# RESERVOIR TRENDS, DEPOSITIONAL ENVIRONMENTS, AND PETROLEUM GEOLOGY OF "CHEROKEE" SANDSTONES IN T11-13N, R4-5E, CENTRAL OKLAHOMA

By

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RESERVOIR TRENDS, DEPOSITIONAL ENVIRONMENTS

AND PETROLEUM GEOLOGY OF "CHEROKEE"

SANDSTONES IN T11-13N,R4-5E,

CENTRAL OKLAHOMA

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## PREFACE

This thesis is primarily a local study of the geometry and trends of sandstones in the Pennsylvanian "Cherokee" Group in the subsurface. In ascending order, these sandstones are known as the Bartlesville, Red Fork, Lower Skinner, Upper Skinner, and Prue. A structural contour map, log maps, and correlation sections were prepared in this study.

The writer is grateful to many individuals who assisted in this study. Dr. John W. Shelton suggested the thesis topic and offered time, encouragement and assistance both in the preparation of the maps and throughout the writing of the paper. Advisory committee members, Dr. John D. Naff, and Dr. John E. Stone made helpful suggestions, comments, and criticisms.

Data for this study were obtained from the Oklahoma City Geological Society Well Log Library, Oklahoma Geological Survey Core and Sample Library, and the Tulsa Well Log Library.

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Special thanks are extended to the writer's parents, Mr. and Mrs. Nicholas Verish for their financial support

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# CHAPTER I

## ABSTRACT

The Middle Pennsylvanian (Desmoinesian) "Cherokee" Group, which unconformably overlies Mississippian Limestone of Osagean age, consists of cyclic sequences of shales, sandstones, thin limestones, and at least one coastal coal bed. The thin limestones and coal bed serve as markers for division of the "Cherokee" Group into transgressive-regressive couplets. The sandstone bodies were deposited during regressions and were preserved during the following marine transgression. In ascending order these sandstone are known as the Bartlesville, Red Fork, Lower Skinner, Upper Skinner, and Prue.

The "Cherokee" sandstones, which are thought to be representative of deltaic environments, are classified as distributary channel and non-channel deposits. The latter category corresponds to delta-fringe, with related subenvironments of interdistributary bay, distributary mouth, and delta front. All sandstones vary in trend. The Upper Skinner Sandstone contains a major east-west trend, and a number of Prue, Red Fork, and Bartlesville sandstone bodies trend north-south. Well developed sandstones in complex trends represent multilateral and multistoried units.

Structural features include a north-northeast-trending fault zone and gentle noses and saddles. An en echelon fault zone at the surface reflects the fault zone along which some dip-slip displacement accompanied the dominant strike-slip displacement. Variations in interval thicknesses probably result from contemporaneous fault movement, reciprocity in sedimentation, and differential compaction associated with variations in sandstone development.

Production of hydrocarbons from "Cherokee" sandstones are from stratigraphic and structural-stratigraphic traps.

# CHAPTER II

# INTRODUCTION

The study area of approximately 216 square mi in T11-13N,R4-5E is in parts of Lincoln, Pottawatomie, and Seminole Counties, Oklahoma (Fig. 1). The stratigraphic interval of investigation is the Pennsylvanian (Desmoinesian) "Cherokee" Group.

Although Oakes (1953) formally divided the "Cherokee" Group into the Cabaniss and Krebs groups, the informal term "Cherokee" is used in this thesis because of its general acceptance by petroleum geologists. The writer follows Jordan (1957) in defining the "Cherokee" Group as the stratigraphic section between the base of the Oswego Limestone and the base of the Demoinesian Series. The type log (Fig. 2) from the study area shows a series of cyclic sequences composed of five lenticular sandstone bodies and thin, persistent stratigraphic markers. Sandstones of the "Cherokee" Group are, in descending order: Prue, Upper Skinner, Lower Skinner, Red Fork, and Bartlesville.

## Objectives

The objectives of this subsurface study are: (1) to determine sandstone trends and geometry within the study area,

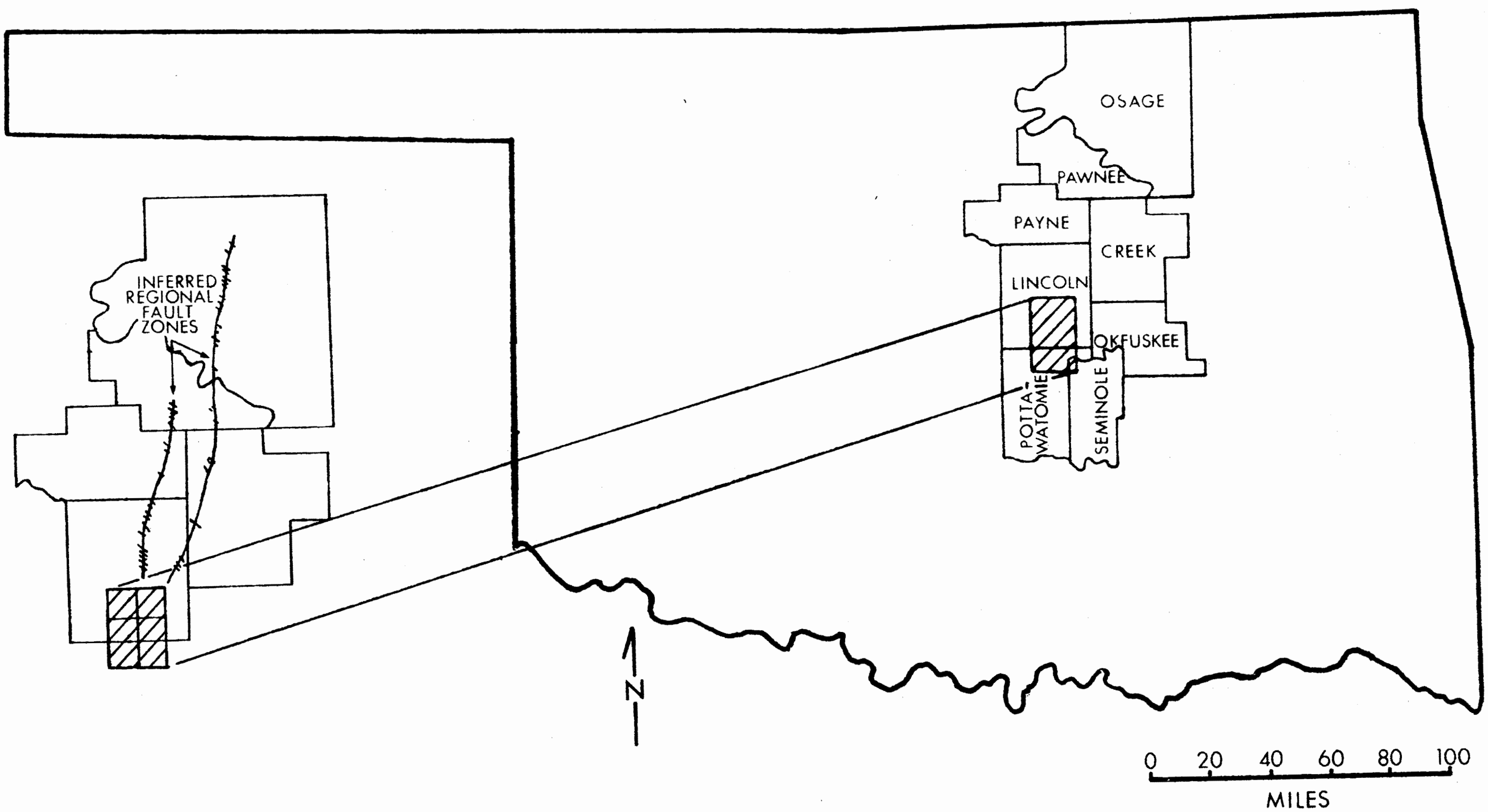



Fig. 1.-Location Map of Study Area and Small En Echelon Faults Together with Inferred Regional Fault Zones

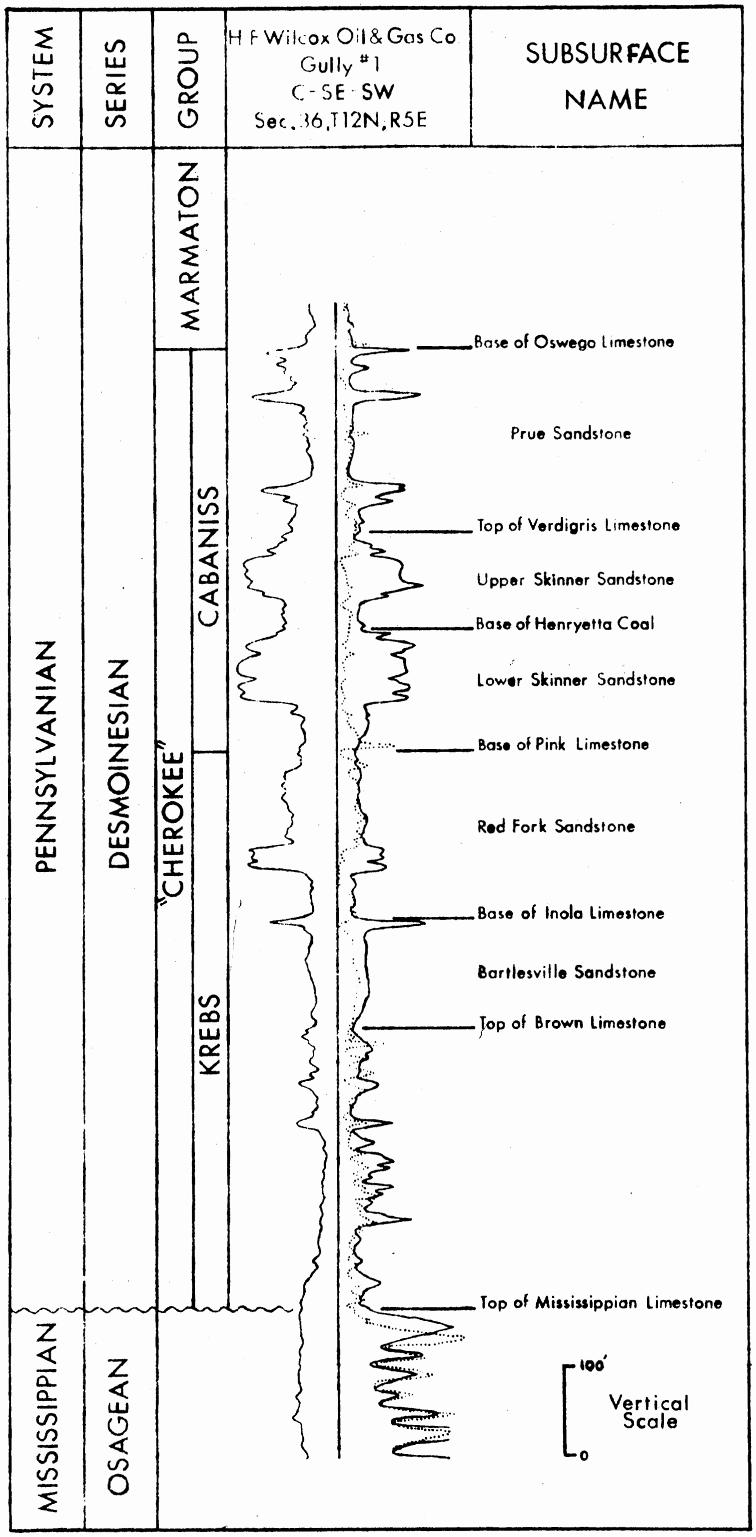



Fig. 2.-Type Electric Log for Area of Study

(2) to estimate depositional environments of the sandstones, (3) to determine the effects of structural influence on "Cherokee" sediments, and (4) to define trapping mechanisms of productive fields.

## Procedure

Data for the preparation of correlation sections, log maps, and a structural map were obtained from approximately 440 electric well logs and various scout tickets. Eight correlation sections were prepared in order to establish a grid pattern for stratigraphic correlations and relationships of the sandstones. Present structure of the "Cherokee" is represented by a structural contour map on the top of the Pink Limestone.

Log maps of the five sandstones were constructed in general areas of sandstone development to show areal distribution and to estimate trends and effective edges.

Six cores of the Prue and Lower Skinner sandstones were used to describe vertical and lateral sequences of sedimentary structures, texture, and visual constituents for estimating environments of deposition. Constituents were determined and reservoir diagenesis was interpreted from thin sections.

## Previous Investigations

Hydrocarbon potential of the "Cherokee" Group was proved in the early 1900's, and the group has been the subject of numerous investigations; early studies were those by Bass (1934, 1936), Bass, et al. (1937), and Leatherock

(1937). Berg (1969) conducted a regional study of the Marmaton Group west of the Nemaha ridge, and Cole (1969) studied the "Cherokee" Group east of the Nemaha ridge. Visher, et al. (1968) made a regional study of the Bartlesville Sandstone.

Local studies of the subsurface geology within the study area are limited to the work by Cole (1955). General studies of the local subsurface geology of nearby areas include those by Masters (1955), Kurash (1961), and Kunz (1961). Mississippian rocks were studied by Heinzelmann (1957) in an area adjacent to the northern part of the thesis area.

# CHAPTER III

# STRUCTURAL FRAMEWORK

## Regional Setting

Structurally, the area under discussion is on the Central Oklahoma platform, east of the Nemaha ridge and northwest of the Arkoma basin.

