SUBSURFACE STRATIGRAPHIC ANALYSIS OF THE PRUE, SKINNER AND RED FORK SANDSTONES, SOUTHERN NOBLE COUNTY, OKLAHOMA

By

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ABSTRACT

The Middle Pennsylvanian (Desmoinesian) Cherokee rocks were deposited during a series of transgressions and less extensive regressions. The Cherokee group consists mostly of shales separated by thin, persistent limestone beds and local lenticular sandstone units. The sandstones considered in this study include, in ascending order, the Red Fork, Lower Skinner, Upper Skinner and Prue sandstones.

The Cherokee group unconformably overlies the Mississippian limestone. The lower part of the Cherokee thins to the west and north of the study area indicating onlap onto the Mississippian System. Locally the Cherokee sediments were influenced by the paleotopography of the Mississippian limestone. In places the Cherokee sediments were also influenced by paleostructure including differential compaction, structural movement or a combination of the two.

The Red Fork, Skinner and Prue sandstones are believed to be deltaic deposits including interdistributary sandstones and siltstones, channel-fill sandstones and crevasse splay deposits. The Cherokee sea advanced from a southerly direction and the source area for the Cherokee rocks is believed to have been to the east and northeast of the study area. The sandstones are present mainly in the eastern part of the study area.

Locally the sandstones of the Cherokee group are commercially productive of hydrocarbons and several fields within the study area produce from the Lower Skinner sandstone interval.

INTRODUCTION

Location of the Study Area

The area of study covers approximately 216 square miles in north-central Oklahoma, including T. 20 N. and T. 21 N., R. 1 W. and R. 1 E., and T. 21 N., R. 2 E. in southern Noble County and T. 20 N., R. 2 E. in northern Payne County. Boundaries of the study area are shown in Figure 1.

Statement of the Problem

The objective of this investigation is to determine the depositional environments of parts of the Middle Pennsylvanian Cherokee group and to estimate the influence of topographic and structural features upon deposition.[1]

Previous Investigations

Many investigations of the Cherokee group have been conducted during the past 80 years; they make up a complicated literary history of the study of these strata. In the first reference (Haworth and Kirk, 1894) the Cherokee group was defined as "ashy white to black

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[1]Most of the stratigraphic names contained in this report are used commonly in subsurface petroleum geology but are regarded by the U. S. Geological Survey and (or) the Oklahoma Geological Survey as being informal terms. Accordingly, the lithologic portions of such names are not capitalized.

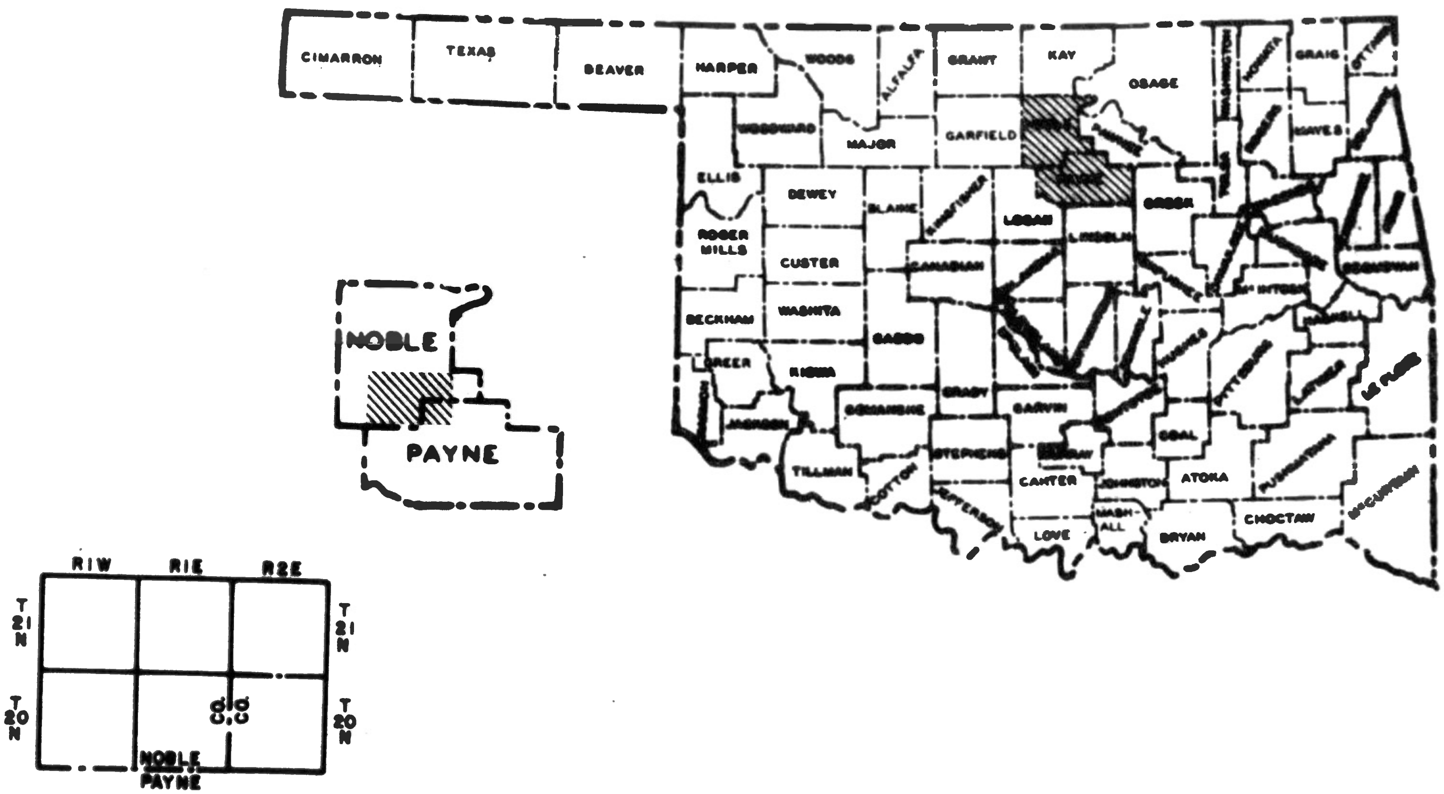


Figure 1.- Location map of the study area.

shales, 500 feet thick, containing many beds of coal, sandstone and limestone." The term "Cherokee Shale" was suggested for all rocks between the top of the Mississippian System and the base of the "Oswego Limestone" (now known as Fort Scott Limestone, Zeller and others, 1968). The type area is Cherokee County, Kansas and rocks of the interval have been studied in eastern Kansas, southeastern Nebraska, southwestern Iowa, northwestern Missouri and northeastern Oklahoma.

The Cherokee Group of Oklahoma, as considered formally in stratigraphy of rocks exposed at the surface, was abandoned by division into the Krebs and Cabaniss Groups (Oakes, 1953). The names of Krebs and Cabaniss are not commonly applied in subsurface geology of northern Oklahoma. Therefore, the term "Cherokee group" is used here to include all strata bounded below by the Mississippian System and above by the Oswego limestone (Fig. 2).

Recent work on the Cherokee group of north-central Oklahoma includes studies of the subsurface in Noble County (Page, 1955; Scott, 1970) and a regional study of the subsurface that includes a part of Noble County (Cole, 1969). Other studies that are related less directly to my investigation include those by Astarita (1975), Berg (1969), Berry (1965), Clayton (1965), Clements (1961), Dogan (1970), Shipley (1975) and Stringer (1957).

Methods and Procedures

Data utilized in this study were obtained from approximately 200 electric well logs, from scout tickets, and from several sample logs. Derrick-floor elevations were used to compute subsea elevations. Twelve correlation sections were prepared to insure accurate correlation

