRETATION OF STRUCTURE CONTOURS.

The structure contours given in figure 5 are drawn upon the surface of the 50-foot limestone bed and represent the folded surface of that bed as it was before parts of it were removed by the action of streams. Every point along any one contour line is at the same elevation above or below sea level, and the lines are drawn to show differences of 20 feet in elevation.

To one unfamiliar with the interpretation of structure contours the following somewhat fanciful conception may be of assistance. Were it possible to remove all the overlying strata and to walk

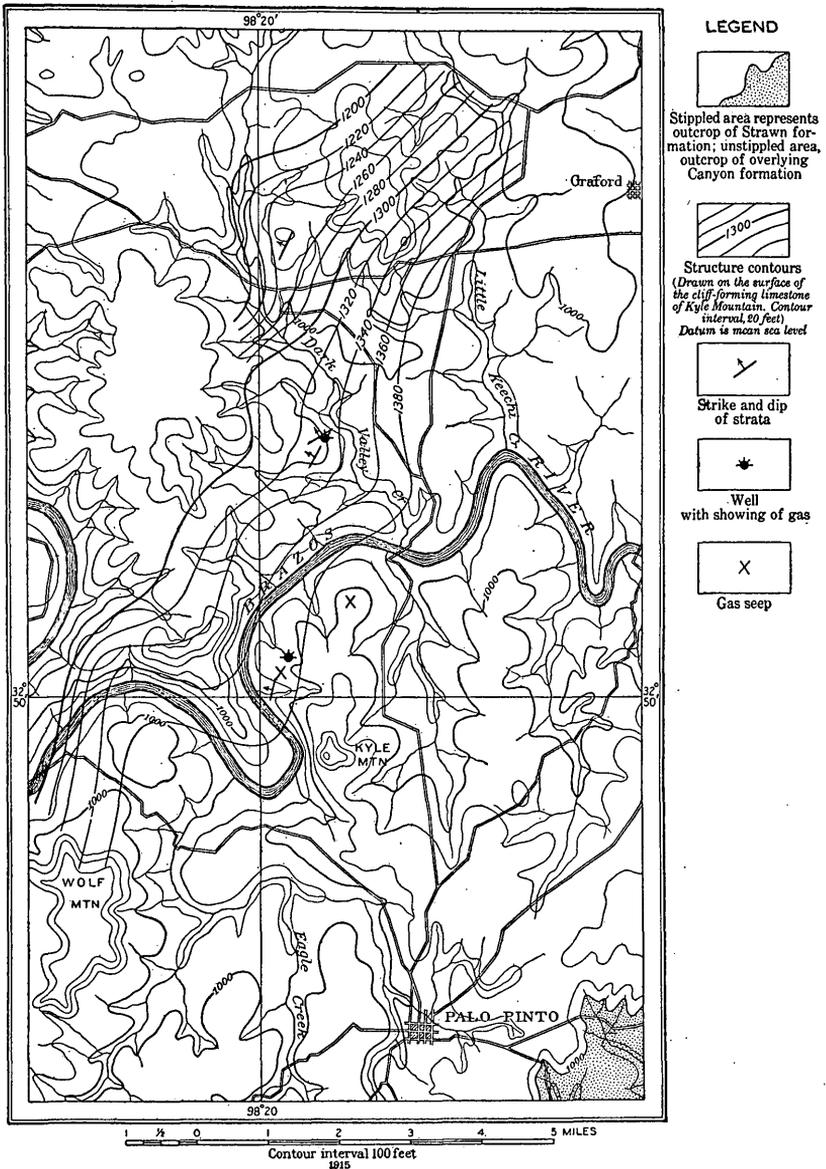


FIGURE 5.—Map of anticlinal structure north of Palo Pinto, Tex.

about on the upper surface of the limestone bed the course followed by one who endeavored to walk always at an elevation of, say, 1,200 feet above the sea, never stepping up or down, would be that indicated by the 1,200-foot contour on the map. When the pedestrian

came to a knoll or jutting point he would be compelled, if he did not wish to ascend, to walk around its side. When he crossed the valley that lay between this knoll and the next he would be compelled, if he did not wish to descend, to walk up the valley to a point where its floor was level with that of the hillside which he had just left. His course, in other words, were it represented by a line, would represent the form of the hills and valleys or their contour. A series of lines drawn at regular intervals above sea level will indicate very clearly, to one accustomed to the reading of contours, the form of the surface represented by them.

### STRUCTURE.

The dominant structure in north-central Texas west of the Cretaceous area is a monocline in which the beds dip toward the northwest at the rate of about 40 or 50 feet to the mile. Superimposed upon this monocline there are, in certain localities, small cross folds, the axes of which trend in a northwesterly direction, at right angles to the prevailing strike of the rocks. It is these cross folds which appear to have been the chief factors in determining the places of accumulation of oil and gas. The broadest cross fold in the part of Palo Pinto County which was examined in greatest detail in the present work lies in the vicinity of Kyle Mountain, 4 miles north of the town of Palo Pinto. Kyle Mountain is about 2 miles southeast of the main line of the escarpment, and the limestone bed which caps it is evidently the same as that forming the escarpment. There is, however, a difference of only about 50 feet in altitude between the thick limestone bed on Kyle Mountain and that of the main escarpment, whereas if the normal dip prevailed at this locality, the bed on Kyle Mountain should be at least 100 feet above that on the escarpment. There is at this locality, therefore, a change of dip such as is found in many places near the axes of cross folds. The presence of a cross fold is demonstrated also by other observations taken along the line of the escarpment.