Regional structure at the position of the Oswego Limestone is a homocline with uniform west-southwest dip of some 50 to 60 ft per mi (Cole, 1955; Fritz, 1978). Structure of pre-Pennsylvanian strata is more complex than that of Pennsylvanian beds. For example, a nose in the younger beds may be a closed structure in older beds below the pre-Pennsylvanian unconformity.

## Local Setting

A structural contour map on the top of the Pink Limestone shows an overall westward dip of approximately 1/2 to 1 degree (Plate 1). The Pink Limestone is a consistent marker above the Red Fork Sandstone.

Gentle noses and saddles, monoclinal features, and faults are the structural anomalies in the area of study affecting "Cherokee" strata. The faults compose a narrow zone which probably represents reactivation of the deep-seated Wilzetta fault mapped by Cole (1955) in T13N,R5E and by Greer (1961) in T13-15N,R6E. Local steepening of the dip is common in the area where faults are mapped, and some noses and saddles, resulting from local variation in direction of dip, show fault closure.

An en echelon fault zone at the surface in eastern Lincoln, western Creek, eastern Pawnee, and Osage Counties, to the north-northeast is thought also to represent the fault zone in the study area and to indicate that the fault is strike-slip in nature (Fig. 1). The north-northwest-trending monocline in the north-central part of the study area extends into T14-15N,R4-5E (Cole, 1955; Greer, 1961) and probably reflects a fault zone at depth. This structure also is suggested by a corresponding en echelon fault zone at the surface in northern Lincoln, eastern Payne, and central Pawnee Counties (Fig. 1).

A prominent south-southwest- to southwest-plunging nose is associated with the Sparks East and Sparks South fields (T13N,R5E). Another significant structure is the faulted west-plunging nose in the vicinity of Wilzetta field (Secs. 26, 35-36, T13N,R5E. A low-relief dome in Secs. 32 and 33, T12N,R4E, and the associated northwest-plunging nose may be genetically related to the north-northwest-plunging nose in Secs. 16,21,28, T11N,R4E.

Other noses independent of those directly related to faulting are described according to location and direction of plunge:

1. Sec. 32, T11N,R5E, northwest plunge.
2. Secs. 18-19, T11N,R5E, southwest plunge.
3. Secs. 35-36, T11N,R5E, west-northwest plunge.
4. Secs. 3-4, T11N,R5E; Secs. 33-34, T12N,R5E, west-northwest plunge.
5. Secs. 22-23, 25-26, T12N,R4E, northwest plunge.
6. Secs. 2-4, T12N,R4E, west plunge.

Prominent saddles are present in the northeast part of T12N,R5E, the southern part of T13N,R4E, and the northeasternmost part of T13N,R5E.

# CHAPTER IV

# STRATIGRAPHIC FRAMEWORK

## Description of Formations

### Bartlesville Sandstone-Brown Limestone

Deposition of the Bartlesville Sandstone occurred during an overall regression which followed the deposition of the Brown Limestone, representing the earliest trangression of "Cherokee" sea into the study area. As defined by Kunz (1961), the Brown Limestone is white to tan, finely crystalline to microcrystalline, and dolomitic; it contains interbeds of light gray to dark gray shale. An unconformity is present at the top of the Mississippian surface, which generally ranges from 150 ft to over 400 ft below the base of the Brown Limestone.

The Bartlesville interval is described by Jordan (1957) as lying between the base of the Inola Limestone and the top of the Brown Limestone. Greer (1961) and Kunz (1961) describe the Bartlesville as a white to buff, moderately well cemented sandstone with frosted, very fine- to medium-grained, angular to well rounded grains. In the study area, it is characterized by local developments of sandstone and large areas of no sandstone. The interval thickness ranges from 70 ft in Sec. 24, T11N,R4E to 165 ft in Sec. 23, T13N,R5E.

Red Fork Sandstone-Inola Limestone

The Red Fork Sandstone was deposited during a regressive phase after deposition of the Inola Limestone, a widespread, transgressive unit. The Inola Limestone, generally less than 10 ft thick throughout the area, is gray to tan, finely crystalline and semi-dense (Greer, 1961). The Red Fork lies in the interval between the base of the Pink Limestone and the top of the Inola (Jordan, 1957). According to Kunz (1961), the sandstone is white to gray, fine- to medium-grained, subangular, well sorted, and porous.

Thickness of the Red Fork interval is a minimum of 40 ft in Sec. 11, T13N,R4E, and Sec. 20, T11N,R4E. Maximum thickness of 200 ft is present in the southeastern part of the study area.

Lower Skinner Sandstone-Pink Limestone

The transgressive Pink Limestone was deposited prior to the regression during which the Lower Skinner Sandstone was deposited. Thickness of the Pink Limestone ranges from 5 to 10 ft throughout the study area; it is described by Greer (1961) and Cole (1955) as gray to light brown, finely crystalline, dolomitic, and dense. The Lower Skinner Sandstone, as defined by Jordan (1957), is the interval between the base of the Henryetta Coal and the top of the Pink Limestone. Cole (1955) defines the sandstone as fine- to medium-grained, sub-angular to subrounded, micaceous, and porous.

The Lower Skinner interval is thickest in part of Sec. 33, T12N,R5E, where it is 260 ft thick. Generally, the interval ranges in thickness from 100 to 180 ft.

Upper Skinner Sandstone-Henryetta Coal

The Upper Skinner Sandstone lies between the top of the Henryetta Coal and the base of the Verdigris Limestone (Jordan, 1957). Shipley (1975) suggests the Henryetta Coal, less than 10 ft thick in the study area, is associated with a transgression because of its persistent and distinctive electric log response on most of the Northern Oklahoma platform. The Upper Skinner Sandstone, which was deposited during the subsequent regression, is white to off-white, fine-grained, angular, porous, and micaceous (Kunz, 1961).

The interval is 80 to 160 ft thick in an east-west trend across the northern part of T11N,R4-5E, where sandstone is well developed. In the northwest corner of T12N, R5E, and southeast portion of T11N,R5E, the interval with sandstone is approximately 40 to 80 ft thick.

Oswego Limestone-Prue Sandstone-
Verdigris Limestone

The Prue Sandstone, as the final regressive phase of the "Cherokee" Group, lies between two transgressions represented by the base of the Oswego Limestone and Verdigris Limestone (Jordan, 1957). The latter, according to Cole (1955), is microcrystalline, tan to gray, mottled and dolomitic. Generally, it is less than 10 ft thick.

In southeastern Lincoln County, Blumenthal (1956) divided the Prue into first, second, and third members. In T11N,R5E, the parts of T11N,R4E, and T12N,R5E, the Prue is divided into poorly defined upper and lower units.

The interval varies from a maximum thickness of 270 ft in the southeast portion of the study area to a minimum thickness of 60 ft in Sec. 9, T11N,R4E.

Cole (1955) describes the sandstone as light tan to buff, fine- to medium-grained, porous, subangular to subrounded, and slightly micaceous. The base of the Oswego Limestone represents the final transgressive phase of the "Cherokee" Group. Greer (1961) describes the Oswego as an off-white to buff, medium-crystalline- to fine-grained, dolomitic, fossiliferous limestone.

## Correlation of Units Into Transgressive - Regressive Couplets

Four north-south and four west-east correlation sections were prepared, using the base of the Oswego Limestone as the datum (Fig. 3). The base of the Oswego Limestone was chosen as the datum because of its consistent character on electric logs and its stratigraphic position at the top of the interval of investigation. The sections, forming a grid network aided not only in correlating the "Cherokee" units, but also in portraying stratigraphic relationships of the sandstones.

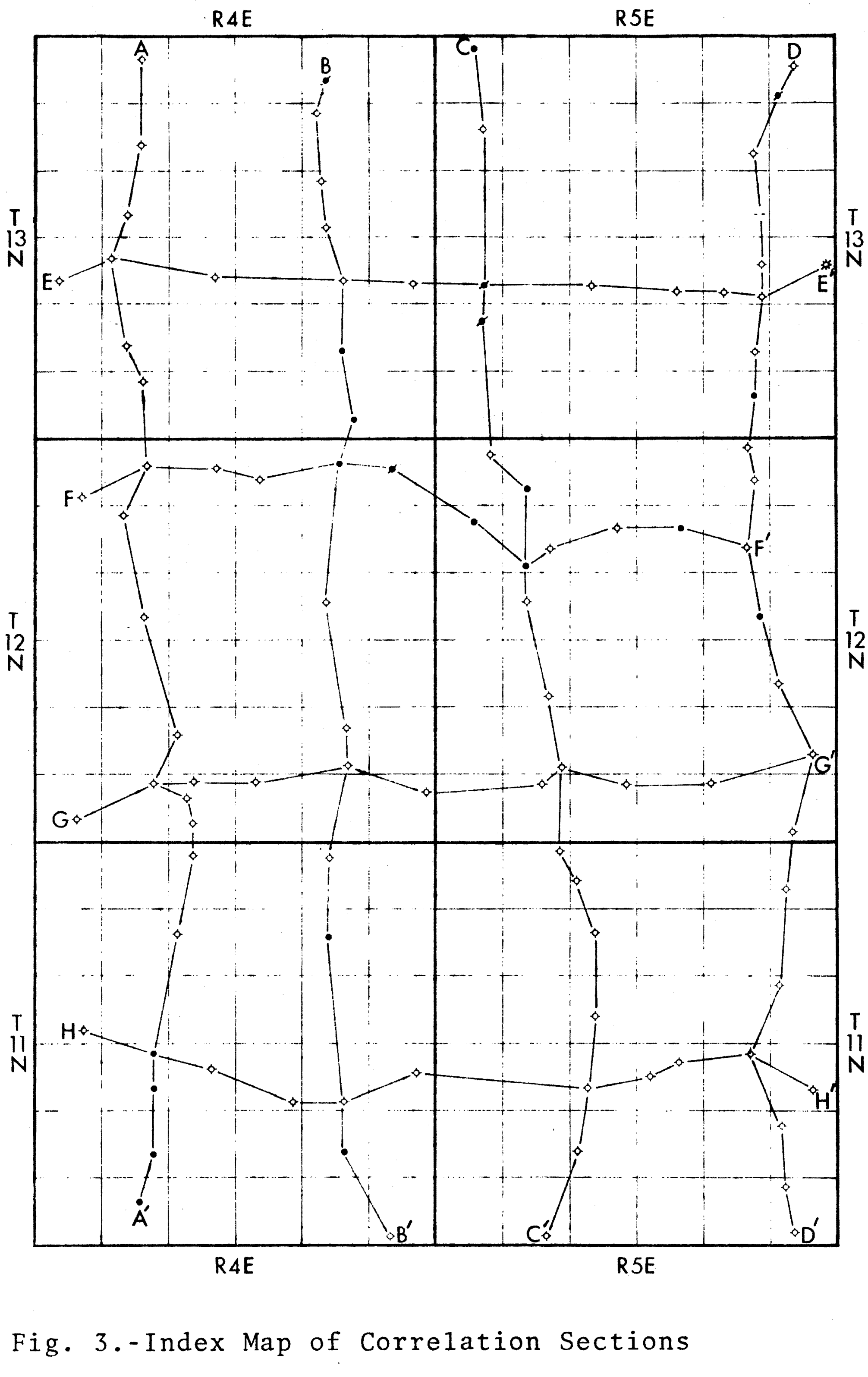



Fig. 3.-Index Map of Correlation Sections

Major sandstone bodies within the "Cherokee" Group are between transgressive marker beds, which are correlatable because of their consistent characteristics on electric well logs. As noted heretofore, these "Cherokee" units are the Brown Limestone, Inola Limestone, Pink Limestone, Henryetta Coal, and Verdigris Limestone, in ascending order. Two successive transgressive markers and the contained sandstone unit constitute a transgressive-regressive couplet, similar to the genetic increment of strata of Busch (1971). Each sandstone unit was deposited during a regression and preserved during the following marine transgression.

North-South Correlation Sections

The north-south correlation sections portray a general southward thickening of the "Cherokee" Group. On section A-A', significant changes in thicknesses of the Prue, Upper Skinner, and Lower Skinner intervals are present between wells 11-14 and 18 and 19 (Plate 2). The changes in wells 11-14 are related primarily to changes in sandstone development. Reciprocity in sedimentation existed, for the "Cherokee" thickness in the wells is essentially constant. Both the Prue and Lower Skinner intervals thicken rather abruptly between wells 18 and 19.

Inferred faults mapped at the position of the Pink Limestone are located between the following wells: 15 and 16 (section B-B'), 10 and 11 (section C-C'), 4 and 5, and 5 and 6 (section D-D'). In each case, the upthrown block is to the south.

Marked change in the thickness of the Prue interval is shown by wells 12 and 13, section B-B', and the interval of study shows a similar southward increase in thickness (Plate 3). The pre-Henryetta coal section in wells 15 and 16 shows the effect of a fault.

On section C-C', southward thickening of the interval of study extends to well 13, south of which it thins gradually (Plate 4). However, movement along the fault between wells 10 and 11 before deposition of Henryetta Coal resulted in a thinner Bartlesville, Red Fork, and Lower Skinner sections in well 11. Conversely, the Prue and Upper Skinner intervals are thicker in well 11. Sand development, probably reflecting differential compaction within the "Cherokee" Group, may be responsible for the 70 ft change in thickness of the Upper Skinner interval between wells 12 and 11, and the 30 ft change between wells 10 and 11. The Lower Skinner interval is 90 ft thicker in well 12 than in well 11.

On section D-D', the Prue interval thickens sharply from well 13 to well 14 (Plate 5). The entire section is affected by the fault zone in the vicinity of well 5, in which the "Cherokee" is considerably thicker than in well 6.