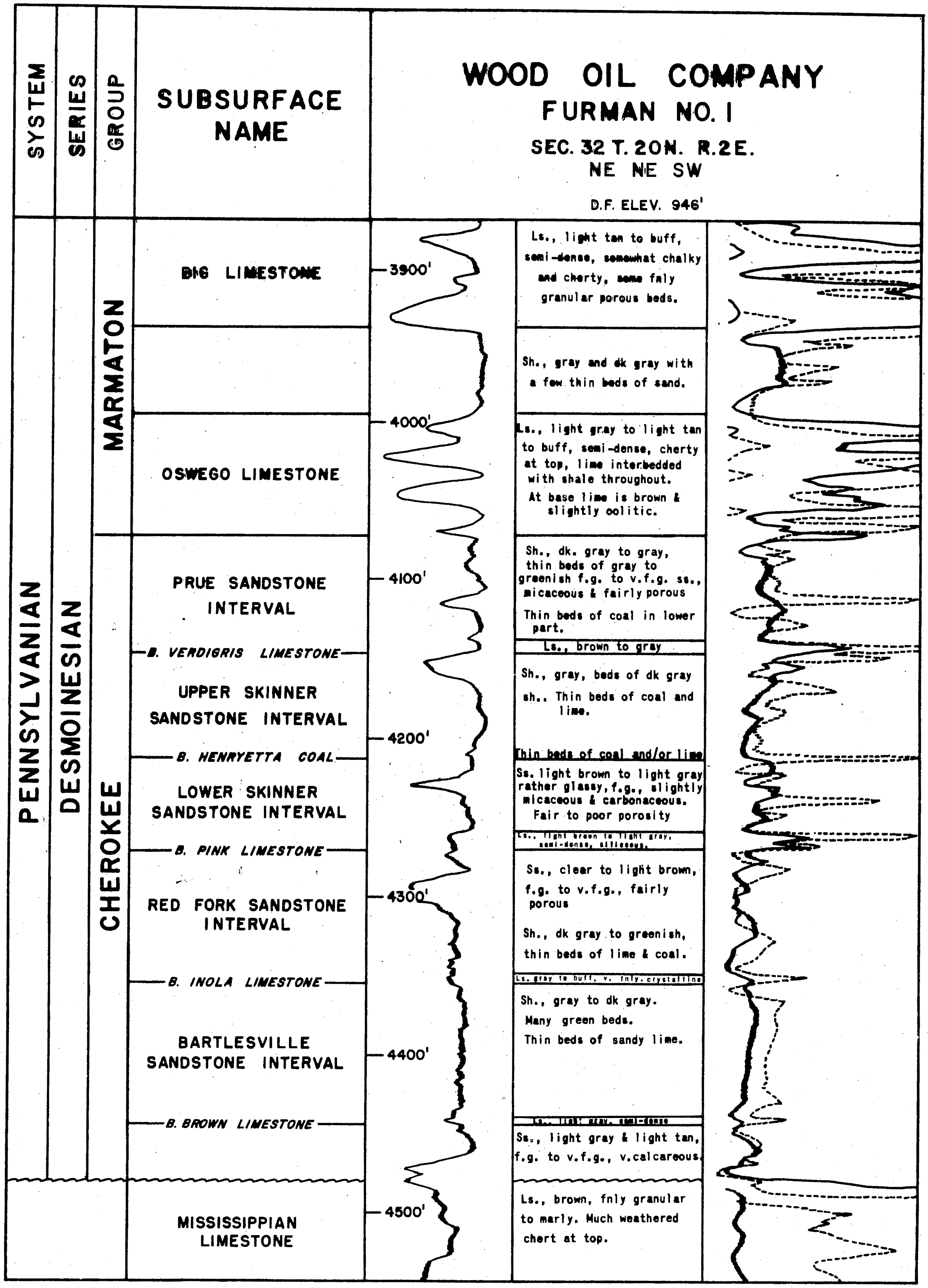


Figure 2.- Type electric and sample log.

of the stratigraphic section across the six-township area. The base of the Oswego limestone was used as the main datum. One of several limestone marker beds within the Cherokee group could have been used, but the base of the Oswego limestone was chosen because it is an extensive marker and is evidence of the end of Cherokee deposition. Seven of these correlation sections are included with this manuscript to illustrate the stratigraphy of the interval studied.

A structural contour map of the base of the Oswego limestone was used to estimate the configuration of the Cherokee group. One isopachous map was prepared that is judged to illustrate the paleotopography of the top of the Mississippian System. A second isopachous map was used to infer location of areas that may have been structurally active during deposition of the Cherokee.

Values of net sandstone thickness were recorded and isopachous maps of each of the sandstones were made. This assumption was held: any part of the SP curve of an electric log through a sand-shale interval that showed negative deflection of 20 millivolts or more was judged to record sandstone.

Representative log maps of each of four sandstone units were made to illustrate the different "log characters" of the sandstones.

Acknowledgements

Appreciation is expressed to several individuals and groups who contributed to this study. Dr. Gary F. Stewart and Dr. John W. Shelton suggested the problem and provided assistance throughout preparation of the maps and writing of the text.

I am grateful to Sun Oil Company for the use of data and drafting and reproduction facilities and to many individuals within the company for their support and encouragement. Many of the electric well logs were obtained from the Geological Information Library of Dallas and the writer appreciates the cooperation of the GILD.

Special thanks are expressed to several persons including Dr. Douglas C. Kent who served on the writer's thesis committee, fellow graduate student Mr. Dale Shipley, who provided useful advice, and Mrs. Mildred Lee, who typed the manuscript. Finally, I am indebted to my husband, Jim, for his patient but persistent prodding.

GENERAL GEOLOGY

Regional Geology

In general, the Cherokee sea covered most of northeastern Oklahoma. The sea advanced from a southerly direction and temporarily was bounded to the west by the Nemaha Ridge and to the east by the Ozark Uplift. Thus, in the study area, southeastward dipping Cherokee sediments were deposited on eroded Mississippian rocks. Total thickness of the Cherokee group ranges from 250 ft in the northwestern part of the study area to 475 ft in the southeastern part.

Past studies indicate that the Cherokee rocks are "cyclic," having been deposited during a series of transgressions and less extensive regressions. Some of the transgressions and regressions were truly regional, whereas others doubtlessly were related to accretions of deltas. The Cherokee consists mostly of shales separated by thin, persistent, presumably "time-parallel" limestone beds. Some of the limestone units extend throughout the entire study area and into the surrounding territory; they can be used as key marker beds. Locally, lenticular sandstone units are within the thick shales. In some places these sandstones are well-developed and are commercially productive of oil and gas.

Classification, Description and Distribution of Rock-stratigraphic Units

Figure 2 illustrates the Cherokee section by a type electric log and sample description. Generalized but accurate descriptions of the rock-stratigraphic units were compiled from published literature, electric logs, and sample logs. Regional correlation sections (Fig. 3, and 4-10, in pocket) were used to determine the distribution and character of the rock-stratigraphic units.[1]

Mississippian System

In the study area the Cherokee group unconformably overlies the Mississippian limestone. The Mississippian was used as the lowermost datum on the correlation sections and a brief discussion of the difficulty of correlation is appropriate.

Residual deposits, mainly of chert, accumulated on the weathered Mississippian rocks before deposition of the Cherokee group. Undoubtedly some of the chert deposits were reworked by processes attendant to deposition of Cherokee sediments. In the strict sense reworked deposits should be classified as detrital deposits of Pennsylvanian age; the chert that remained in place also could be classified as Pennsylvanian, if the end of deposition of Mississippian rocks is considered to be the end of Mississippian time. These are "academic" arguments however, because from an operational standpoint, the section of residual and

[1]Figures 4 through 10 are in the pocket, in the back of this report. A list of all well logs used in construction of correlation sections is included as the Appendix.

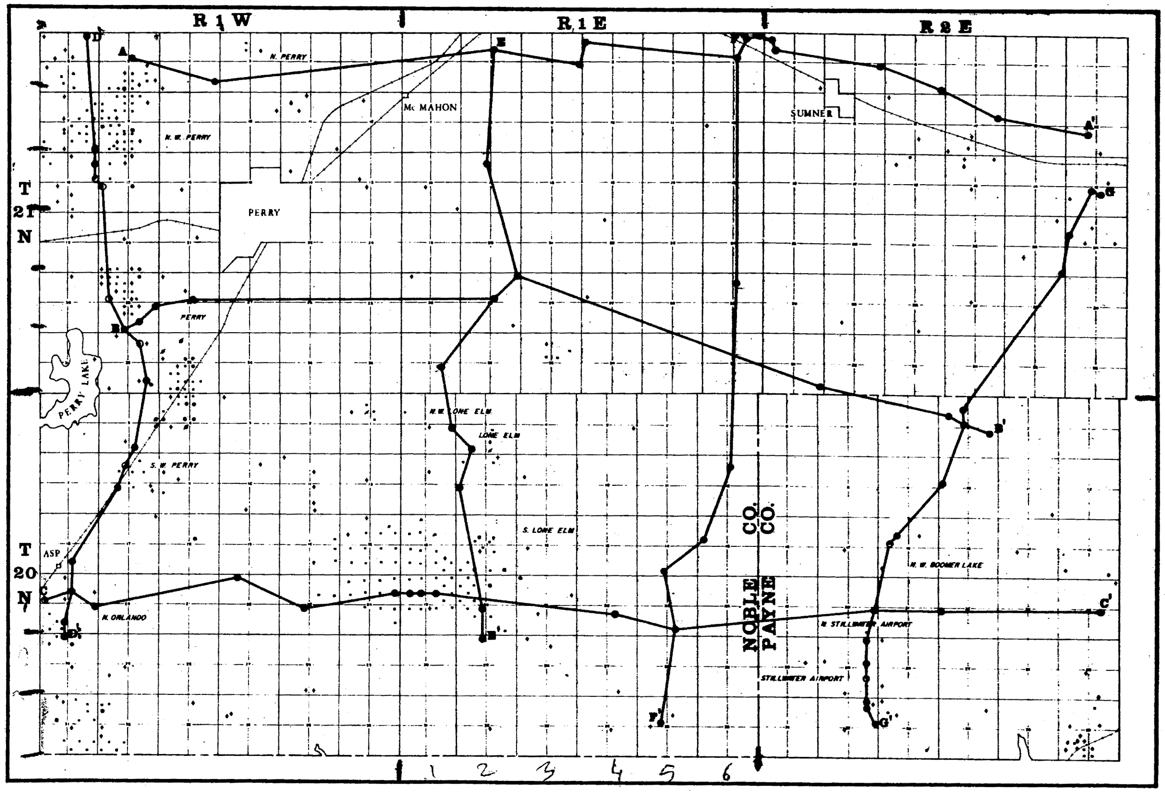


Figure 3.- Location map of correlation cross-sections.

reworked chert, known as the "Mississippi Chat" is not recognizable on every electric log, and even with the aid of well samples it is difficult to distinguish reworked chert from chert weathered in place. Therefore, for practical purposes of this thesis, this assumption was held: residual and reworked chert should show lower resistivity on electric logs than do unweathered Mississippian rocks. Thus, the top of the Mississippian was recorded at the uppermost highly resistant section recorded. I recognize that some Mississippian rocks may have been mapped as Pennsylvanian, but this error is considered to be preferable to errors that would be made in attempting to distinguish between residual and reworked chert.

Pennsylvanian System, Desmoinesian Series,
Cherokee Group, Marker Beds and Sandstones

Brown limestone.- The Brown limestone, which is about 5 ft thick, is generally recognizable in the eastern two-thirds of the study area. It is used in the thesis primarily to illustrate the onlap of the Cherokee group onto the Mississippian. Figure 11 shows the generalized western limit of the Brown limestone. The onlap relationship may be observed on the regional correlation sections. For illustration see correlation section A-A' (Fig. 5, in pocket), wells numbered 2 and 3, and correlation section B-B' (Fig. 5, in pocket), wells numbered 4 and 5.