The gas seep on the Dalton ranch, 1 mile northwest of Kyle Mountain, is a little south of the axis of this fold, which extends in a northwesterly direction. (See fig. 5.) The old well on Dark Valley Creek 1 mile above its mouth is near the axis of the syncline, on the opposite side of the fold. From dip and strike readings taken on the limestone bed exposed near the old well there appears to be at this locality a small local roll which may account for the gas found in the well. The prominent hill 4 miles due north of the bridge over Brazos River and 4 miles west and a little south of Graford appears to be near the axis of another and smaller anticline. The beds at the southeast end of this hill dip to the northwest, but

2 miles farther west the strike changes until the beds dip to the west, as if this anticline were separated from that of Kyle Mountain by a shallow syncline whose axis lies in the vicinity of Dark Valley Creek. (See fig. 5.) In Wolf Mountain the strike of the beds appears to be approximately north, a fold northeast of Wolf Mountain being separated from the Kyle Mountain fold by a shallow syncline. How far the Kyle Mountain fold extends toward the southeast has not been determined, but it is probable that a minor fold of this nature would not extend for any great distance.

Details of structure were not worked out in other parts of the area. The gas wells in the Thurber field, 3 miles southwest of Strawn, appear to be on a small dome or anticline, as is shown by a comparison of the logs of the wells.

A thin bed of limestone half a mile west of Brazos strikes N. 72° E. and dips toward the northwest at low angles. At Mineral Wells the strike of the beds is N. 41° E., and on Brazos River between Mineral Wells and Palo Pinto it is N. 61° E. Northwest of Santo a broad semicircular valley about 3 miles wide is bordered by steep escarpments capped by a thick bed of sandstone. From a brief inspection of this locality the beds appear to be very nearly horizontal.

#### OIL AND GAS.

Gas was encountered in the well on the Dalton ranch, 1½ miles northwest of Kyle Mountain, at depths of 385 and 854 feet. The limestone bed which forms the surface at the Dalton well appears to be that which caps a prominent escarpment a little west of the Thurber gas field, and from a study of the well logs in that field it seems probable that the gas is derived from the same sand as that which was encountered at 840 feet in the Dalton well. This sand lies about 140 feet below the Thurber coal. The oil reported from the Crenshaw well, about 1½ miles northwest of the town of Mineral Wells, appears to have been derived from beds at this same horizon. The mineral water and "showings" of oil at Mineral Wells are obtained from a sand about 300 feet above the Thurber gas sand.

The Dalton well is on the flank of the anticline north of Kyle Mountain, and as it did not obtain oil or gas in commercial quantity from the Thurber gas sand or from any higher bed, it is probable that if oil or gas are to be found in commercial quantity in the Kyle Mountain anticline they must be sought in deeper sands. It is reported in the trade journals that the new oil field northwest of Strawn obtains its oil from a sand lower than that producing gas in the field west of Thurber. If this report is correct, there is a chance of obtaining either oil or gas in the equivalent of this sand

in the Kyle Mountain anticline. This anticline is now being tested by a well being drilled close to the old Dalton well. If gas should be encountered in this test well, oil is probably to be sought down the dip to the northwest and gas up the dip to the southeast. If oil should be encountered in the test well, future drilling should be done either northwest or southeast of the first well along the axis of the anticline, but the wells should not be placed very far apart, as the extent of the anticlinal structure in these directions is unknown. If the well should prove to be a dry hole, it is probably useless to expect that the sands tested by it will be found productive in other parts of the Kyle Mountain anticline.

A fold similar to the Kyle Mountain anticline but less extensive appears to lie about 4 miles north of the Brazos River bridge on the Palo Pinto-Graford road. This fold, though presumably not so favorable to oil accumulation as the Kyle Mountain anticline, may contain deposits of oil or gas and should be tested by a well southwest of the southeast extremity of the high bluff or mountain which lies north of its axis. (See fig. 5.) Another anticlinal fold occurs between Kyle and Wolf mountains.

The probabilities are somewhat against the finding of oil or gas in the synclines which lie northeast and southwest of the Kyle Mountain anticline.

#### WATER SUPPLY AT MINERAL WELLS.

The possibility of finding soft water near Mineral Wells at greater depths than any yet reached by the wells in that town is a question of considerable local interest, and although it has no bearing on the occurrence of oil it may not be out of place to discuss it here.

Soft water of good quality is now obtained from a sand about 50 feet below that which carries the "mineral water." This soft-water sand apparently lies about 70 feet above the Thurber coal. At Thurber several deep wells have been drilled by the Texas & Pacific Coal Co., but in none of them was good water obtained in beds below the coal. Numerous sands were encountered, but the water contained in them was either salty or charged with "alkalies." Considering these facts, the chances of obtaining a good water supply at Mineral Wells by deep drilling into the beds tested at Thurber appear to be poor.