## West-East Correlation Sections

Correlation section E-E', shows a gradual eastward thickening of the interval of study to well 7, east of which an eastward increase is rather sharp (Plate 6). The fault between wells 9 and 10 is upthrown to the east; the Red Fork interval shows the most abrupt change in thickness across the fault. Changes in the Prue and Red Fork intervals, demonstrating reciprocity in sedimentation, are shown by wells 5 and 6.

Section F-F', shows eastward thickening of the "Cherokee" Group which is interrupted by the fault zone between wells 10 and 11 (Plate 7). Section G-G' also shows eastward thickening to the fault, which lies between wells 8 and 9 (Plate 8). Also, rather abrupt eastward increases in the Prue interval thickness are shown by wells 6 and 7 and 9-11.

On section H-H', the sharpest change in interval thickness affects the Prue in wells 3 and 4; the interval is 115 ft thick in well 3, but 220 ft thick in well 4 (Plate 9). Eastward from well 4, the Prue interval shows an overall gradual increase. A fault zone is represented by a horst in the vicinity of well 6. The western fault may have been active during deposition of the Red Fork and Lower Skinner, based on the thicker intervals and better sandstone development in the downthrown block. In particular, the Red Fork is poorly developed on the horst.

# CHAPTER V

# CHARACTERISTICS OF SANDSTONES

## Geometry

A log map was prepared for each of the five sandstones in the "Cherokee" Group (Plates 10-14). These maps are useful in the comparison of log characteristics of a sandstone because many logs can be observed simultaneously. Log maps permit use of subtle variations in log characteristics to delineate sandstone trends and to define sandstone edges more accurately than numerical values of thickness used in the preparation of conventional maps.

The top of the log tracing corresponds to the marker above the sandstone unit, and the bottom of the tracing corresponds to the marker below the sandstone, except where the total depth of a well is above that marker. These incomplete sections are indicated on log maps by symbols. The geographic position of each well is indicated by the top of the log tracing. Curves were terminated opposite extreme deflections to avoid interference with adjacent logs.

### Bartlesville Sandstone

The Bartlesville, which is developed only in parts of the study area, is thinner than the younger "Cherokee" sandstones. Although sandstone is developed at different stratigraphic positions, individual genetic units cannot be distinguished. The Bartlesville shows an anastomosing pattern in T13N,R5E, with widths of sandstone development varying from ½ mi to more than 2½ mi (Plate 10). Lateral and lower contacts of sandstone bodies may be sharp or gradational. Sandstone within trends is 10 to 70 ft thick.

Red Fork Sandstone

Generally, the Red Fork is better developed in the eastern part of the area than in the west, a feature which results in a gross north-south orientation of sandstone (Plate 11). Net sandstone within the interval ranges from 10 to 130 ft in thickness. The Red Fork is divided into rather ill-defined upper and lower units, both of which are multistoried and multilateral in part. They are present as anastomosing belts or trends. Belts of the upper unit, most of which are oriented north-northeast, range in width from ¼ mi to more than 2 mi. A belt in T11N,R4E, is thought to divide into four branches. Several trends may terminate within the study area.

Sandstone in the lower unit is developed most extensively in the eastern part of the study area. Although trends of this unit vary widely in orientation, well developed sand is common along and/or near the north-northeast fault zone. Sandstone in these belts exhibits sharp lower contacts and sharp or gradational lateral contacts. The sandstone bodies are ¼ mi to 2½ mi wide. Local areas of no sandstone are present within the sandstone belts. Some trends may terminate within the study area.

## Lower Skinner Sandstone

The Lower Skinner Sandstone exhibits complex patterns of sandstone bodies in terms of stratigraphic position, thickness and trend (Plate 12). Upper and lower units are delineated in the northern half of the study area, whereas thick, undifferentiated multistoried and multilateral units are present in the southern third. Belts or trends of the upper unit in T13N,R4-5E, and T12N,R5E, are characterized by sharp lateral contacts. The lower contact is sharp in some areas and gradational in other areas. Widths range from approximately ½ mi to 4 mi and Lower Skinner Sandstone within the interval is from 10 to 50 ft thick. Trends of the lower unit exhibit similar characteristics. Trends of both upper and lower units vary widely in orientation.

Widespread multistoried and multilateral units in the southern third of the study area show rather abrupt variations in development; some are mappable, but others are not, primarily because of correlation problems. Lower contacts are generally sharp; lateral contacts may be sharp or gradational. In this area of multistoried and multilateral bodies, sandstone is as much as 170 ft thick. Narrow, north-trending areas of poorly developed sandstone are in T11N,R4E.

## Upper Skinner Sandstone

Sandstone is developed only in parts of T11-12N (Plate

13). A prominent multistoried and multilateral sandstone body extends westward in a relatively narrow belt in T11-12N,R4-5E. The belt, which ranges in width from 3/4 mi to 1 3/4 mi extends beyond the study area both to the east and west. Lateral and basal contacts are sharp. Thickness of net sandstone within this belt ranges from 20 to 120 ft; the thickest sandstone is in Sec. 34, T12N,R5E. Three local areas of poor sandstone development lie within this trend.

Minor trends apparently associated with this more prominent belt are present in T12N,R5E. They generally are less than ¼ mi wide, and they contain sharp lateral boundaries. Sandstone within trends ranges in thickness from 10 to 40 ft. The narrow trend in the southeast part of the study area has similar characteristics. Three narrow sandstone trends, apparently of different ages, are present in Sec. 7, T12N,R5E.

<u>Prue Sandstone</u>

Multistoried sandstone bodies are present in much of the eastern part of the area (Plate 14). The western tier of townships generally contains very little sandstone, a feature which gives a gross north-south trend to sandstone development. However, there is considerable range in the trends of sandstone belts, which form bifurcating patterns. The belts are less than 1 mi to more than 3 mi wide in the north and east. Sandstones in these trends are characterized by sharp contacts. Thickness of sandstone within trends ranges from less than 10 ft in the northwest part of T12N, R5E to over 200 ft in the southeast part of the study area. Local areas of poorly developed sandstone and/or no sandstone lie within several trends.

The Prue Sandstone interval is divided into poorly defined upper and lower units in the central and southeastern parts of the study area. In the latter there is abrupt thickening. Sharp lateral contacts are common features to both upper and lower units; multistoried bodies are present in both.

## Internal Features

Characterization of internal features of "Cherokee" sandstones is based primarily on examination of six cores, one from the Prue and five from the Lower Skinner (Figs. 4-18).

Four of the wells with cored Lower Skinner are within the Payson and Payson East fields,(an area common to T12N, R4-5E and T13N,R4E), which have been producing oil from the Lower Skinner Sandstone since 1940 and 1952, respectively (Atchison and Wiggins, 1977). The fifth Lower Skinner core is from an unproductive well in Sec. 32, T12N,R4E. The Prue core is from a well in Sec. 19, T13N,R5E, in Sparks South field, which has been producing oil from the Prue Sandstone since 1945 (Atchison and Wiggins, 1977).

Calibration of textural features in the cores to log characteristics helped in making inferences about boundaries, noted heretofore, and textural sequences.

## Sedimentary Structures and Textures

Lower Skinner Sandstone. The four cores from producing wells show gradually coarsening-upward sequences from a very fine- to fine-grained sand (Figs. 4-12). The base is a gradational contact. Medium-scale crossbedding and low-angle inclined bedding are present in cores from Gulf, Goodell No. 1, Gulf, Queenan No. 1, and Gulf, Queenan No. 3. A common structure in two wells is horizontal bedding. Sedimentary structures common to the four cores include small-scale crossbedding, interstratified shale and sandstone, deformed features due to soft-sediment flowage, thin (2mm) beds of sideritic clay drape, intraformational clay fragments, and burrows. Sorting is generally moderate to good; the better developed sandstone is well sorted.

Two thin sandstone units in the Vierson and Cochran, South Payson Unit No. 18-4 core are separated by approximately 24 ft of interstratified shale and sandstone (Figs. 7-9). The upper unit is horizontally bedded, bioturbated, and fine- to medium-grained. Recognizable skeletal material includes pelecypods. The lower unit, which is fine-grained, contains horizontal bedding, massive bedding, small-scale crossbedding, ripple marks, burrows, and load casts.

The Lower Skinner Sandstone, in Gulf, Christian Stewardship No. 1 in Sec. 32, T13N,R5E, is very fine- to fine-grained; grain size is characterized by an overall upward increase (Figs. 13 and 14). Horizontal lamination, small and medium-scale crossbedding, cut-outs, and load casts

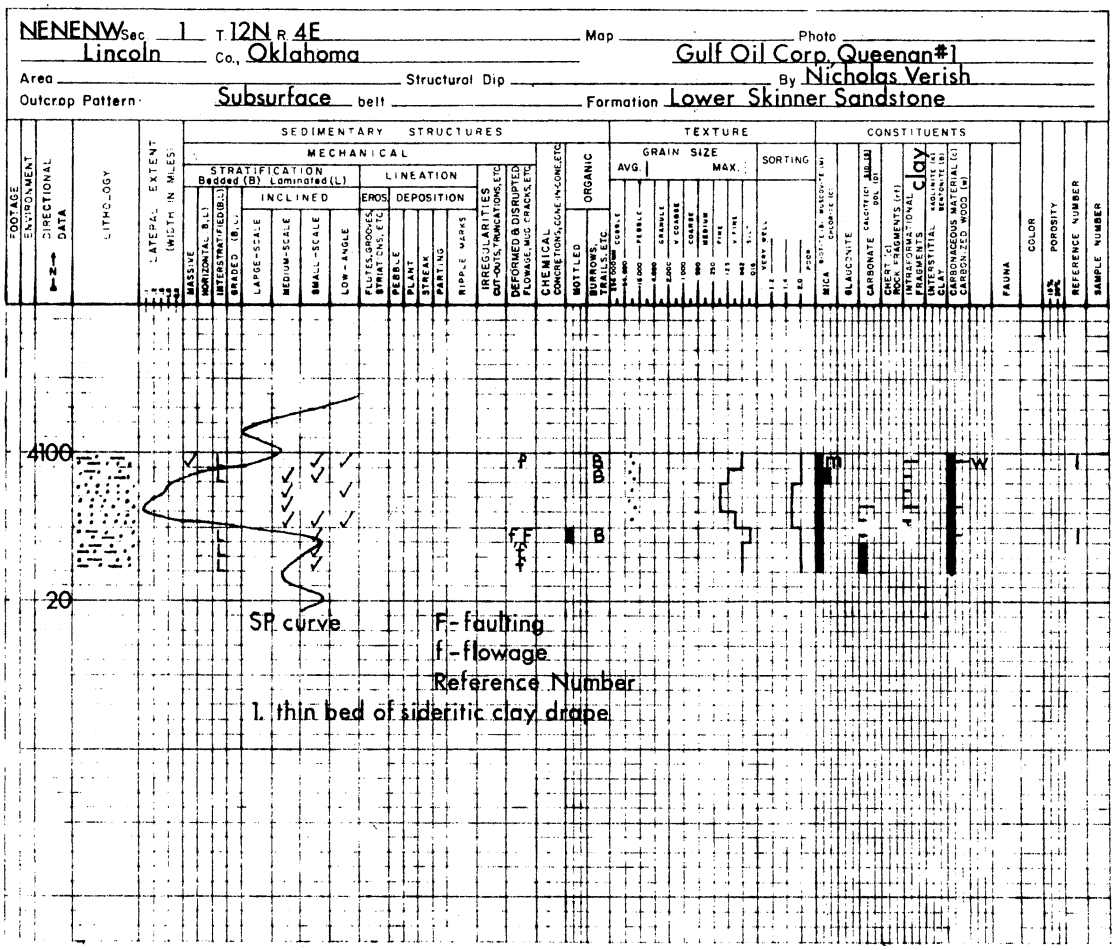



Fig. 4.-Core Description of Lower Skinner Sandstone, Gulf Oil Corporation, Queenan No. 1 with Electric Log of Interval

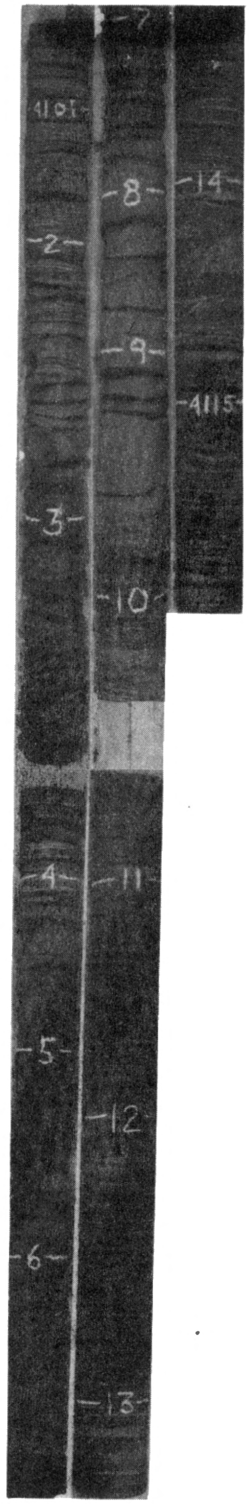



Fig. 5.-Photograph of Lower Skinner Sandstone,
Gulf Oil Corporation, Queenan No. 1