Inola Limestone.- The Inola Limestone generally is gray to buff, very finely crystalline limestone, and is approximately 5 ft thick. It lies 80 to 100 ft above the Brown limestone. The interval between

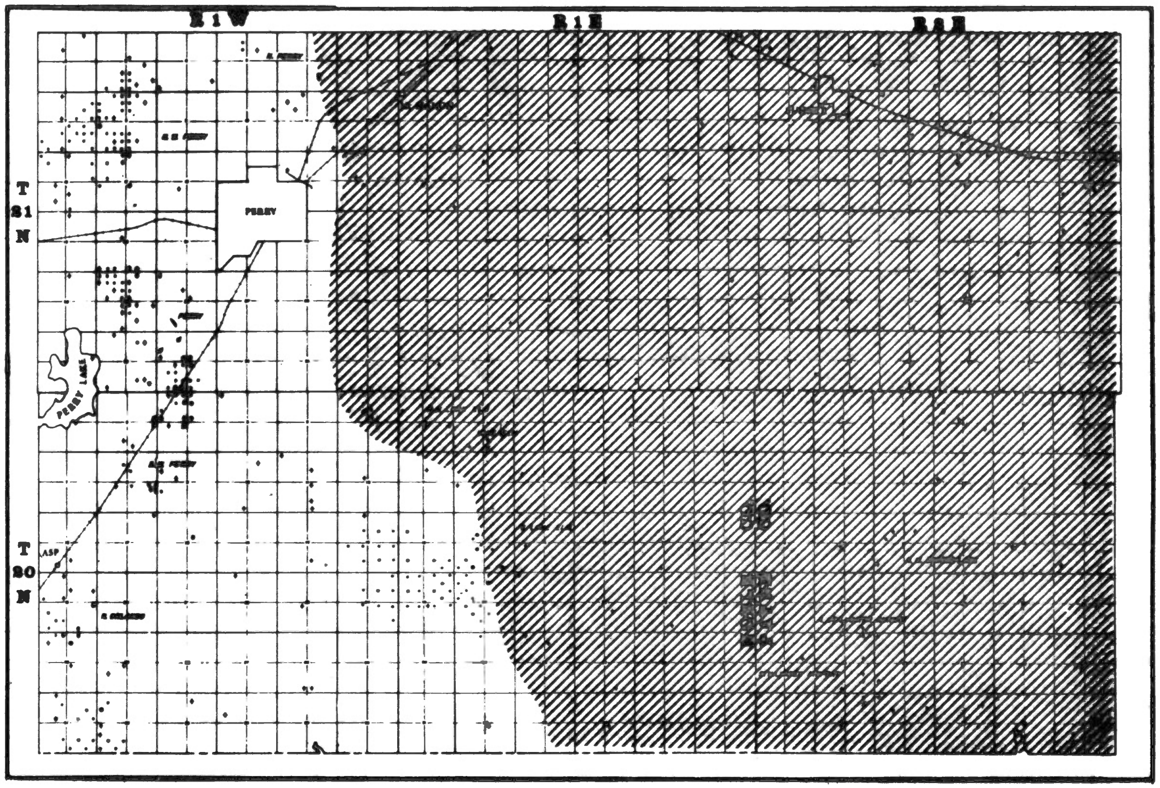


Figure 11.- Generalized western limits of the Brown limestone.

the top of the Mississippian limestone and the Inola Limestone thins from about 180 ft in the southeastern part of the study area to about 50 ft in the northwestern part, indicating onlap of the Cherokee onto the Mississippian. The most apparent east-to-west thinning is illustrated on correlation sections B-B' (Fig. 5) and C-C' (Fig. 6); south-to-north thinning is shown on correlation section F-F' (Fig. 9). Other transgressive-regressive couplets of the Cherokee thin in similar fashion, but in the study area, the Inola and Brown limestones best illustrate onlap of the Cherokee group.

In some parts of the thesis area the Inola Limestone is not discernible on electric logs; the Inola is less extensive in the study area than other limestone marker beds discussed herein. Figure 12 shows the distribution of the Inola limestone. Note especially the absence of the Inola in the northeastern part of the study area.

Red Fork sandstone interval.- At most places, rocks of the Red Fork interval consist of gray or dark gray to greenish gray, micaceous shale containing little or no sandstone. Where present, sandstone is "colorless" to light brown, fine- to very-fine-grained, moderately porous, micaceous, and as thick as 30 feet. The Red Fork sandstone commonly lies 10 to 30 ft below the Pink limestone (Fig. 2) but is not consistent in stratigraphic position from place to place. Well 14, section A-A' (Fig. 4) shows the Red Fork sandstone interval at a locality where it contains sandstone.

Pink limestone.- The Pink limestone (Fig. 2) is an extensive, light brown to light gray, somewhat compact, siliceous limestone

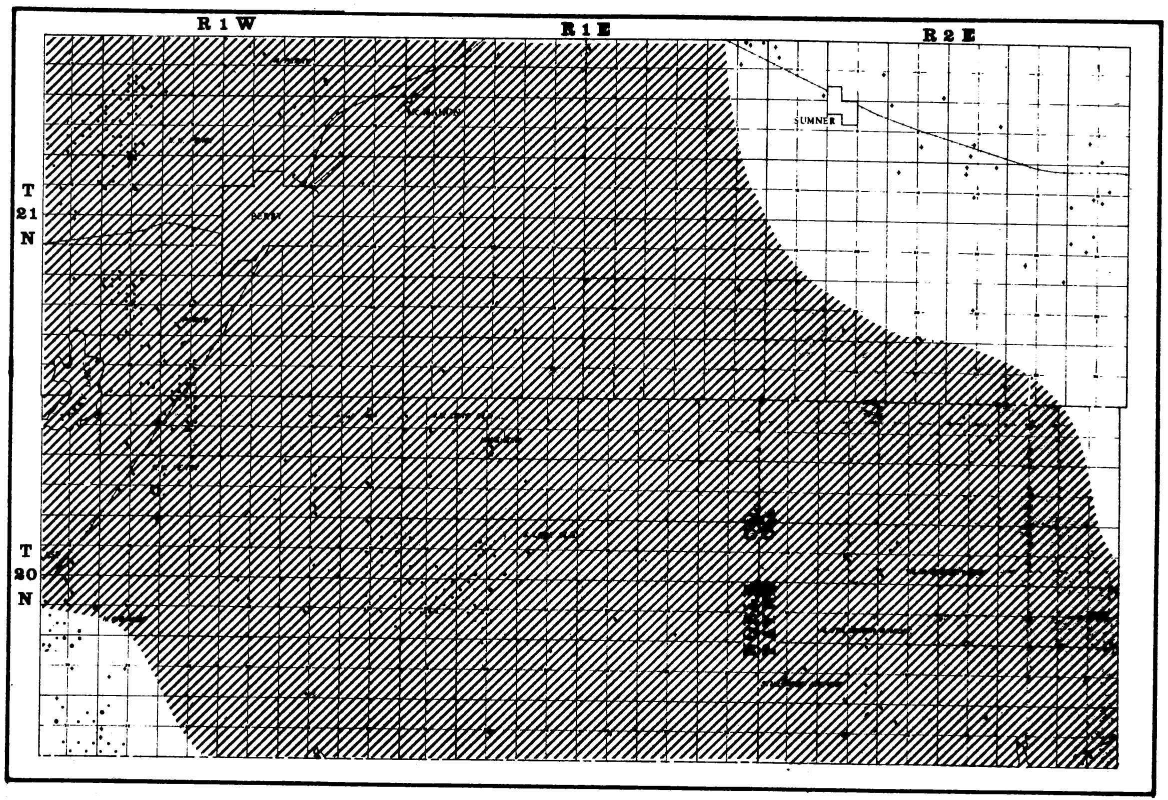


Figure 12.- Distribution map of the Inola Limestone.

approximately 10 ft thick. The Pink lies 50 to 90 ft above the Inola Limestone and is continuous over the entire study area.

Lower Skinner sandstone interval.- At most places, sandstone of the Lower Skinner interval is light gray to white, fine-grained to very-fine-grained, micaceous, generally "tight," but porous and permeable in some wells. Locally, the sandstone is carbonaceous and calcareous. Shale of the Lower Skinner is dark gray and micaceous with thin beds of green shale and of coal. The Lower Skinner sandstone is present in most wells examined in the thesis area and is commonly "broken" by beds of shale. The gross sandstone thickness is as much as 35 feet. The sandstone generally is 70 to 80 ft below the Verdigris Limestone and only a few feet above the Pink limestone.

Henryetta coal.- In this area of central Oklahoma the Henryetta coal is a consistent and reliable marker separating the Upper and Lower Skinner sandstone intervals. The Henryetta coal is distinguished readily on most electric logs by exceptionally large resistivity shown on the lateral curve.

Upper Skinner sandstone interval.- The Upper Skinner interval predominantly is gray to dark gray or black micaceous shale with thin beds of coal. A few lenticular sandstones occur in the eastern one-third of the study area. The sandstone is white to gray, glassy, fine-grained, calcareous, micaceous, fairly porous to "tight" and carbonaceous locally. The unit generally is less than 15 ft thick and is approximately 10 ft below the Verdigris Limestone. Well 5 of correlation section F-F' (Fig. 9) shows sandstone in the Upper Skinner interval.

Verdigris Limestone.- The Verdigris Limestone is the uppermost limestone marker bed in the Cherokee group; it is approximately 90 to 140 ft above the Pink limestone and 50 to 70 ft below the Oswego limestone. The Verdigris is buff to light brown, finely crystalline to granular, generally about 10 ft thick and extends throughout the thesis area.

Prue sandstone interval.- The Prue sandstone interval consists of gray to dark gray shale interbedded with thin beds of coal, siltstones and discontinuous beds of sandstone. The sandstone is white, glassy, fine-grained, micaceous, calcareous, "tight" and generally is less than 10 ft thick. Beds of sandstone are at various stratigraphic positions within the interval, but mostly are about 10 to 20 ft below the base of the Oswego limestone.