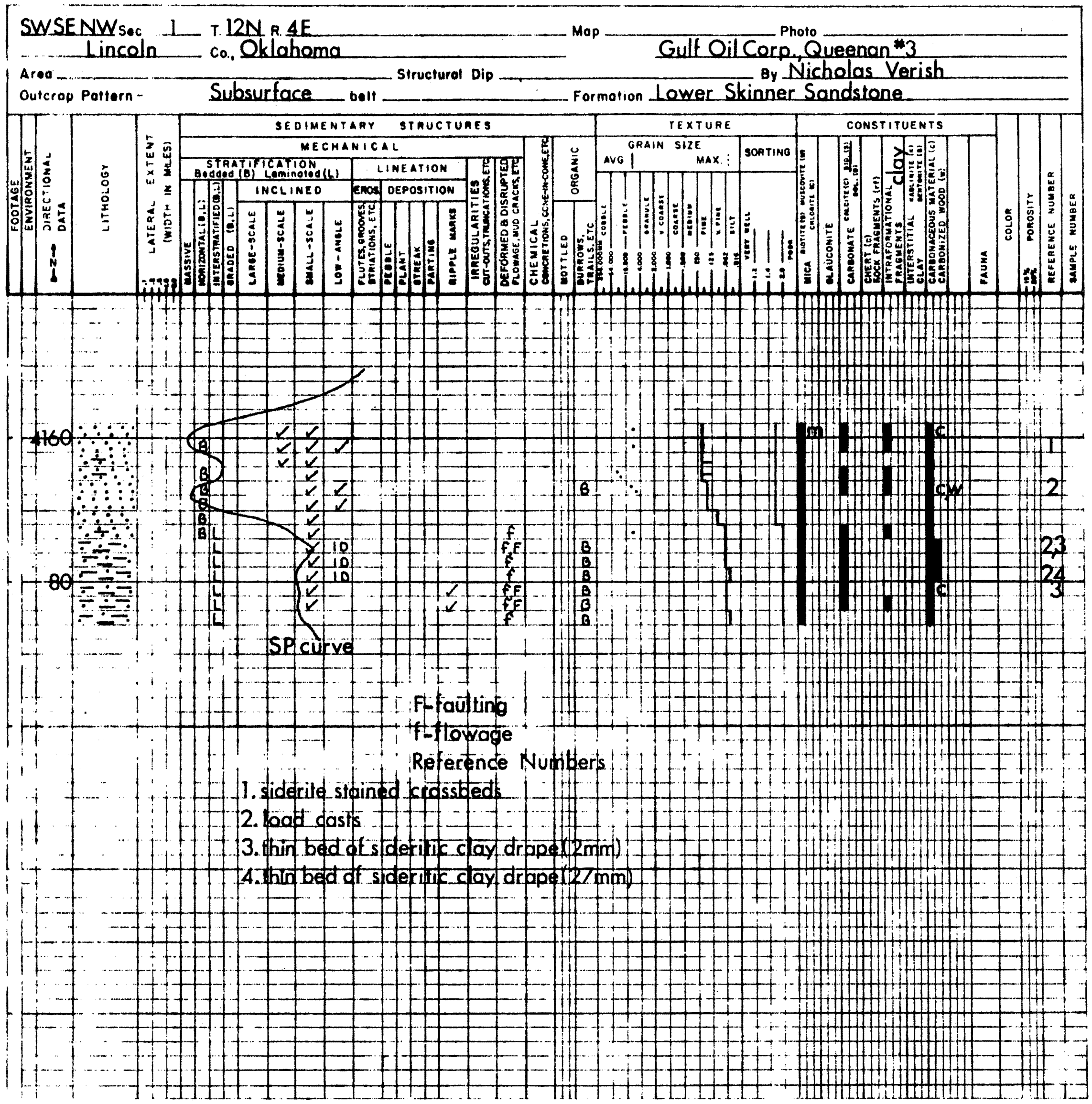



Fig. 6.-Core Description of Lower Skinner Sandstone, Gulf Oil Corporation, Queenan No. 3 with Electric Log of Interval

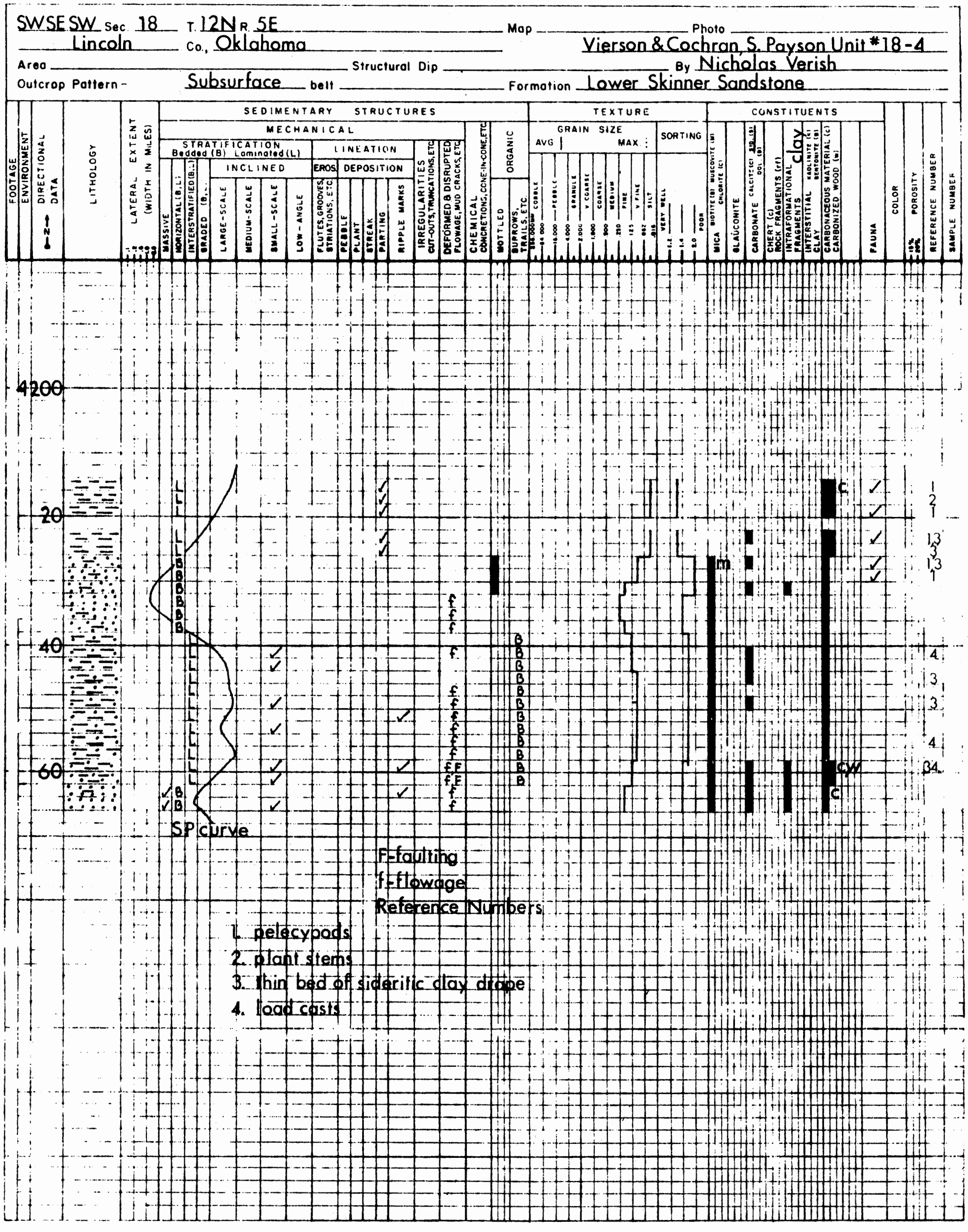



Fig. 7.-Core Description of Lower Skinner Sandstone, Vierson and Cochran, South Payson Unit No. 18-4 with Electric Log of Interval

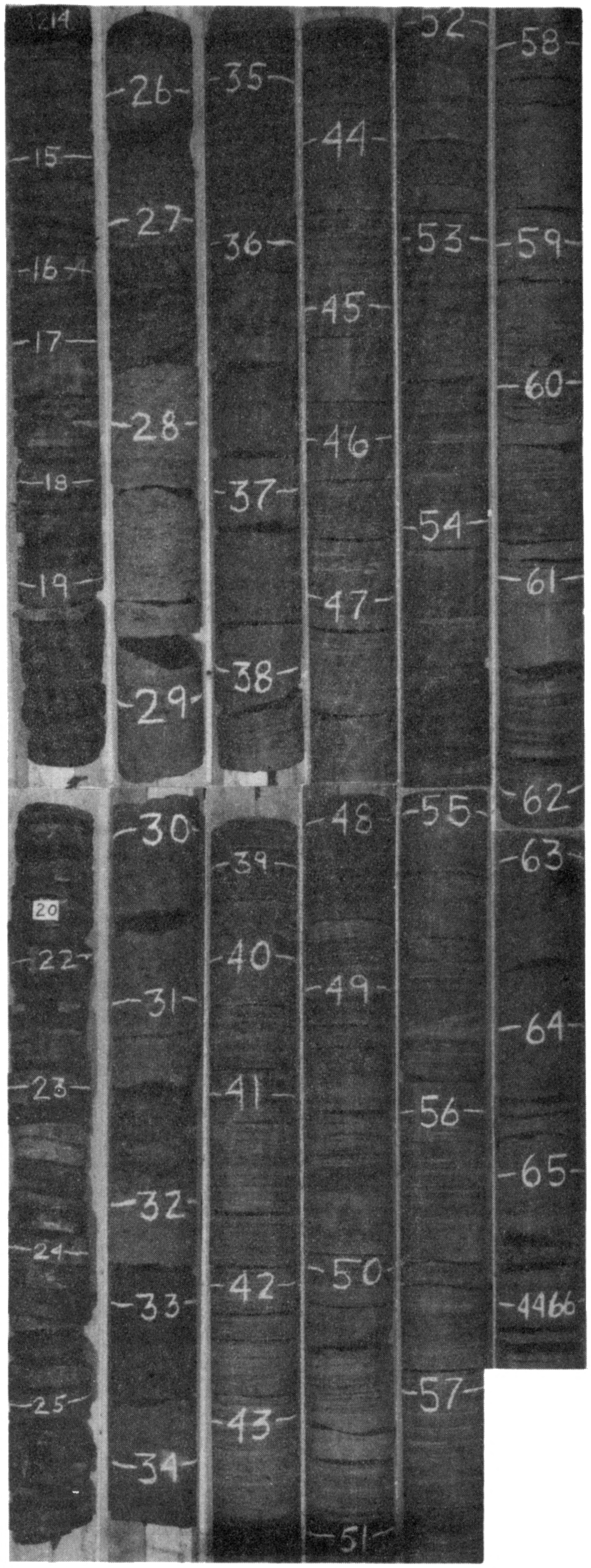
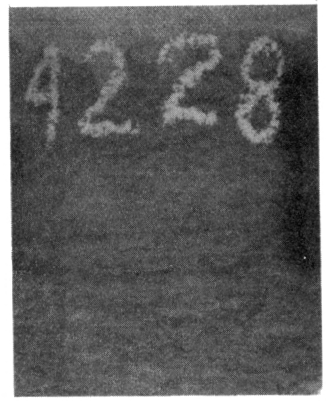


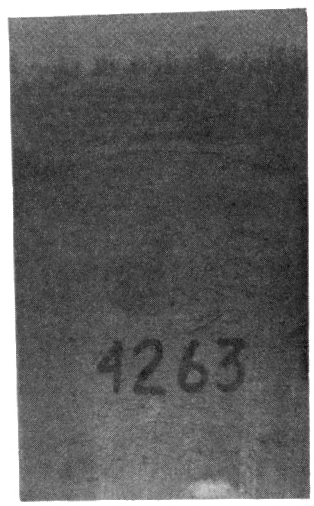

Fig. 8.-Photograph of Lower Skinner Sandstone, Vierson and Cochran, South Payson Unit No. 18-4


A. Pelecypod Shell




B. Bioturbation

C. Load Casts, Burrows, Interlatmination, and Small-scale Crossbedding




D. Horizontal Bedding, Soft-sediment Folds, Intraformational Clay Fragments, and Massive Bedding

Fig. 9.-Significant Internal Features of Lower Skinner Sandstone, Vierson and Cochran, South Payson Unit No. 18-4

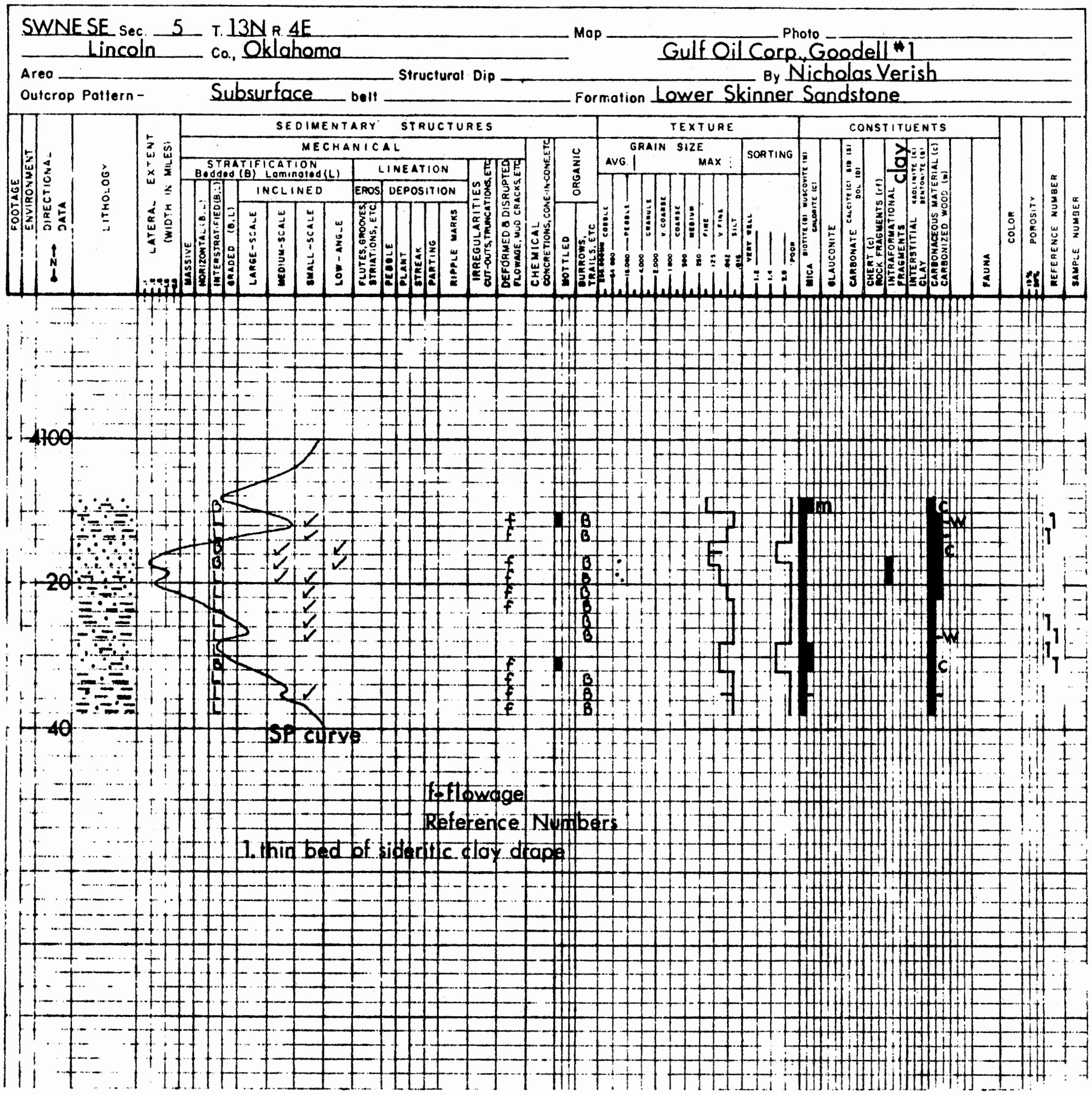



Fig. 10.-Core Description of Lower Skinner Sandstone, Gulf Oil Corporation, Goodell No. 1 with Electric Log of Interval

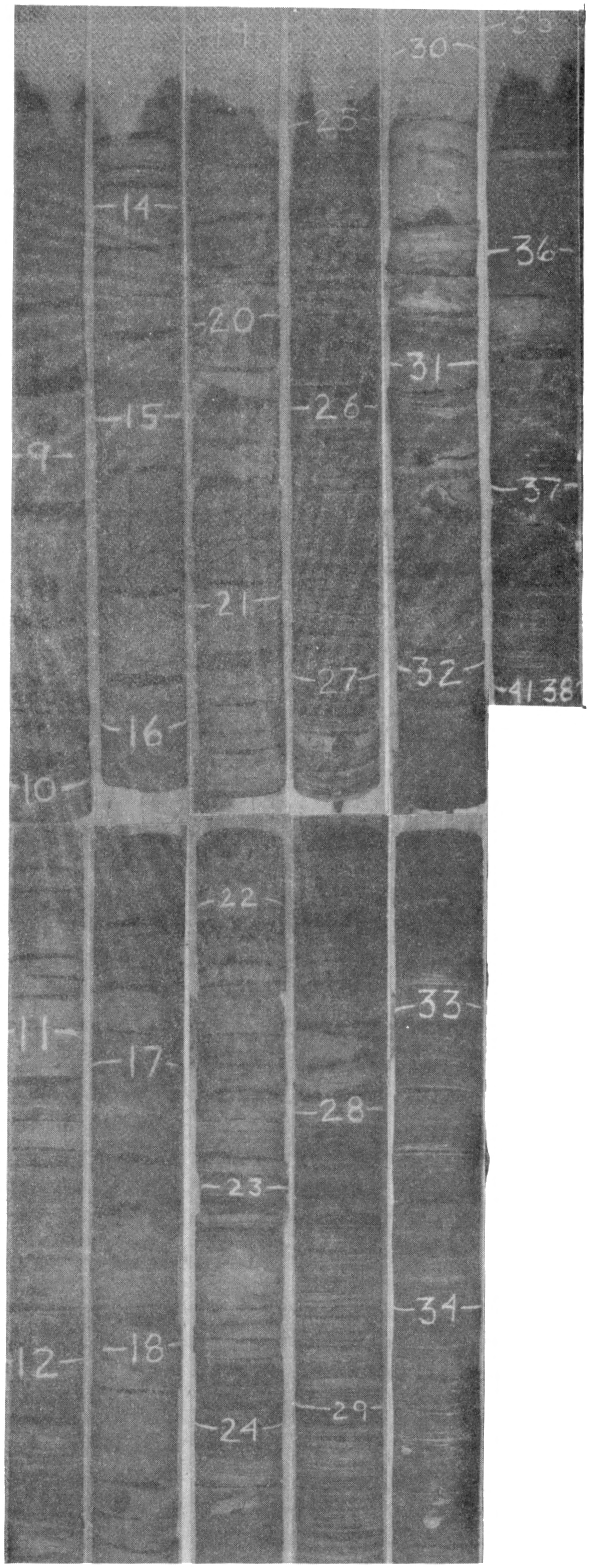
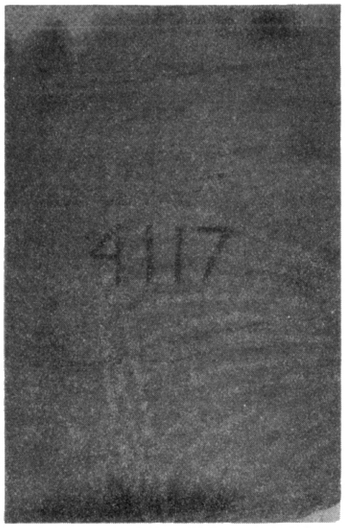



Fig. 11.-Photograph of Lower Skinner Sandstone,
Gulf Oil Corporation, Goodell No. 1




A. Medium-scale Cross-bedding and Low-angle Inclined Bedding

B. Deformed Features Due to Soft-sediment Flowage

C. Interlamination, Burrows, Load Features, and Small-scale Cross-bedding

Fig. 12.-Significant Internal Features of Lower Skinner Sandstone, Gulf Oil Corporation, Goodell No. 1

are typical structures (Fig. 15). Directly above and below the sandstone are interstratified shale and sandstone, with pronounced initial dip. Deformed bedding due to soft-sediment flowage and soft-sediment faulting, burrows, and a thin coal bed are present in the interstratified zone. Structures common to both the sandstone and interstratified section include small-scale crossbedding, cut-outs, and load casts.

Prue Sandstone. The upper part of the Prue Sandstone, represented by 15 ft of core in the Gulf, Hamm No. 1 is fine-grained sand, with shale interbeds (Figs. 16 and 17). Horizontal bedding, massive bedding, small-scale crossbedding and low-angle inclined bedding are characteristic structures (Fig. 18). Shale interbeds show small-scale crossbedding, deformation due to flowage, and burrows.

## Constituents

Lower Skinner Sandstone. Macroscopic constituents common to the five Lower Skinner cores include muscovite, siderite, carbonaceous material, and carbonized wood. Major framework constituents consist of quartz (and chert), feldspar, microcline, muscovite, rock fragments, and carbonate. Accessory minerals include biotite, zircon, apatite, pyrite, glauconite, siderite, magnetite, rutile, hematite, and illmenite. Iron-oxide coating of grains is common at some levels. Other minerals present as matrix and/or cement are kaolinite, illite, chlorite, sericite, and carbonate.

Quartz percentages of total constituents range from 55 to 75. The four Lower Skinner cores in Payson and Payson

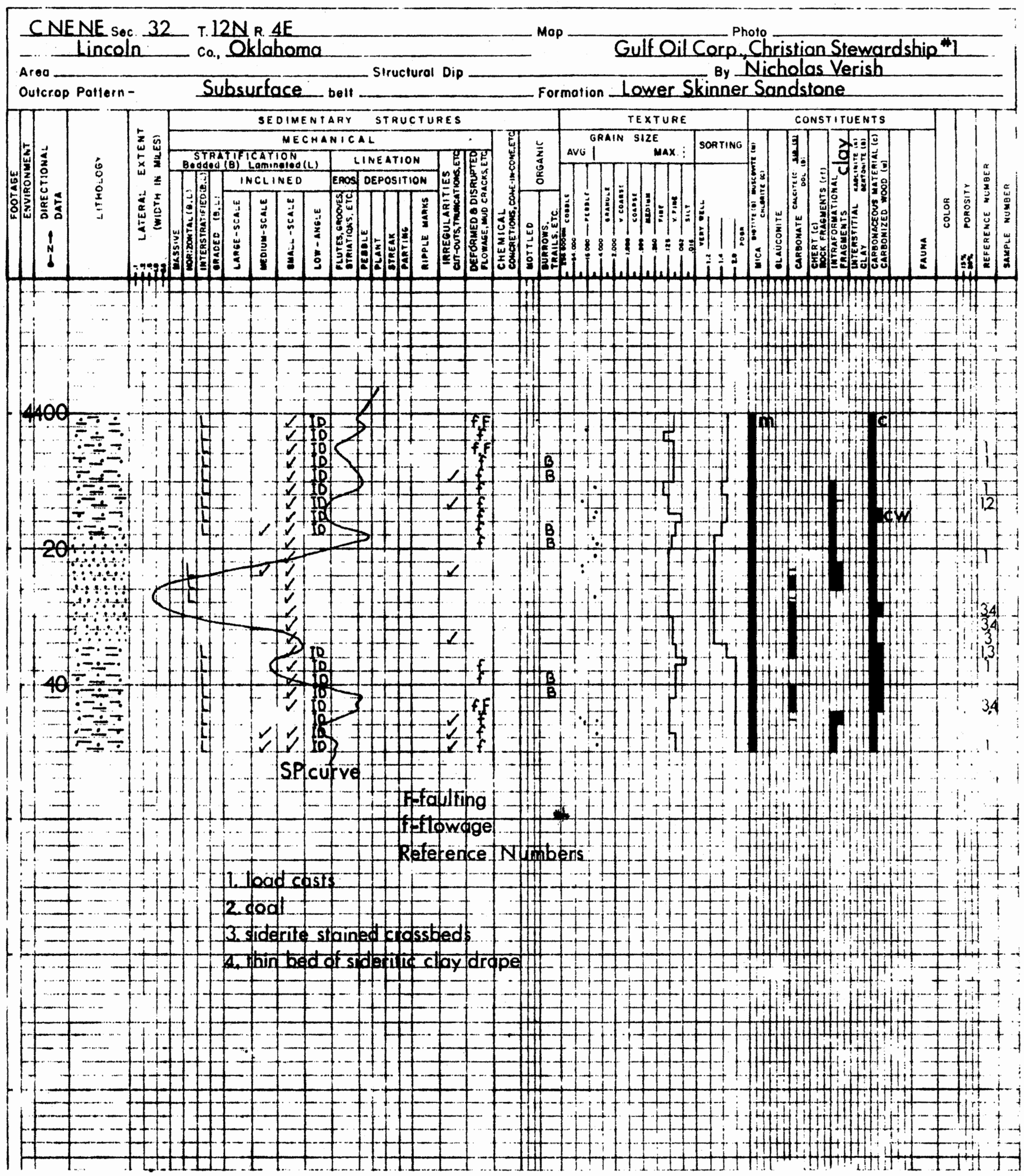



Fig. 13.-Core Description of Lower Skinner Sandstone, Gulf Oil Corporation, Christian Stewardship No. 1 with Electric Log of Interval