The top of the Prue sandstone interval is the top of the Cherokee group. The overlying Oswego limestone is part of the Marmaton Group and consists mostly of thick interbedded shales and limestones.

Paleotopography and Paleostructure

Paleotopography

Two isopachous maps were constructed as a means to estimate the extent to which paleotopography of Mississippian rocks and structural movement during deposition of the Cherokee affected deposition of the Cherokee group.

Paleotopography developed on the Mississippian limestone can be approximated by contouring thickness of the interval between the top of the Mississippian and a limestone marker bed a short distance above this unconformity. The rationale of this method is based on these assumptions: (a) the Cherokee marker bed was deposited in a position that for all practical purposes was horizontal; (b) rocks below the marker bed should have thinned depositionally above paleotopographic "highs" and thickened into paleotopographic "lows;" and therefore (c) an isopachous map of rocks of such an interval should indicate paleotopography.

In the study area, the Pink limestone is the consistent marker nearest above the Mississippian limestone. The Mississippian paleotopographic surface has been approximated by mapping the thickness of the interval between the base of the Pink and the top of the Mississippian (Pl. 1). Thickness of the interval ranges from 100 ft in the western part of the study area to more than 300 ft in the eastern part. The greatest local relief is near the northeastern corner of the study area (Pl. 1).

Plate 1 indicates that a southeast-trending drainage system developed on the Mississippian surface, and that two major streams crossed the study area. One of the major streams apparently entered the western part of the study area near the boundary between T. 20 and 21 N., and flowed southeasterly. This presumed stream and its tributaries extended across most of T. 20 N., R. 1 E. and R. 2 E. Areas of thin Pink lime-to-Mississippian interval are shown near the corners of the study area. The thinnest areas suggest two broad, gentle paleodrainage divides in the northwestern and southwestern corners of the study area. In the northeastern corner Plate 1 shows more than 80 ft of local relief, with the highest part centered in Sec. 14, T. 21 N., R. 2 E. A small isolated topographic "high" occurs in the southeastern part of the study area in Sec. 33, T. 20 N., R. 2 E.

Paleostructure

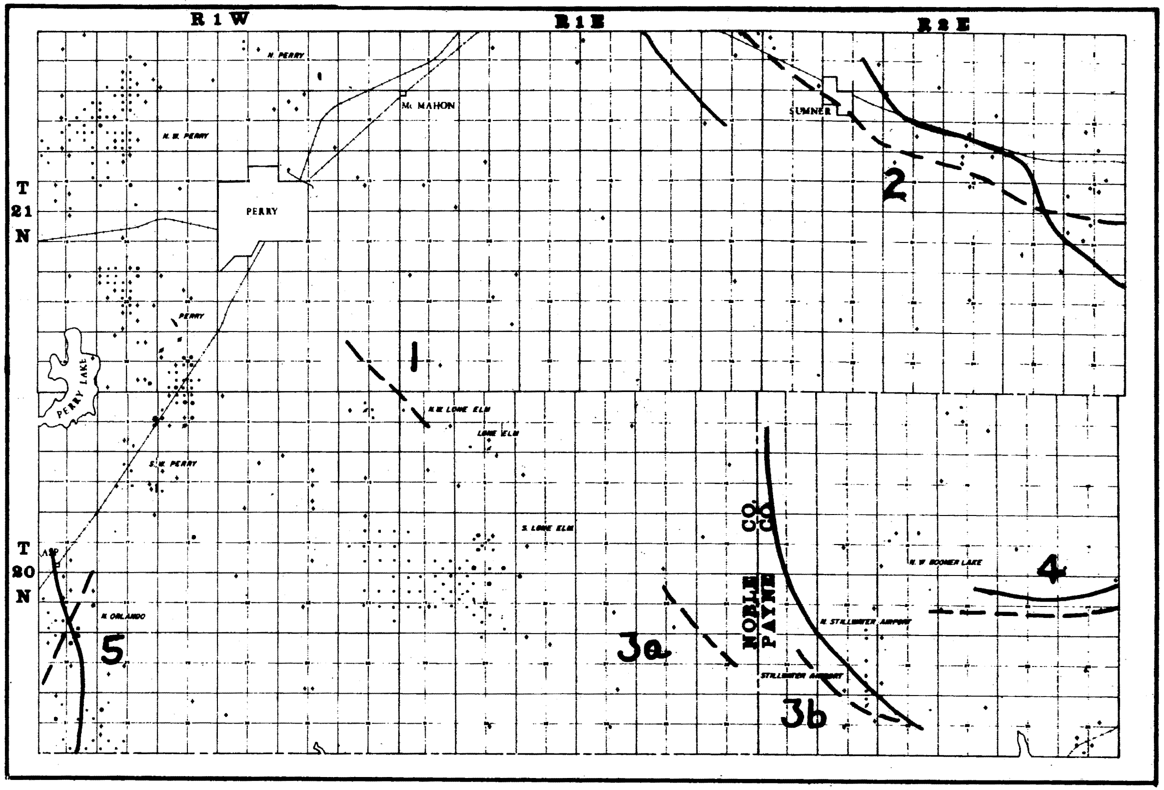
Thickness of a stratigraphic interval between two marker beds can be mapped to infer possible paleostructural movement. An isopachous map of the interval between the base of the Oswego limestone and the base of the Pink limestone was constructed as a means to estimate to what extent, if any, structural movement influenced thickness of this part of the Cherokee group (Pl. 2). Possible structural factors include differential compaction, folding due to differential movement of rocks older than those of the interval mapped, or to some combination of the two. Differential compaction of sediments on existing topographic or structural highs would result in an accentuation of these features; for example, thick deposits of mud in topographically low areas compact more (in terms of feet) than do thinner deposits over high area.

The "paleostructure" map shows several thin or thick northwest-trending patterns that seem to be anomalous. The interval mapped ranges from less than 150 ft thick in the western part of the study area to more than 220 ft in the eastern part (Pl. 2). Anomalously thin rocks trend from (a) Sec. 1, T. 21 N., R. 1 E., to Sec. 25, T. 21 N., R. 2 E.; (b) Sec. 36, T. 21 N., R. 1 W., to Sec. 7, T. 20 N., R. 1 E.; and (c) Sec. 23, T. 20 N., R. 1 E., to Sec. 33, T. 20 N., R. 2 E. Likewise, in several areas rocks of the interval are exceptionally thick. These areas include (a) Sec. 33, T. 21 N., R. 1 W., to Sec. 19, T. 20 N., R. 1 E.; (b) Sec. 11, T. 21 N., R. 1 W., to Sec. 30, T. 21 N., R. 1 E.; and (c) Sec. 10, T. 20 N., R. 2 E., to Sec. 12, T. 20 N.,

R. 2 E. The paleostructure map shows an exceptionally thin interval in the southwesternmost part of T. 20 N., R. 1 W.; the thinning probably is the result of movement, during deposition, of the upthrown side of a fault at North Orlando Field.

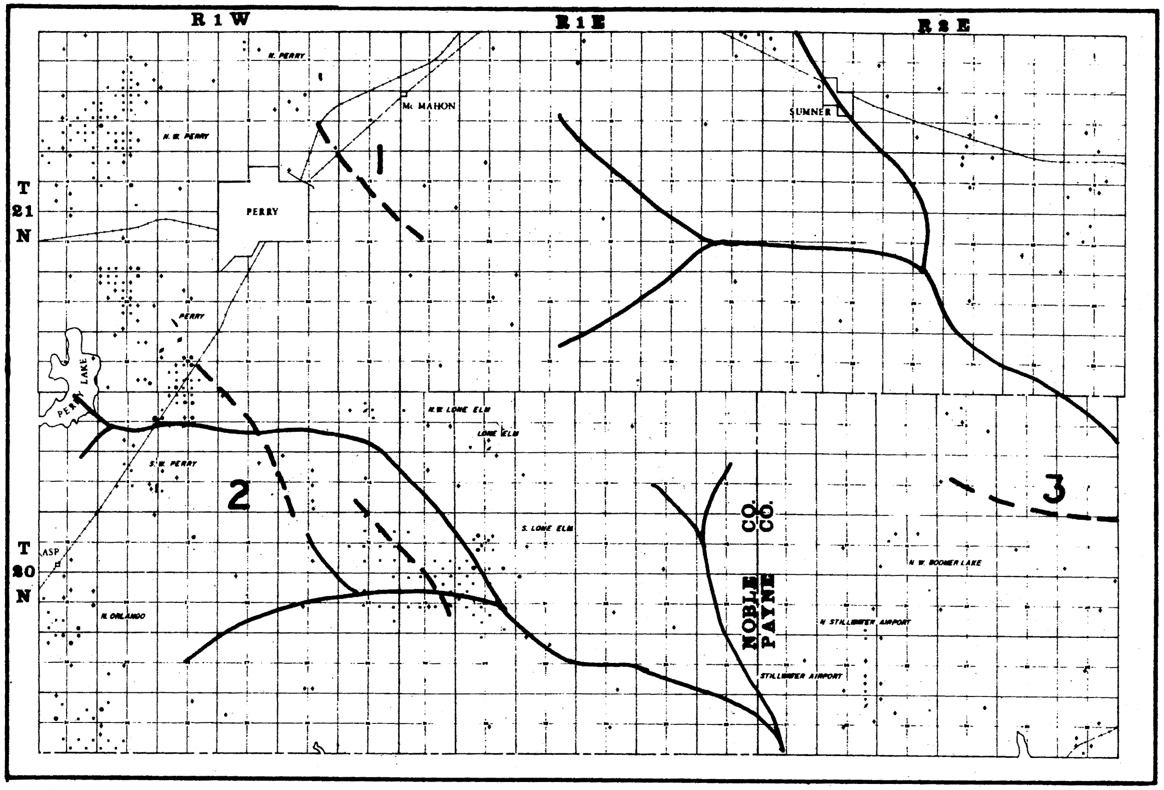
Figures 13 and 14 show relative locations of positive paleostructural features and paleotopographic "highs," and negative paleostructural features and paleotopographic "lows," respectively. My interpretation of these maps is conservative; namely, paleostructural trends that are located near paleotopographic trends and that show similar orientation are assumed to show effects of (a) structural movement due to deformation of rocks older than the interval mapped, or (b) differential compaction of rocks within the interval mapped due to variation in kinds of sediment, or (c) differential compaction of rocks within the interval mapped, owing to paleotopographic "highs" and "lows," or (d) some combination of (a), (b) and (c). The information available to me does not permit sufficient testing of these hypotheses. However, paleostructural trends that are not located near paleotopographic trends are considered to show effects of either differential compaction of rocks within the interval mapped, or actual deformation of these rocks due to differential movements of rocks older than the Pink limestone (probably Mississippian and older).