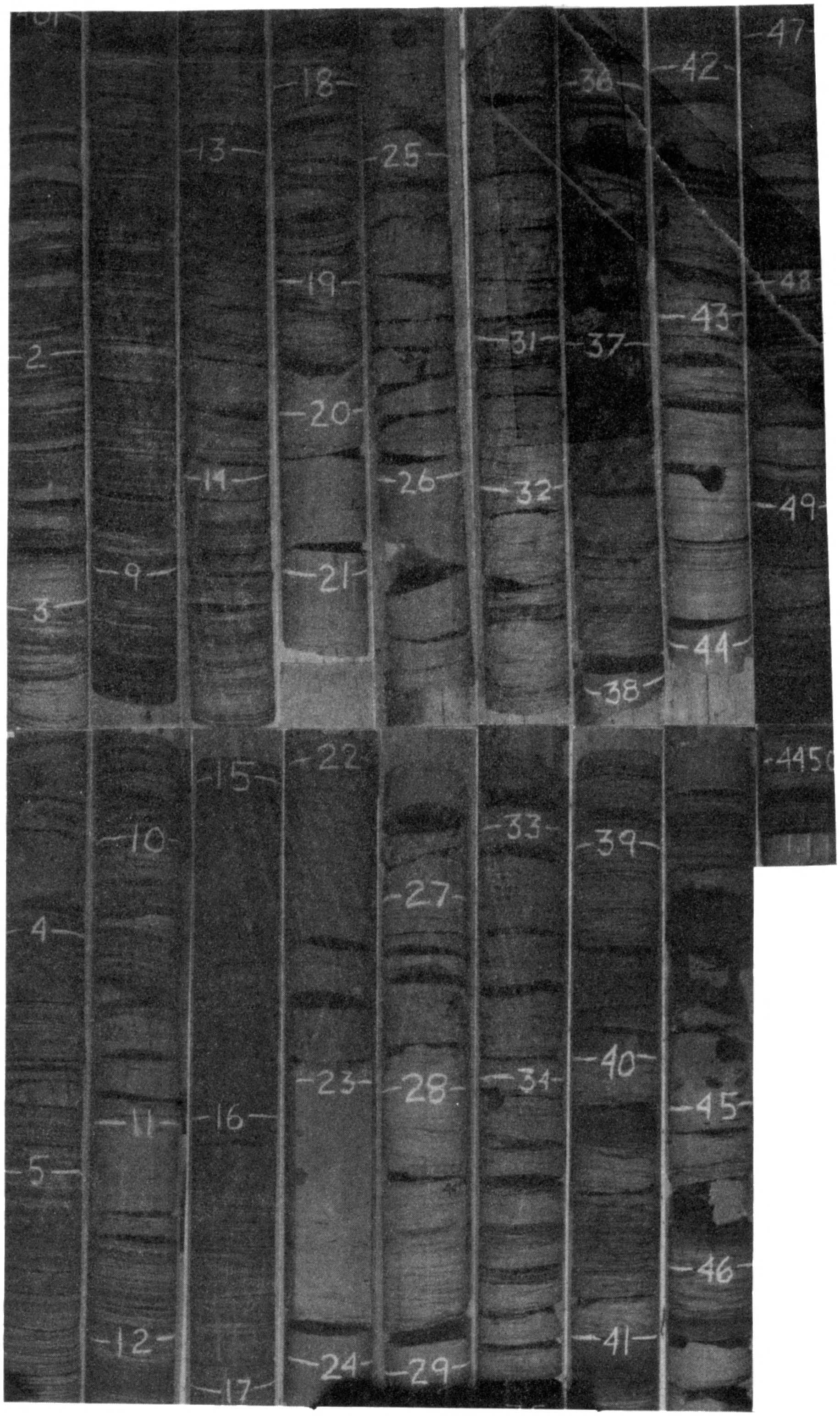
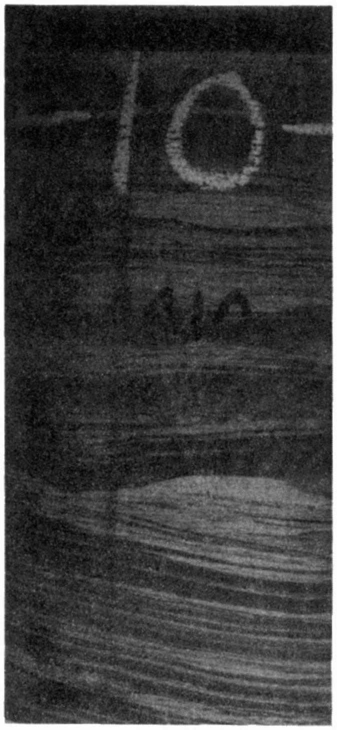
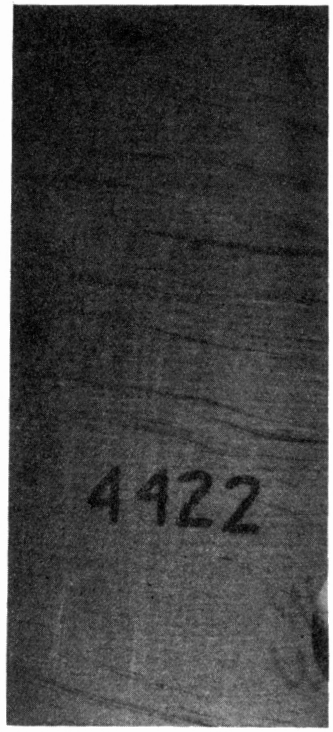


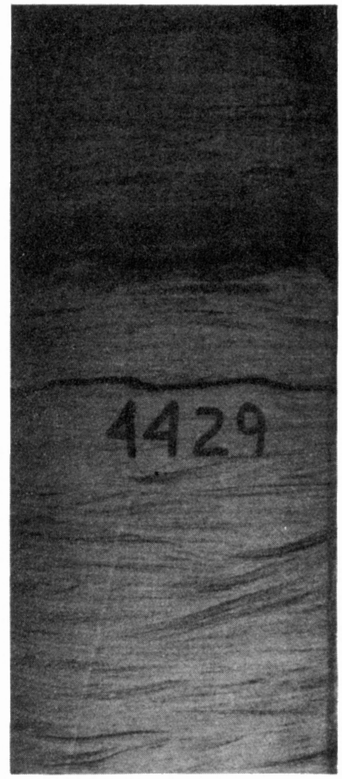

Fig. 14.-Photograph of Lower Skinner Sandstone, Gulf Oil Corporation, Christian Stewardship No. 1



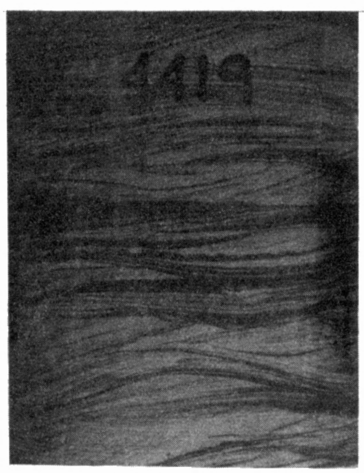
A. Initial Dip, Truncations, and Interlamination



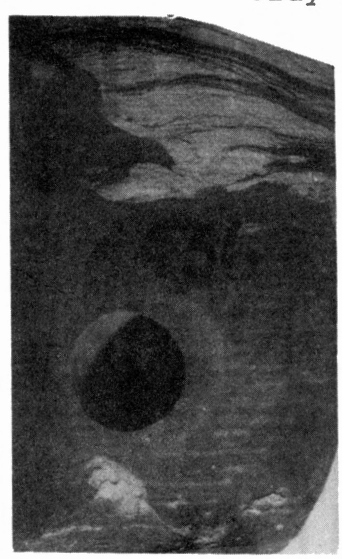

B. Medium-scale Crossbedding, Initial Dip, and Shale Inter-laminae




C. Siderite-stained Small-scale Crossbedding and Clay Interbed




D. Flaser Bedding and Load Casts



E. Soft-sediment Deformed Bedding

Fig. 15.-Significant Internal Features of Lower Skinner Sandstone, Gulf Oil Corporation, Christian Stewardship No. 1

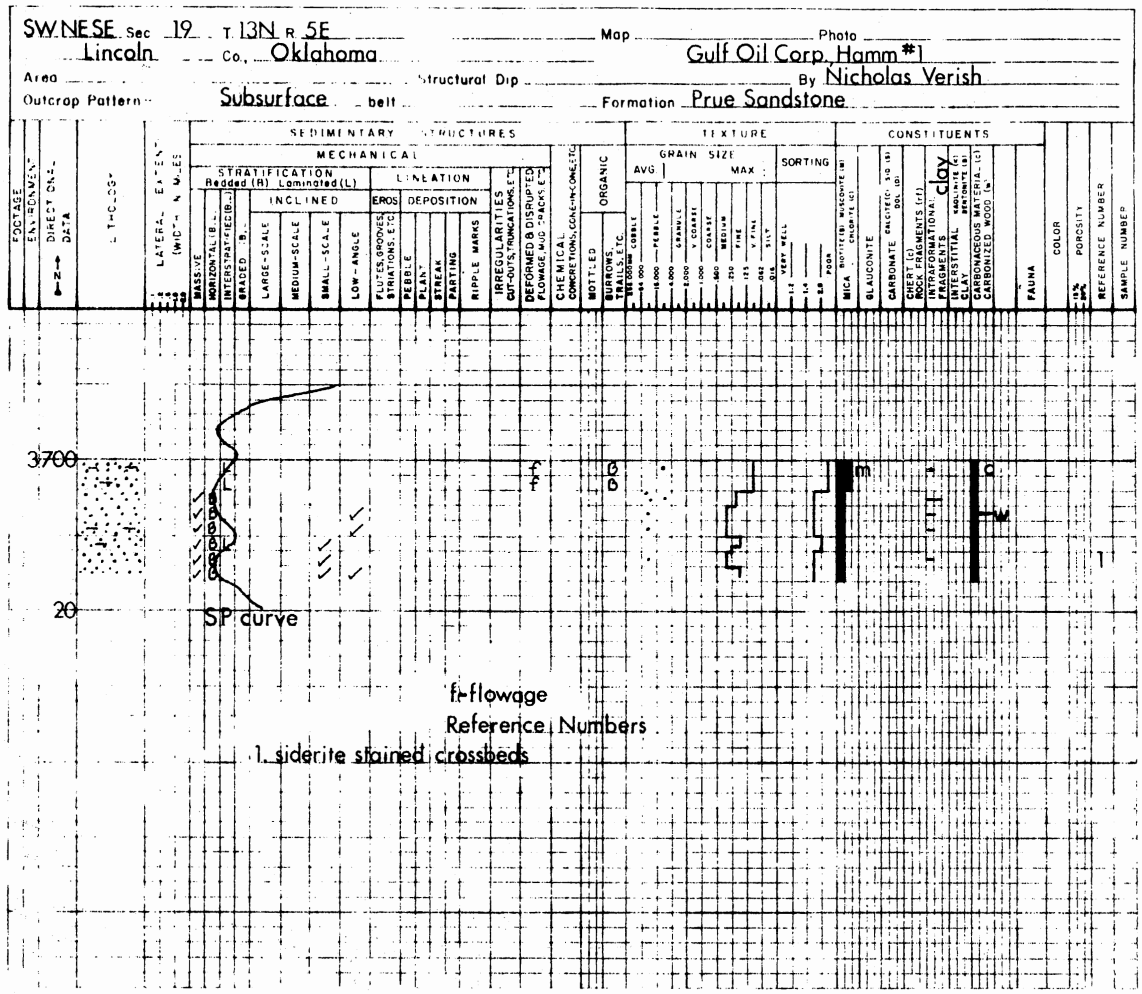



Fig. 16.-Core Description of Prue Sandstone, Gulf Oil Corporation, Hamm No. 1 with Electric Log of Interval

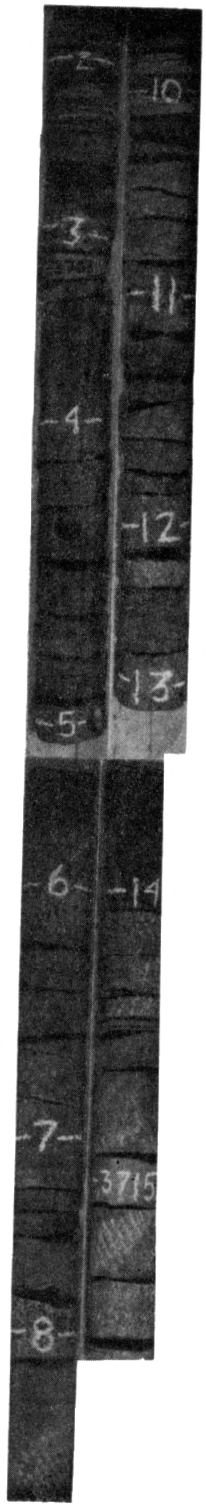
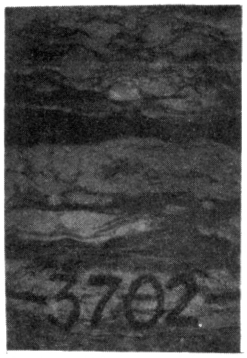
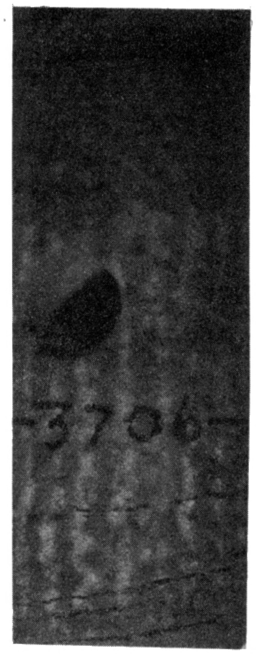


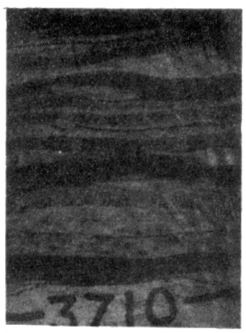

Fig. 17.-Photograph of Prue Sandstone, Gulf Oil Corporation, Hamm No. 1




A. Burrows and Intra-
Formational Clay
Fragments




B. Low-angle Inclined
Bedding




C. Interlamination,
Small-scale Cross-
Bedding, and Hor-
izontal Bedding

Fig. 18.-Significant Internal Features of Prue Sandstone,
Gulf Oil Corporation, Hamm No. 1

East fields contain 70-75 percent quartz; the Lower Skinner core in Sec. 32, T12N,4E contains 55 to 60 percent quartz. In terms of framework only, quartz composes 75 to 80 percent. Kaolinite, the most abundant clay, composes as much as 15 percent of some samples. The Lower Skinner is classified as a Subarkose or Arkosic wacke.