Figure 13 shows that trend 1 is a positive paleostructural feature that is not indicated on the paleotopographic map; this suggests that the feature is due to structural movement. The paleotopographic "high" and positive paleostructural trend located near the northeastern corner (trend 2) are clearly apparent on both isopachous maps. This fact indicates probable structural movement along a paleotopographic feature.



Paleotopographic Trend — Paleostructural Trend

Figure 13.- Paleotopographic and paleostructural trends inferred from areas where rocks of the Mississippian limestone-Pink limestone interval and the Pink limestone-Oswego limestone interval, respectively, are anomalously thin.



——— Paleotopographic Trend   — — — — Paleostructural Trend

Figure 14.- Paleotopographic and paleostructural trends, inferred from areas where rocks of the Mississippian limestone-Pink limestone interval and the Pink limestone-Oswego limestone interval, respectively, are anomalously thick.

Paleostructural trend 3b probably is a continuation of trend 3a; these probably are associated with a paleotopographic "high," thus implying occurrence of depositional thinning, differential compaction, and (or) structural movement. Trend 4 is a broad positive feature probably related to underlying topography and structural movement, perhaps coupled with differential compaction and depositional thinning. Trend 5 indicates a relationship of structural movement with paleotopography; the confirmed existence of a major fault in the area (Pl. 3, this report, and Page, 1955) suggests that actual structural movement of Mississippian and older rocks was a controlling factor during time of deposition of the Cherokee.

Figure 14 shows that trend 1 is a relatively prominent negative feature not associated with paleotopography, and judged therefore probably to be due to local structural movement. Trend 2 is a long negative feature roughly corresponding to a paleotopographic depression, indicating differential compaction and possibly structural movement. Trend 3 is a prominent negative feature not directly related to paleotopography, and therefore suggestive of structural movement as the controlling factor.

STRUCTURAL GEOLOGY

The study area is in the west-central portion of the Northeastern Oklahoma Platform, approximately 20 mi east of the Nemaha Ridge. Other regional tectonic provinces that border the Northeastern Oklahoma Platform include the Ozark Uplift to the northeast, the Arkoma Basin to the southeast and the Hunton Arch to the south.

A structural contour map was prepared with the base of the Oswego limestone (i.e. the top of the Cherokee group) as datum (Pl. 3). Regional strike is north-northwest and the dip is west-southwest except where interrupted locally by folds or faults. Dip is not uniform over the study area; it varies from about 60 to about 70 ft per mi in the eastern two-thirds (T. 20 and 21 N., R. 1 and 2 E.) of the area to about 20 to 40 ft per mi in many parts of the western one-third.

Several positive structural features interrupt the essentially homoclinal surface of the base of the Oswego limestone in the eastern two-thirds of the study area. A prominent northwest-trending nose extends across the northern one-half of T. 21 N., R. 2 E., but the only structural feature shown as closure at the contour interval of 20 ft is a small north-trending anticline with approximately 40 ft of closure at Stillwater Airport Field in Sec. 28, 29, 32 and 33, T. 20 N., R. 2 E. (Pl. 3). A small but prominent southwest-trending nose is associated with the Lone Elm Field in Sec. 5 and 6, T. 20 N., R. 1 E. A broad, gentle, west-plunging nose is west of the town of McMahon, trending through Sec. 2 and 11, T. 21 N., R. 1 W. (Pl. 3).

The western one-third of the study area is structurally more complex and thus markedly different from the eastern two-thirds. The largest anticlinal feature is associated with the Perry and Southwest Perry Fields, centered in Sec. 29, T. 21 N., R. 1 W. (Pl. 3). This structure is irregular in outline, trends north-northwest, covers approximately 7 sq mi, and shows more than 40 ft of closure at the base of the Oswego limestone. A very prominent nose extends southward from the Perry anticlinal structure toward the broad synclinal structure mapped in the southernmost part of T. 20 N., R. 1 W. Another nose southwest of the Perry anticlinal structure (Sec. 30, T. 20 N., R. 1 W.) plunges toward the same synclinal area (Pl. 3).

North of the larger Perry structure is a smaller but well-developed anticline. This fold trends northeastward, covers approximately 3 sq mi, has about 40 ft of closure, and is steeper on the eastern flank. It is associated with the Northwest Perry Field and is centered in Sec. 5 and 8, T. 21 N., R. 1 W. (Pl. 3). Published maps and reports indicate that closure of these structures increases with depth (Clayton, 1965; Page, 1955).

In the extreme southwestern part of T. 20 N., R. 1 W. a major normal fault, probably a normal fault, seems to trend northeastward and to be down-to-the-northwest (Pl. 3). The data available indicate that at the base of the Oswego limestone, strata are displaced more than 40 ft at some localities. The structural contour map (Pl. 3) also indicates that the fault cuts the southwestern flank of the Perry anticline. Two smaller faults that are associated with the major fault are mapped in Sec. 5, T. 20 N., R. 1 W. and Sec. 19, T. 20 N., R. 1 W.

INFERRED DEPOSITIONAL ENVIRONMENTS AND TRENDS OF SANDSTONE UNITS

Depositional environments and trends of Cherokee sandstone units have been inferred after careful examination of all data available. Included in addition to the data already discussed are a log map and an isopach map of net sandstone in each of the sandstone units.

The shape of the SP curve of an electric log is indicative of the vertical sequence of the textures and lithologies of depositional units (Visher and others, 1971; Shelton, 1973). Each pattern is suggestive of a particular environment or subenvironment. On a regional scale the construction of a log map enables one to group "like" log shapes, thus outlining the limits of presumed different paleodepositional environments. Log maps of selected areas have been constructed to illustrate shapes of the SP curve for each sandstone unit (Pl. 5, 7, 9, and 11).

Red Fork Sandstone

The net-sandstone thickness map of the Red Fork (Pl. 4) indicates that sandstone of the Red Fork interval primarily is in the southern one-half of the thesis area. The thickest units are in the southeastern part; thinner deposits are in the southwestern part, at Orlando North Field and the Lone Elm Fields.

The typical Red Fork sandstone interval, illustrated in Plate 5, consists predominantly of shale that contains siltstone and sandstone locally. Except in a few isolated wells, sandstone is in about the same stratigraphic position, only a few feet below the Pink limestone. The net-sandstone thickness map (Pl. 4) indicates that most of the sandstone units trend northward. The SP curve in this interval is slightly "funnel-shaped," implying a gradational base and sharp to gradational top. This evidence suggests that the sandstone is a coarser-upward non-channel, regressive unit. This thin, fine-grained to very fine-grained sandstone probably represents interdistributary deposits of a lower deltaic plain.

An isolated body of Red Fork sandstone occurs east of Sumner, in Sec. 9-13, T. 21 N., R. 2 E. Shapes of SP curves indicate that this sandstone probably is composed of minor distributary channel deposits. The SP curve shows evidence of a sandstone unit, 10 to 20 ft thick, with the sharp basal contact and gradational upper contact that is indicative of the finer-upward channel-fill deposits. A second deposit of this type is shown in Sec. 33-36, T. 20 N., R. 2 E. The east-west orientation of these two channel-like deposits suggests the hypothesis that they may be crevasse splays that originated from a north-trending distributary, which was located a short distance east of the study area (Cole, 1969).

The three wells that show the log shape judged to be characteristic of channel deposits are located in Sec. 33, T. 20 N., R. 2 E., Sec. 36, T. 20 N., R. 2 E., and in Sec. 12, T. 21 N., R. 2 E. The electric log of the third well is log number 14 on correlation section A-A' (Fig. 4).

The data available suggest that in the study area the Red Fork sandstone is a lower deltaic-plain facies with interdistributary fine-grained sandstones and minor distributary channel or crevasse splay deposits.

Lower Skinner Sandstone

The net-sandstone thickness map of the Lower Skinner sandstone (Pl. 6) indicates that the sandstone extends across most of the study area. The Lower Skinner is the only Cherokee sandstone unit in the northwestern and north-central parts of the study area. Net sandstone is more than 20 ft thick in the Lone Elm Field, and locally is more than 30 ft thick. The northern one-half of T. 20 N., R. 2 E. and the southern part of T. 21 N., R. 2 E. are shown to include Lower Skinner sandstone thicker than 20 feet. A Lower Skinner channel-fill deposit is present in Sec. 36, T. 20 N., R. 2 E. Sandstones in this area are approximately 20 ft thick. Plate 7 shows probable channel-fill sandstones in Sec. 1, 13 and 24, T. 20 N., R. 1 W. and Sec. 20, 28 and 29, T. 20 N., R. 1 E. In the north-central, southwestern and southeastern parts of the study area, sandstone in the Lower Skinner interval is thin. At some places the Lower Skinner contains no sandstone (Pl. 6).

In most parts of the study area the Lower Skinner sandstone interval contains three thin sandstone units. This combination of sandstone units is illustrated on the selected log map of the Lower Skinner sandstone interval (Pl. 7). The lowermost of these sandstone units is the most consistent; it is sheet-like and extends over almost all of the thesis area. It is absent only in a few of the wells examined, all of which are near either the southeastern or the northeastern corner of the study area (Pl. 7). At many places a second sandstone unit is approximately 10 ft above the lowermost sandstone and at a few places a third sandstone is developed higher in the interval. At some localities the middle and upper sandstones form one unit.

A survey of all the electric logs, combined with a grading system on a work map, pinpointed the locations and distributions of the three Lower Skinner sandstone strata. This map showed that (1) where one sandstone is present the net-sandstone thickness is less than 10 feet; (2) where two sandstones are present the net sandstone thickness ranges from 10 to 20 feet; (3) where three sandstones are present the net sandstone thickness is more than 20 ft, on the average; (4) the area where all three sandstones are present is the northern one-half of T. 20 N., R. 2 E.; (5) the lowermost unit extends almost throughout the entire study area; (6) the middle unit is present in most of the western two-thirds of the study area; and (7) the upper sandstone unit generally is limited to the northwestern part, but is developed locally in the northeastern part.[1] These generalizations simply indicate that the individual sandstone units are "constant" in thickness and that the variations shown on the net-sandstone thickness map of the Lower Skinner sandstone interval are reflective of the presence or absence of entire sandstone units.

Throughout the area most of the Lower Skinner sandstones are thin, fine-grained sandstones with gradational upper and lower contacts. The sheet-like lower sandstone unit may be associated with a delta-fringe environment. Another possible depositional environment is interdistributary bays in a lower deltaic plain.

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[1]This map is on open file at the Department of Geology, Oklahoma State University.

Upper Skinner Sandstone

The net-sandstone thickness map of the Upper Skinner sandstone interval (Pl. 8) indicates that within this interval, sandstone is limited to the southeastern one-half of the thesis area. Upper Skinner sandstone is in all of T. 20 N., R. 2 E., in the eastern one-quarter of T. 20 N., R. 1 E. with an extension into the Lone Elm Field area, and in the eastern one-quarter of T. 21 N., R. 2 E. Within this area of sandstone development there is a notable absence of sandstone in the southwestern part of T. 20 N., R. 2 E., in the area near Stillwater Airport Field.

The log map of the Upper Skinner interval (Pl. 9) shows that the sandstone generally is a few feet below the Verdigris Limestone. Within the thesis area, Upper Skinner sandstone is at a lower stratigraphic position in only two wells. These wells are in Sec. 25, T. 20 N., R. 2 E. and Sec. 10, T. 21 N., R. 2 E. The sandstone is developed best in the northern one-half of T. 20 N., R. 2 E. Distribution and orientation of the sandstone indicate transportation probably from the east or northeast, and the general pattern of the SP curve indicates that the thin sandstone unit has a gradational basal contact and a sharp to gradational upper contact (Cole, 1969).

Examination of all the logs available indicates that only one well shows development of a probable channel-fill sandstone. This well is located in Sec. 13, T. 20 N., R. 1 E. and is well number 5 on correlation section F-F' (Fig. 9). The typical sharp basal contact and gradational upper contact are indicated by the SP curve. The net-sandstone thickness map suggests that the probable channel deposit is oriented generally in a northerly direction.

The information available implies that the Upper Skinner sandstone is of lower deltaic-plain origin, consisting of interdistributary sandstones and siltstones, and minor distributary channel sandstones. The accumulation at Lone Elm South Field may be a crevasse splay deposit.

Prue Sandstone

Of the Cherokee sandstones within the study area, the Prue sandstone is smallest in areal extent. The net-sandstone thickness map (Pl. 10) indicates only four localized deposits, all in the eastern one-half of the study area. All of these deposits are thinner than 20 ft except in one well, in Sec. 36, T. 20 N., R. 2 E. The westernmost accumulation occurs in the Lone Elm South Field area. The largest area of Prue sandstone extends from Sec. 34, T. 20 N., R. 1 E. to Sec. 3, T. 20 N., R. 2 E. trending northeasterly, generally along the Noble County-Payne County line. A small deposit in the southeastern corner of the thesis area, in Sec. 36, T. 20 N., R. 2 E., thickens southward. The fourth deposit is in Sec. 13 and 14, T. 21 N., R. 2 E. and trends eastward. The orientation and distribution of the accumulations indicate that the source area probably was northeast of the study area (Cole, 1969).

Detailed study of the electric logs suggests that in many of the wells in T. 20 N. and T. 21 N., R. 2 E., the Prue interval contains siltstones; in general, siltstone is present only locally in the western two-thirds of the study area. None of the electric logs examined shows the characteristic SP pattern of a channel-fill deposit. The SP curve indicates that the Prue sandstone is a thin, non-channel, regressive unit with a gradational basal contact and graditional to sharp upper contact.

The electric logs also indicate that the sandstone is developed at two positions within the Prue interval. The upper sandstone unit is only in the southeastern part of the study area, in the eastern one-half of T. 20 N., R. 2 E. The lower unit is more widespread; it makes up the entire thickness of all other deposits shown on the net-sandstone thickness map.

The representative log map (Pl. 11) illustrates the typical Prue sandstone and siltstone interval. The data imply that the Prue sandstone is a lower deltaic-plain facies, with fine-grained sandstones and siltstones suggestive of an interdistributary environment.

General Trends

In the northwestern portion of the study area, the only interval that contains sandstone is the Lower Skinner sandstone interval. This sandstone is sheet-like and covers the entire northwestern area. The sandstone is more than 10 ft thick in the western one-half of T. 21 N., R. 1 W. Also, one small "pod" of Red Fork sandstone is developed in Sec. 18, T. 21 N., R. 1 W. In the north-central part of the study area, the only sandstone developed also is the Lower Skinner sheet sandstone. In both areas, no obvious relationship appears to exist between sandstone accumulations and paleotopography or paleostructure.

Red Fork, Lower Skinner, Upper Skinner and Prue sandstones are all present in the eastern one-half of T. 21 N., R. 2 E., southeast of the town of Sumner. The Red Fork sandstone is a minor distributary channel or crevasse deposit. There appears to be no direct relationship between the Red Fork deposit and paleotopography of the Mississippian limestone, as the Red Fork sandstone appears to be sub-parallel to a paleotopographic "high." The Upper Skinner and Prue sandstones show the same general distribution as the Red Fork sandstone. However, the Lower Skinner sandstone is absent or very thin over the paleotopographic "high" Trend 2 as shown on the map illustrating relationships between paleotopographic high and paleostructural positive trends (Fig. 13). Trend 2 may have been positive enough during deposition of the Cherokee that sand being brought from the northeast did not cross the "high," but was deposited on its northern side. Deposition of the Lower Skinner sheet sandstone was extensive enough to surround this barrier.

The southwestern part of the thesis area, like the northwestern part, includes only the Lower Skinner sandstone and minor Red Fork deposits. Both units are thickest in Sec. 19 and 30, T. 20 N., R. 1 W; they thin eastward in T. 20 N., R. 1 W.

The area near Lone Elm Field (T. 20 N., R. 1 W. and 1 E.) includes the maximal amount of Cherokee sandstone. Within each of the intervals sandstones are relatively thick, and are oriented in a northwesterly direction. The map illustrating negative paleotopographic and paleostructural trends (Fig. 14) indicates that a paleotopographic "low" and a paleostructural negative feature (Trend 2) were in the same position and were oriented similar to the sandstone accumulations. This suggests local influence of paleostructure and paleotopography on accumulation of sand during deposition of the Cherokee group.

All of the sandstone units also are present along the Noble County-Payne County line between T. 20 N., R. 1 E. and T. 20 N., R. 2 E. The only Upper Skinner distributary channel-fill sandstone is in Sec. 13,

T. 20 N., R. 1 E. and is oriented north-south, sub-parallel to a paleotopographic "low" (Fig. 14). The other sandstones, although not channel deposits, appear to have accumulated in this topographically low area.

A paleotopographic "low" and paleostructural negative feature (Trend 3, Fig. 14) are mapped in the northern one-half of T. 20 N., R. 2 E. The Lower Skinner sheet sandstone is thickest and best developed in this area. The Upper Skinner and Red Fork sandstones also are well developed locally. The Prue sandstone is not in all of the wells in this area but the Prue interval is very silty.

In the southeastern part of the thesis area, specifically the southern one-half of T. 20 N., R. 2 E., sandstones are notably absent south and east of Stillwater Airport Field in Sec. 28, 29, 32 and 33, T. 20 N., R. 2 E. This area corresponds to Trend 3b on the map illustrating paleo-positive trends (Fig. 13), indicating that the paleotopographic "high" and paleostructural positive feature probably were related to the lack of deposition of sand in this area. The Red Fork sandstone does not follow this trend precisely, as the net-sandstone thickness map (Pl. 4) and electric logs indicate a distributary channel or crevasse deposit extending from Sec. 36, T. 20 N., R. 2 E. to Sec. 33, T. 20 N., R. 2 E. Perhaps the positive feature was a barrier that limited westward extension of the Red Fork deposit.

The extreme southeastern corner of the thesis area as mapped on the paleotopographic map (Pl. 1) indicates the presence of a minor paleotopographic "low." There is evidence of a north-trending Lower Skinner channel deposit in Sec. 36, T. 20 N., R. 2 E. The Red Fork, Upper Skinner and Prue net-sandstone thickness maps also indicate a buildup of sandstone in Sec. 36, T. 20 N., R. 2 E. These sandstones extend south of the thesis area (Shipley, 1975).

PETROLEUM GEOLOGY

The first production established in the thesis area was at Perry Field in 1922. The second commercial discovery was at Orlando Field in 1929. Both of these fields are still producing but neither field has produced from the Cherokee sandstones. The most recent significant discovery in the thesis area was in September 1969 when production was established at Lone Elm North Field. Figure 15 shows the locations, discovery dates and producing intervals of fields in the thesis area. Production ranges from 2400 to 5200 ft in depth and from Ordovician ("Wilcox" sand) to Pennsylvanian ("Sams" sand) in age (Table 1).