Prue Sandstone. Macroscopic constituents include muscovite, carbonaceous material, carbonaceous wood, and intraformational claystone fragments. The last is present at several levels in the cored interval.

In thin section, feldspar (plagioclase), quartz (and chert), microcline, rock fragments, and carbonate are the main framework constituents. Matrix-cement includes kaolinite, illite, chlorite, iron-oxide coating grains, and carbonate.

Quartz percentages vary from 65 to 70 of the total constituents. It represents 80 to 85 percent of the framework grains. Kaolinite composes 3 to 8 percent of the total constituents. The Prue may be characterized as a Subarkose.

## Depositional Environment

Deposition of the five "Cherokee" sandstones within the study area are thought to represent various elements of deltaic complexes, which are divided into channel and non-channel deposits. Channel units are distributary deposits, and where they are multilateral, they may constitute alluvial plains. Non-channel deposits are delta-fringe units which may have formed in such subenvironments as interdistributary bay, distributary mouth, and delta front. Some relatively thin, narrow units probably represent offshore bars, possibly tidal bars, or small splay-like distributaries.

## Bartlesville Sandstone

Belts of sandstone with sharp basal and lateral contacts suggest channel deposition. However, some relatively narrow bodies have gradational lower and lateral contacts, a feature suggestive of delta-fringe near distributary mouths or shallow-marine tidal bars. More than one genetic unit within a particular trend is indicated by sandstone at different stratigraphic positions, changes in sandstone thickness, and variations in log character. Most channels were minor distributary channels, which probably were less than 30 ft deep. The area was west of the major deltaic lobe (Visher, 1968).

## Red Fork Sandstone

Narrow belts with sharp lateral contacts probably represent distributary deposits. The minor channels probably were from 15 to 20 ft deep, and the larger channels were as much as 50 ft deep. Multistoried-multilateral sandstones may have formed an incipient alluvial plain. Areas of no sandstone between channel deposits indicate alluvial-plain formation was aborted during an early phase.

Possible channel fill or prodelta-tidal flat areas by-passed by distributaries include Sec. 25, T12N,R4E, Sec. 13, T13N,R5E, and Sec. 9, T12N,R5E. Paleoslope apparently was to the south and west. Regional sandstone distribution suggests the source area was to the northeast (Cole, 1968).

Lower Skinner Sandstone

Multistoried-multilateral units in the southern third of the study area may constitute a small alluvial plain. Distributary deposits are suggested for both upper and lower sandstone bodies with sharp basal and lateral contacts and narrow trends. Gradational basal contacts and internal features in local areas where the trends are somewhat wider suggest delta-fringe deposits below distributary facies. Internal features in four cores, such as interstratified shale and sandstone, deformed bedding due to soft-sediment flowage, load casts, and bioturbation, suggest delta-fringe or shallow marine. They, together with horizontal bedding overlying interstratified shale and sandstone, clay interbeds, initial dip beneath horizontal bedding, and their limited distribution suggest deposition near distributary mouth. In the north-central part of the study area, sandstone bodies widen where changes in trend occur. Areas of poorly developed sand within trends may represent channel fill; these deposits are present in the central part of T11N,R4E, Secs. 17-20, T13N,R4E, and the core in Sec. 32, T12N,R4E.

A westerly paleoslope is suggested by the west trending belt of thick sandstone, flanked on the north by relatively thin sandstone bodies. The ultimate source area to the southeast is suggested by regional distribution of sandstone (Cole, 1968).

Upper Skinner Sandstone

Sharp lateral and lower contacts of sandstone bodies indicate deposition within a channel. Local areas of no sandstone within major trends are probably channel fill. The prominent multistoried-multilateral west trend indicates a westerly transport direction and local paleoslope.

Prue Sandstone

The multistoried-multilateral units, characteristically with sharp lower and lateral contacts, are suggestive of channels. However, based on serrated log character, the Prue locally in the north-central part may consist of delta-fringe units or they may underlie channel deposits. The undifferentiated, multistoried-multilateral sandstone body in the northeast part of T12N,R5E, is bulb-shaped in outline. Major channels were approximately 50 ft deep; minor channels were 25 ft deep or less. In the northeast, local patches of delta-fringe or abandoned channel fill deposits may be present where the sandstone is less than 60 ft thick.

The marked increase in thickness of the interval in the southeast part of the study area (Plate 14) apparently represents the edge of the depositional platform which effectively divided the Prue province to the north and the Calvin province to the south (Krumme, 1975). In the study area, sand apparently was derived from both sources.

Initial dip, clay pebbles, and carbonaceous wood in the core in Sec. 19, T13N,R5E, are suggestive of a channel deposit; interbeds, flaser bedding, and deformed features in the upper part of the core suggest channel fill. The cored interval is thought to represent the deposits of a distributary which was filled after abandonment.

## Diagenetic Modifications of Sandstones

Thin-section examination of Prue and Lower Skinner sandstones indicates that formation of secondary clay minerals, quartz overgrowths, and carbonate cement has reduced initial porosity (Figs. 19 and 20). Recognizable secondary minerals compose 2 to 15 percent of the rocks. Kaolinite is present as pore filling, and inferred illite and chlorite line quartz grains. Although kaolinite is present in pores, it has not plugged them completely. The presence of secondary chlorite and illite lining the quartz grains may have inhibited cementation by quartz overgrowths to a significant extent. Contacts between grains are dominantly long (or line) (Fig. 21). Fine- to medium-grained sandstones are characterized by coarsely crystalline kaolinite and relatively abundant carbonate cement.

In fine- to medium-grained sandstones, scattered large pores are thought to represent secondary porosity formed by leaching of carbonate grains (Fig. 22). Secondary porosity apparently is absent in very fine- to fine-grained sandstone.

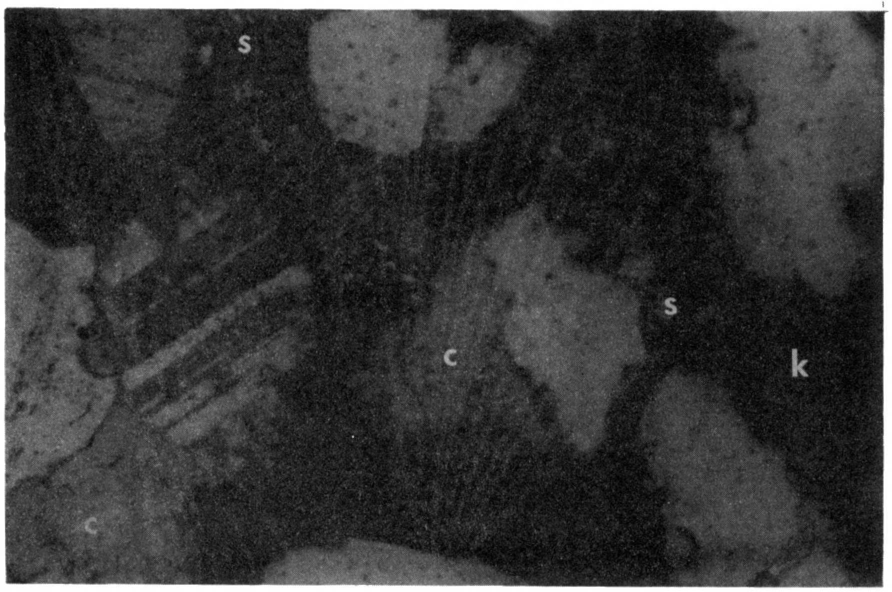



Fig. 19.-Kaolinite (k), Sericite (s), and Carbonate Cement (c) Reducing Initial Porosity, Lower Skinner Sandstone. Field of View .65 X .45 mm, Crossed Nicols

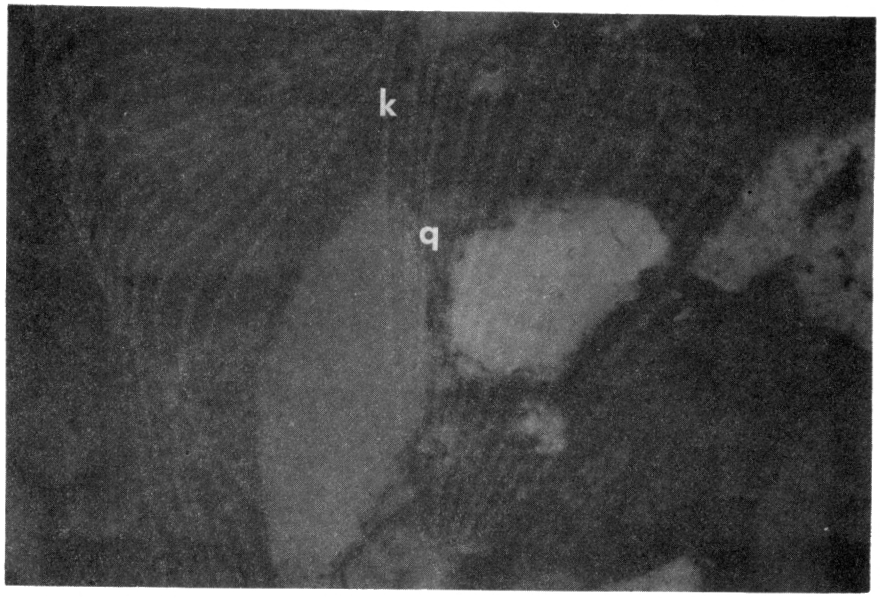



Fig. 20.-Quartz Overgrowth (q) and Kaolinite (k) Reducing Initial Porosity, Lower Skinner Sandstone. Field of View .65 X .45 mm, Crossed Nicols

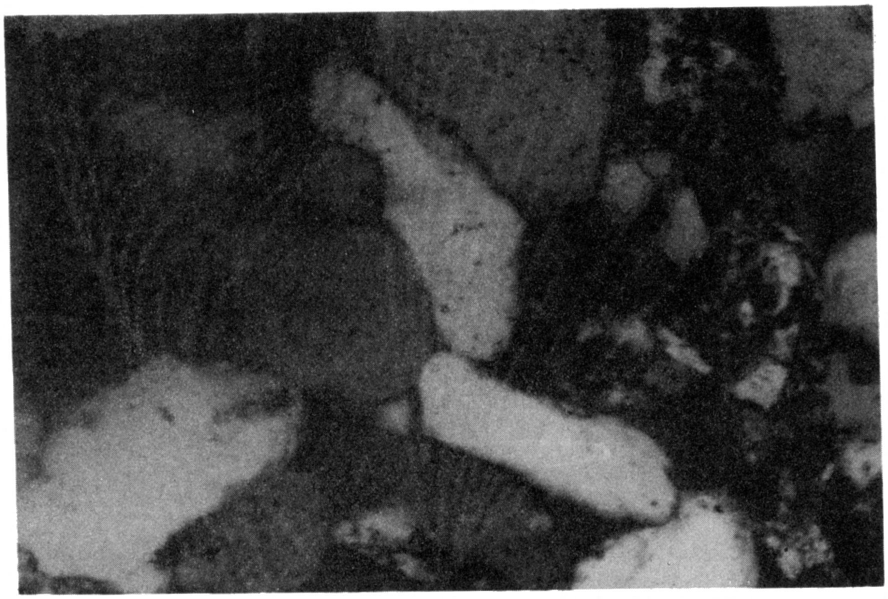


Fig. 21.-Long (or line) Contacts Between Grains, Lower Skinner Sandstone. Field of View .65 X .45 mm, Crossed Nicols

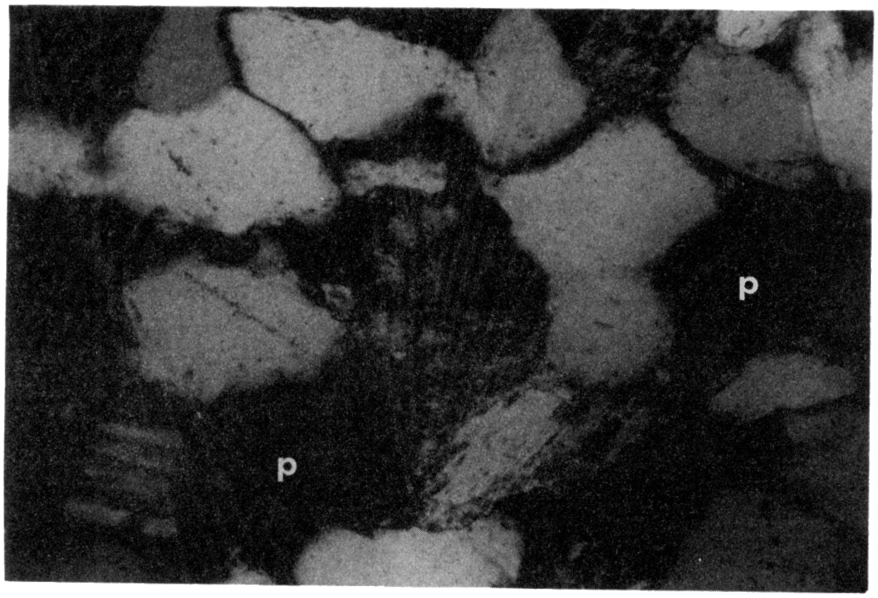



Fig. 22.-Large Pores (p) Representing Secondary Porosity Formed by Leaching of Carbonate Grains, Lower Skinner Sandstone. Field of View .65 X .45 mm, Crossed Nicols

## CHAPTER VI

## PETROLEUM GEOLOGY

Pennsylvanian and older rocks have produced petroleum in the study area (Fig. 23). Reservoirs include the Pennsylvanian Prue, Lower Skinner, Red Fork, and Bartlesville sandstones, Silurian-Devonian Hunton Group, Ordovician Viola Limestone, Simpson Group, and "First and Second Wilcox" sandstones. Nine fields produce or have produced solely from sandstones of the "Cherokee" Group (Table I); seven fields produce from both "Cherokee" sandstones and pre-Pennsylvanian reservoirs (Table II); and eight fields produce from pre-Pennsylvanian reservoirs (Table III). Production ranges in depth from 3202 to 5542 ft. Data concerning production in the study area are from Atchison and Wiggins (1977).