The most recent production figures available indicate that cumulative production to 1 January 1974 was 16,401,935 bbls of oil and 8,727,174 MCF of gas; 225,863 bbls of oil and 453,477 MCF of gas were produced in 1973. The Perry Fields account for almost all of the gas and most of the oil. Production records to 1 January 1974 show that Orlando (including Orlando North), Stillwater North, Lone Elm North, Lone Elm Northwest, Lone Elm South, Perry, Perry Northwest, and Perry Southwest are the only fields still producing.

Cherokee sandstones have produced hydrocarbons in only three fields. Production from the Lower Skinner sandstone was discovered at Perry Southeast Field in 1955 and at Perry Southwest Field in 1956. Both of these fields also produce from other units. The Stillwater North Field was discovered in 1955; it produces from the Lower Skinner sandstone.

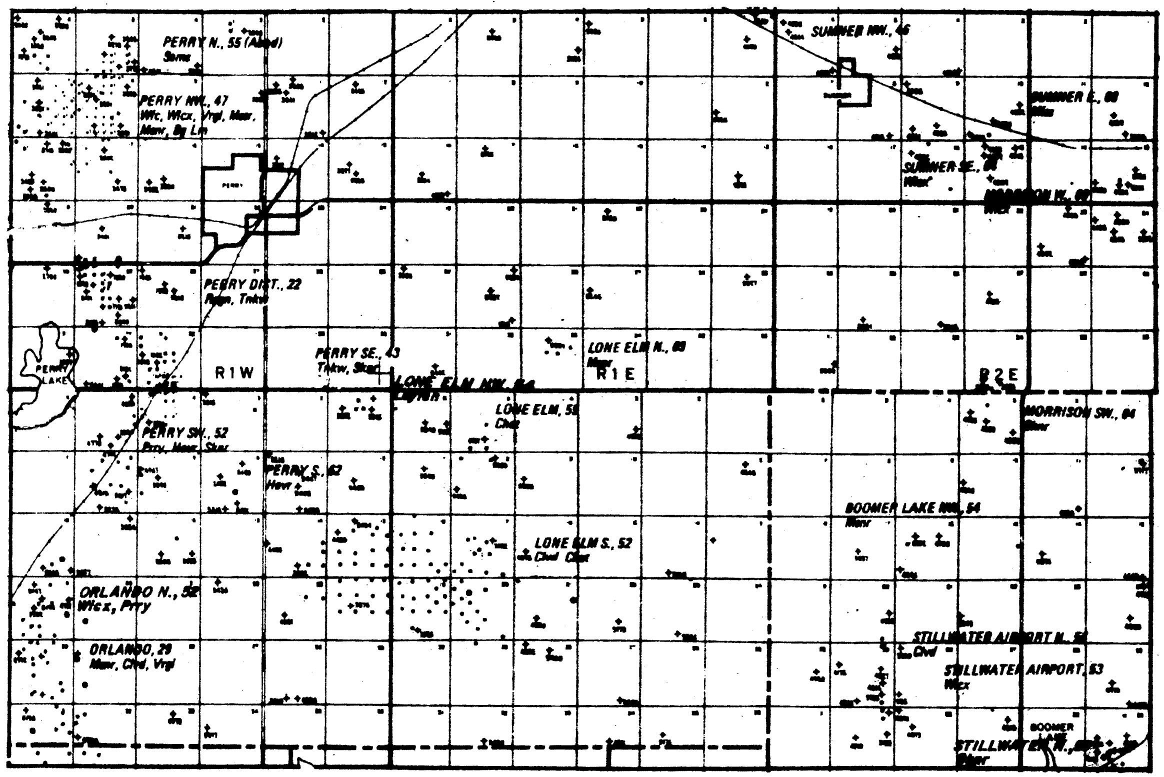

Figure 15.- Map showing locations, discovery dates, and producing intervals of petroleum fields.

TABLE 1

ABBREVIATED STRATIGRAPHIC SECTION
OF PRODUCING INTERVALS

Subsurface Nomenclature		Abbreviation	
Pennsylvania	"Sams" Sd.	Sams	Virgilian (Vrgl)
	Ragan Sd.	Ragan	
	Hoover Sd.	Hovr	
	Endicott Sd.		
	Tonkawa Sd.	Tnks	
	Perry Gas Sd.	Prry	Missourian (Mssr)
	Avant Ls.		
	Layton Sd.		
	Cleveland Sd.	Clvd	
	Big Lime	Bg Lm	Desmoinesian
	Skinner Sd.	Sknr	
	Red Fork Sd.	Rd Fk	
	Burgess Sd.	Brgs	
Mississippian	Mississippi Chat	Chat	
	Mississippi Lime	Miss	
Devonian	Misener Sd.	Msnr	
Ordovician	Wilcox Sd.	Wlcx	

The International Oil and Gas Development Yearbook does not record production statistics for individual units within a field; therefore Cherokee production cannot be isolated in those fields that produce from more than one interval. Production statistics to 1 January 1974 for the three fields with Cherokee production show cumulative production of 845,397 bbls of oil with 20,435 bbls having been produced in 1973. The Perry Southeast, Perry Southwest and Stillwater North Fields account for 5.15 percent of the total cumulative production (to

1 January 1974) and for 7.98 percent of the 1973 production in the thesis area. Table 2 provides additional information about the three fields that produce from the Cherokee interval.

The most productive fields (the Perry and Orlando Fields) are in the western one-third of the study area, in the structurally more complex region (Fig. 15). These larger reservoirs almost certainly are due to structural, rather than stratigraphic, entrapment of hydrocarbons. The Lone Elm Fields, however, are probably the result of stratigraphic entrapment with minor structural control. The smaller fields in the eastern two-thirds of the study area are most likely stratigraphic traps possibly influenced by local structural conditions.

The above production information was obtained primarily from the International Oil Scouts Association and from Page (1955).

TABLE 2

DATA FOR FIELDS PRODUCING FROM THE CHEROKEE INTERVAL

Field	Producing Formation	Yr. Disc.	Depth to Production	Total Acres	No. Wells Producing	Production 1973 bbls	Production Cum 1-1-74 bbls
Perry S. E.	Tonkawa	1943	3495 ft	120	3	0	37,768
	Skinner	1955	4758 ft				
Perry, S. W.	Perry	1952	3500 ft	400	10	16,374	622,434
	Skinner	1956	4735 ft				
	Hoover	1960	2365 ft				
Stillwater N.	Skinner	1955	4067 ft	100	2	4,061	185,195

CONCLUSIONS

The principal conclusions of this study are as follows:

1. The Cherokee group unconformably overlies the Mississippian limestone.

2. The Cherokee rocks thin west and north of the study area indicating onlap of the Cherokee group onto the Mississippian System.

3. A southeast-trending drainage system developed on the Mississippian surface and two major streams crossed the study area.

4. The Red Fork, Skinner and Prue sandstone intervals are shale intervals with local lenticular sand deposits.

5. The Red Fork, Skinner and Prue sandstones are believed to be deltaic in origin. Inferred depositional environments include lower deltaic-plain interdistributary, distributary channel and crevasse splay facies.

6. The source area for the Cherokee sediments is believed to have been to the east and northeast of the study area.

7. The sandstone deposits are mainly in the eastern and central part of the study area.

8. The structural contour map on the base of the Oswego limestone indicates essentially homoclinal dip in the eastern two-thirds of the study area. The western one-third is more complex.

9. The sediments deposited during Cherokee time were influenced locally by the paleotopography of the Mississippian limestone. The

Cherokee rocks also were influenced locally by paleostructure, including differential compaction and structural movement.

10. Parts of the Cherokee group are commercially productive of hydrocarbons within the study area.

11. Hydrocarbon reservoirs in the study area are the result of structural and stratigraphic entrapment or a combination of the two.

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APPENDIX

LOCATIONS OF LOGS ON CORRELATION SECTIONS

Correlation Section A-A'

1. Warren Oil Corp. No. 1 Mark Gordon "B"
   SW SW NE Sec. 5, T. 21 N., R. 1 W.

2. Livingston Oil Co. No. 1 Walter Kehres
   NE SE SE Sec. 4, T. 21 N., R. 1 W.

3. Skiles Drilling No. 1 Brorsen (also E-1)
   NW SW NE Sec. 5, T. 21 N., R. 1 E.

4. Lynn Drilling No. 1 Cress
   NE NE SE Sec. 4, T. 21 N., R. 1 E.

5. O. H. Parker No. 1 Adams
   SW NW NW Sec. 3, T. 21 N., R. 1 E.

6. Hanlon-Boyle No. 1 Juanita Allen (also F-2)
   SW SW NE Sec. 1, T. 21 N., R. 1 E.

7. Magaw and Zimmer No. 1 Gerken (also F-1)
   NE NW NE Sec. 1, T. 21 N., R. 1 E.

8. Gulf Oil No. 1 Juanita
   NE NE NE Sec. 1, T. 21 N., R. 1 E.

9. Cities Service Oil No. 1 Hansen
   C NW NW Sec. 6, T. 21 N., R. 2 E.

10. Gulf Oil No. 1 Hansen
    NE SW NW Sec. 6, T. 21 N., R. 2 E.

11. Red Patton Drilling and G. A. Brown No. 1 Scott
    NE NE SE Sec. 5, T. 21 N., R. 2 E.

12. Sun Oil No. 1 McBride
    SE SE SE Sec. 4, T. 21 N., R. 2 E.

13. Magnolia Petroleum No. 1 A. J. Jenke
    C SE NE Sec. 10, T. 21 N., R. 2 E.

Correlation Section A-A' (Continued)

14. O. F. Warren Co. No. 1 Henry Voise Jr.
NE SW Sec. 12, T. 21 N., R. 2 E.

Correlation Section B-B'

1. Noble Drilling No. 1 Briggs (also D-7)
SE SE SW Sec. 29, T. 21 N., R. 1 W.

2. George Hopper No. 1 Gillaspy
NE SW SE Sec. 29, T. 21 N., R. 1 W.

3. Summit Drilling No. 1 Gillaspy
NE NE SE Sec. 29, T. 21 N., R. 1 W.

4. Deep Rock Oil No. 1 Somnes
SW SW NE Sec. 28, T. 21 N., R. 1 W.

5. F. A. Gillespie and Sons No. 1 Gorath (also E-4)
SW SW NE Sec. 29, T. 21 N., R. 1 E.

6. Harry J. Schafer No. 1 Tappe (also E-3)
NE NE NE Sec. 29, T. 21 N., R. 1 E.

7. Jones and Pellow Oil No. 1 Bay
NE SE SE Sec. 31, T. 21 N., R. 2 E.

8. T. R. Wagoner No. 2 Mitchell
NE SW NW Sec. 3, T. 20 N., R. 2 E.

9. Marathon Oil No. 1 Mitchell (also G-6)
SE SE NW Sec. 3, T. 20 N., R. 2 E.

10. Seneca Oil and Russell Maguire No. 1 Pulley
C NE SE Sec. 3, T. 20 N., R. 2 E.

Correlation Section C-C'

1. J. E. Trigg and J. M. Porter No. 1 Shaw
SW SW NW Sec. 19, T. 20 N., R. 1 W.

2. Helmerich and Payne No. 1 Capers (also D-14)
NW SW NE Sec. 19, T. 20 N., R. 1 W.

3. Smith and Gurrsen No. 1 Green
NE NE SE Sec. 19, T. 20 N., R. 1 W.

4. Magnolia Petroleum No. 1 F. J. Dvorak
NW NE NW Sec. 22, T. 20 N., R. 1 W.

Correlation Section C-C' (Continued)

5. Domestic Oil No. 1 Snyder
NE NE SW Sec. 23, T. 20 N., R. 1 W.

6. Tennessee Gas Transmission Co. No. 2 Herman G. Habben
NE SE NE Sec. 24, T. 20 N., R. 1 W.

7. Tennessee Gas Transmission Co. No. 3 Nora N. Elgin
NE SE NW Sec. 19, T. 20 N., R. 1 E.

8. Tennessee Gas Transmission Co. No. 1 Nora N. Elgin
NE SE NW Sec. 19, T. 20 N., R. 1 E.

9. Tennessee Gas Transmission Co. No. 6 Sherrard
NE SE NE Sec. 19, T. 20 N., R. 1 E.

10. Publishers Petroleum No. 1 Meagher
C NW SE Sec. 22, T. 20 N., R. 1 E.

11. Spartan Oil and Gas No. 1 C. R. Smith (also F-7)
SW SE Sec. 32, T. 20 N., R. 1 E.

12. Howell and Howell No. 1 Houck (also G-10)
NE NE SE Sec. 20, T. 20 N., R. 2 E.

13. L. B. Jackson No. 1 Ritter
NW NW SW Sec. 22, T. 20 N., R. 2 E.

14. Russell Cobb, Jr. No. 1 O'Donnell
NE NW SE Sec. 24, T. 20 N., R. 2 E.

Correlation Section D-D'

1. Warren Oil No. 1 Floyd Taylor
NW NE NE Sec. 6, T. 21 N., R. 1 W.

2. Schermerhorn Oil No. 1 Vertz
SE SE SE Sec. 7, T. 21 N., R. 1 W.

3. Schermerhorn Oil No. 1 R. Brand
SE NE NE Sec. 18, T. 21 N., R. 1 W.

4. Schermerhorn Oil No. 2 R. Brand
SE SE NE Sec. 18, T. 21 N., R. 1 W.

5. Summit Drilling No. 1 Schurkens
NW NW SW Sec. 17, T. wl N., R. 1 W.

6. Summit Drilling No. 2 Ragan
SE SW NW Sec. 29, T. 21 N., R. 1 W.

Correlation Section D-D' (Continued)

7. Noble Drilling No. 1 Briggs (also B-1)
SE SE SW Sec. 29, T. 21 N., R. 1 W.

8. Summit Drilling No. 1 Grank Dauman
SE NW NE Sec. 32, T. 21 N., R. 1 W.

9. Kirkpatrick and Bale No. 1 Lavington
NW SE SE Sec. 32, T. 21 N., R. 1 W.

10. Creslenn Oil No. 1 Kemnitz
SW SW SE Sec. 5, T. 20 N., R. 1 W.

11. White Eagle Oil No. 1 Nelson
SE NE NW Sec. 8, T. 20 N., R. 1 W.

12. King-Stevenson Oil No. 1 Aldrich
NW NE SW Sec. 8, T. 20 N., R. 1 W.

13. Ohio Oil No. 1 Hubbertt
NW SW SE Sec. 18, T. 20 N., R. 1 W.

14. Helmerich and Payne No. 1 Capers (also C-2)
NW SW NE Sec. 19, T. 20 N., R. 1 W.

15. Newton Barrett No. 1 Lively
NE SE SW Sec. 19, T. 20 N., R. 1 W.

16. Barrett Petroleum No. 1 Schnur
NE NE NW Sec. 30, T. 20 N., R. 1 W.

Correlation Section E-E'

1. Skiles Drilling No. 1 Brorsen (also A-3)
NW SW SE Sec. 5, T. 21 N., R. 1 E.

2. Redlands Oil Co. and Max Pray No. 1 Max H. Fox
SE NE NW Sec. 17, T. 21 N., R. 1 E.

3. Harry J. Schafer No. 1 Tappe (also B-6)
NE NE NE Sec. 29, T. 21 N., R. 1 E.

4. F. A. Gillespie and Sons No. 1 Gorath (also B-5)
SW SW NE Sec. 29, T. 21 N., R. 1 E.

5. Skiles Drilling No. 1 Manzilla Heirs
NE NW SE Sec. 31, T. 21 N., R. 1 E.

6. H. Waggoner No. 1 Haxton
NE NE SE Sec. 6, T. 20 N., R. 1 E.

Correlation Section E-E' (Continued)

7. Jones and Pellow Oil No. 1 Heppler
SW SE SW Sec. 5, T. 20 N., R. 1 E.

8. M. E. Stone No. 1 Swartz
NW NW SW Sec. 8, T. 20 N., R. 1 E.

9. Shell Oil No. 2 V. P. Biggs
NE NE SW Sec. 20, T. 20 N., R. 1 E.

10. Aurora Gasoline Co. No. 1 Hodge
NE NE NW Sec. 29, T. 20 N., R. 1 E.

Correlation Section F-F'

1. Magaw and Zimmer No. 1 Gerken (also A-7)
NE NW NE Sec. 1, T. 21 N., R. 1 E.

2. Hanlon-Boyle No. 1 Juanita Allen (also A-6)
SW SW NE Sec. 1, T. 21 N., R. 1 E.

3. Watchorn Oil and Gas No. 1 Hirschman
SW NW NE Sec. 25, T. 21 N., R. 1 E.

4. Tennessee Gas and Oil No. 1 C. E. Bunch
SW NW NE Sec. 12, T. 20 N., R. 1 E.

5. White Shield Oil and Gas No. 1 Spillman
SW NW Sec. 13, T. 20 N., R. 1 E.

6. Weimer-Fitzhugh No. 1 Springfield
SE SE SW Sec. 14, T. 20 N., R. 1 E.

7. Spartan Oil and Gas No. 1 C. R. Smith (also C-11)
SW SE Sec. 23, T. 20 N., R. 1 E.

8. Continental Oil No. 1 De Vilbliss
SE SE NW Sec. 35, T. 20 N., R. 1 E.

Correlation Section G-G'

1. Massey and Moore No. 2 School Land "A"
C W½ NW SE Sec. 13, T. 21 N., R. 2 E.

2. Roy A. Godfrey No. 1 School Land "A"
NE NE SE Sec. 13, T. 21 N., R. 2 E.

3. Mohawk Drilling No. 2 Schmaltz
NW SW NW Sec. 24, T. 21 N., R. 2 E.

<u>Correlation Section G-G'</u> (Continued)

4. Woods Drilling No. 1 Nichols
   SE SE SE Sec. 23, T. 21 N., R. 2 E.

5. H. B. Mabee No. 1 Williams
   SE NE NW Sec. 3, T. 20 N., R. 2 E.

6. Marathon Oil No. 1 Mitchell (also B-9)
   SE SE NW Sec. 3, T. 20 N., R. 2 E.

7. T. N. Berry No. 1 Earle White
   SW SW NW Sec. 10, T. 20 N., R. 2 E.

8. T. W. and G. M. Loffland, Jr. No. 2 State
   NW SE NW Sec. 16, T. 20 N., R. 2 E.

9. T. W. and G. M. Loffland, Jr. No. 1 State
   SE SW NE Sec. 16, T. 20 N., R. 2 E.

10. Howell and Howell No. 1 Houck (also C-12)
    NE NE SE Sec. 20, T. 20 N., R. 2 E.

11. J. D. Wrather, Jr. No. 2 Laughlin
    NW NE NE Sec. 29, T. 20 N., R. 2 E.

12. J. D. Wrather, Jr. No. 1 Laughlin
    SW SE NE Sec. 29, T. 20 N., R. 2 E.

13. Flynn Oil No. 1 Lucas
    SW NE SE Sec. 29, T. 20 N., R. 2 E.

14. S. C. Yingling No. 1 Swart
    NW NE NE Sec. 32, T. 20 N., R. 2 E.

15. S. C. Yingling No. 2 Swart
    SW NE NE Sec. 32, T. 20 N., R. 2 E.

16. Warren Oil No. 1 Swart
    SE SE NE Sec. 32, T. 20 N., R. 2 E.

VITA

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Master of Science

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