Fields producing from the "Cherokee" apparently are structural-stratigraphic or stratigraphic traps. Based on a structural contour map with the base of the Oswego Limestone as the reference surface (Fritz, 1978), Sparks East field is on a south-southwest- to southwest-plunging nose, across which the Prue Sandstone pinches out (Plate 14).

Prue production in Arlington Northwest, Arlington West, Wilzetta and Wilzetta South fields probably is from stratigra-

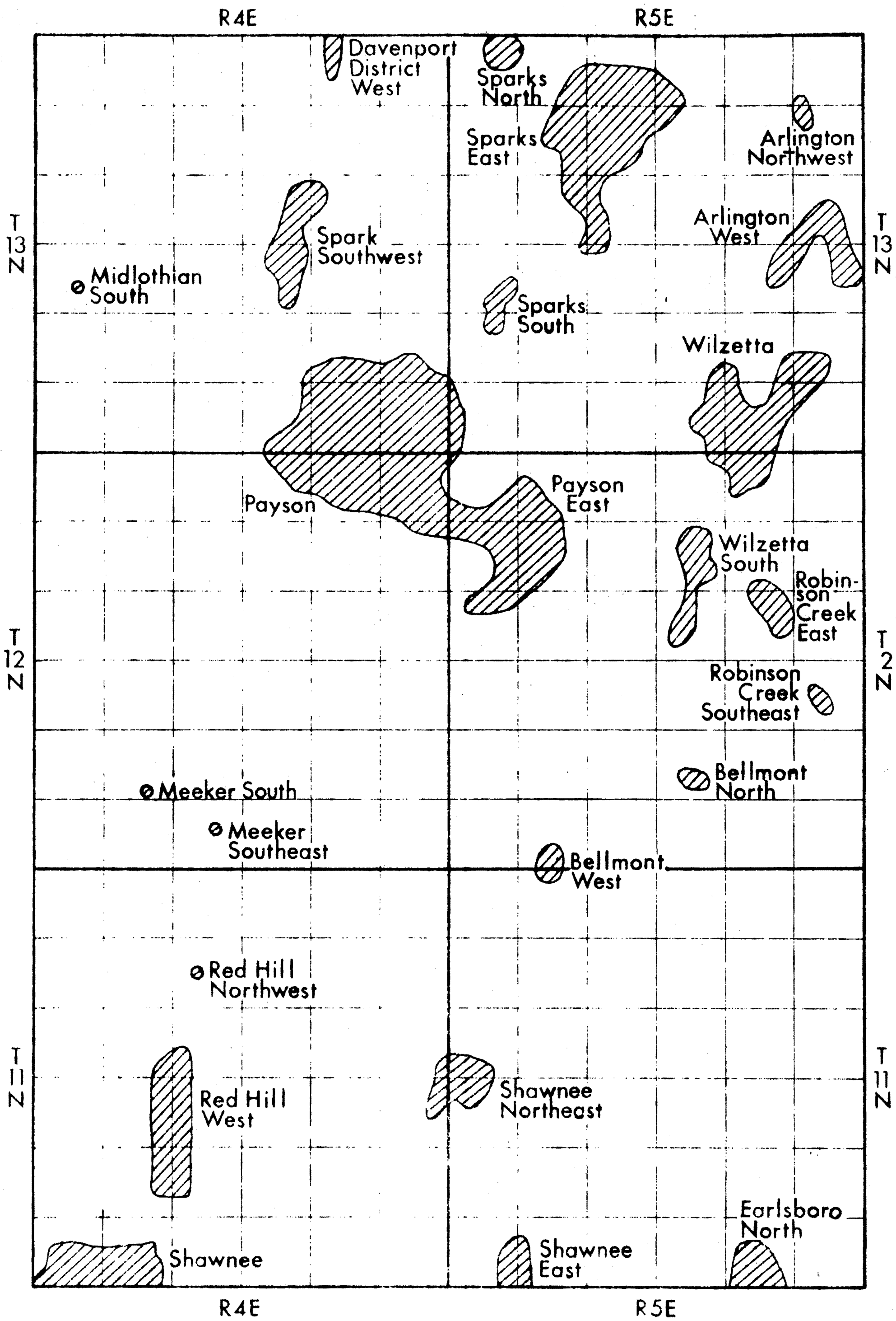



Fig. 23.-Index Map of Oil and Gas Fields

TABLE I

FIELDS IN T11-13N, R4-5E PRODUCING FROM "CHEROKEE" SANDSTONES

| Field | Year Disco-vered | Producing Formation | Depth to production (ft) | Total Acres | Oil Production BBls in 1975 | Oil Production Cum BBls to 1-1-76 | Gas Produc. Cum MCF to 1-1-76 |
|---|---|---|---|---|---|---|---|
| Arlington Northwest | 1963 | Prue | 3356 | 20 | 0 | 367 | 97,000 |
| Davenport District West | 1940 | Lower Skinner | 3920 | 2,512 | 39,021 | 6,473,380 | 8,074,405 |
| Midlothian South | 1965 | Lower Skinner | 4371 | 10 | 0 | 6,646 | 0 |
| Payson | 1940 | Lower Skinner | 4200 | 4,670 | 24,440 | 15,285,595 | 0 |
| Payson East | 1952 | Lower Skinner | 4090 | 1,840 | 0 | 2,963,216 | 0 |
| Red Hill Northwest | 1975 | Lower Skinner | 4404 | - | 0 | 0 | 0 |
| Red Hill West | 1965 | Lower Skinner | 4390 | 440 | 15,082 | 303,119 | 2,944,331 |
| Sparks Southwest | 1961 | Lower Skinner | 4173 | 140 | 83,524 | 408,217 | 0 |
| Sparks North | 1966 | Bartlesville | 4004 | 120 | 0 | 25,000 | 0 |

TABLE II

FIELDS PRODUCING FROM "CHEROKEE" SANDSTONES AND PRE-PENNSYLVANIAN FORMATIONS

| Field | Year Disco-vered | Producing Formation | Depth to produc-tion (ft) | Total Acres | Oil Production | | Gas Produc. |
|---|---|---|---|---|---|---|---|
| | | | | | BBls in 1975 | Cum BBls to 1-1-76 | Cum MCF to 1-1-76 |
| Arlington West | 1953<br>1959 | Prue<br>Hunton<br>"Second Wilcox" | 3202<br>4214 | 380 | 44,332 | 1,249,327 | 198,000 |
| Shawnee | 1934 | Lower Skinner<br>Earlsboro<br>Hunton | 4425<br>4450<br>5230 | 960 | 29,680 | 7,351,815 | 0 |
| Shawnee East | 1949 | Bartlesville<br>"Wilcox" | 4100<br>5504 | 600 | 43,797 | 967,526 | 0 |
| Sparks East | 1950 | Prue<br>Hunton | 3500<br>4762 | 1780 | 38,618 | 7,528,759 | 85,197 |
| Sparks South | 1945<br>1948 | Prue<br>"Wilcox" | 3640<br>4984 | 130 | 0 | 841,000 | 0 |
| Wilzetta | 1934 | Prue<br>Hunton<br>Simpson<br>Viola | 3346<br>4260<br>4450<br>4536 | 540 | 8,893 | 3,880,545 | 585,881 |
| Wilzetta South | 1936 | Prue<br>Red Fork<br>Hunton<br>Viola<br>"Wilcox" | 3313<br>3803<br>4339<br>4473<br>4510 | 240 | 12,622 | 1,933,303 | 0 |

TABLE III

FIELDS PRODUCING FROM PRE-PENNSYLVANIAN FORMATIONS

| Field | Year Disco-vered | Producing Formation | Depth to pro-duction (ft) | Total Acres | Oil Production BBls in 1975 | Oil Production Cum BBls to 1-1-76 | Gas Produc. Cum MCF to 1-1-76 |
|---|---|---|---|---|---|---|---|
| Bellmont North | 1966 | "First Wilcox" | 4753 | 80 | 1,285 | 518,432 | 0 |
| | 1966 | "Second Wilcox" | 4770 | | | | |
| Bellmont West | 1950 | "First Wilcox" | 5010 | 110 | 0 | 9,000 | 0 |
| | | "Second Wilcox" | 4961 | | | | |
| Earlsboro North | 1936 | Hunton | 4400 | 1060 | 37,336 | 11,398,719 | 0 |
| | | "Wilcox" | 4600 | | | | |
| Meeker South | 1957 | "Wilcox" | 5536 | 10 | 0 | 2,000 | 0 |
| Meeker South-east | 1953 | "Wilcox" | 5542 | 80 | 0 | 83,000 | 0 |
| Robinson Creek East | 1954 | Viola | 4450 | 110 | 679 | 47,157 | 0 |
| Robinson Creek Southeast | 1959 | "First Wilcox" | 4715 | 80 | 6,878 | 22,699 | 0 |
| Shawnee North-east | 1942 | "Wilcox" | 4850 | 420 | 29,303 | 4,941,313 | 0 |
| | 1949 | Hunton | 4635 | | | | |

phic traps. Structural influence may be important at Wilzetta where a faulted, west-plunging nose is present in Secs. 26, 35-36, T13N,R5E.

Local updip edges of permeable Lower Skinner Sandstone are present in Davenport District West, Payson, Payson East, Red Hill Northwest, Red Hill West, Midlothian South, and Shawnee fields (Plate 12). Because "Cherokee" structural dip is rather uniformly to the west, these fields are thought to be stratigraphic traps.

The two shut-in Red Fork Sandstone gas wells in Secs. 16 and 20, T13N,R5E, are on the south-southwest- to southwest-plunging nose noted heretofore. Permeable Red Fork Sandstone, as well as Prue, pinches out across this nose (Plates 11 and 14). Red Fork Sandstone production in Wilzetta South apparently is stratigraphically trapped, apparently due to updip changes in the reservoir. However, some structural control may be afforded by a north-northeast-trending fault inferred to be present in the lower part of the "Cherokee".

Bartlesville Sandstone production in Sparks North field is from a stratigraphic trap. An arcuate updip limit of sandstone is coupled with uniformly west-southwest dipping beds (Plates 1 and 10).

# CHAPTER VII

## GEOLOGIC HISTORY

The oldest Pennsylvanian rocks in the study area are the "Cherokee" Group. Cyclic deposition, which characterized pre-Oswego Desmoinesian, was related to transgressions and regressions. The earliest transgression was over the eroded Mississippian surface. The five lenticular sandstones delineated in the study area were deposited during regressions. Transgressive units consist of thin limestones and a coastal coal.

A north-northeast-trending strike-slip fault zone with some dip-slip displacement apparently was active during the early part of "Cherokee" deposition. During deposition of the "Cherokee" Group, there apparently was reciprocity in sedimentation, probably due to differential compaction and/or paleotography. This relationship is developed in the area not affected by the contemporaneous faulting or relatively rapid rates of subsidence.

Early "Cherokee" regressions were from the craton and/or Applachian uplift to the northeast, whereas the Ouachita uplift became more important as a source area with time. Evidence for this interpretation is best displayed by the Prue-Calvin sandstone complex. None of the regressions progressed to the stage of a well developed alluvial plain in the area of study. Incipient plains probably formed during deposition of the Red Fork, Lower Skinner, and Prue. Prodeltaic-shallow marine conditions characterized much of the area during deposition of the Bartlesville and Upper Skinner.

Stratigraphic and stratigraphic-structural hydrocarbon traps formed as the result of deposition of lenticular sandstones and structural development. Contemporaneous faulting may have been responsible for formation of some traps, but structural noses and regional dip were introduced as structural elements at an undetermined time after deposition.

Initial porosity and permeability of reservoir rocks were reduced by secondary kaolinite, illite, sericite, chlorite, carbonate, and quartz overgrowths. In the coarser grained sandstones, some carbonate has been leached to form secondary porosity.

# CHAPTER VIII

## SUMMARY

The principal conclusions of this study are as follows:

1. Rocks of the Pennsylvanian (Desmoinesian) "Cherokee" Group are the oldest Pennsylvanian units in the study area; they unconformably overlie Mississippian Limestone of Osagean age.

2. The "Cherokee" Group is composed of cyclic sequences of shales, sandstones, thin limestones, and at least one coastal coal bed.

3. The transgressive limestones and coal with the intervening sandstone units constitute transgressive-regressive couplets.

4. The most prominent structural feature, affecting lower "Cherokee" strata, is a fault zone, which is reflected by an en echelon fault zone at the surface.

5. Changes in interval thicknesses represent variations in sandstone development, differential compaction, reciprocity in sedimentation, and contemporaneous fault movement.

6. All sandstones, except probably the Bartlesville, contain multistored-multilateral sandstone bodies, which in detail show complex patterns of distribution.

7. Inferred depositional environments of the five "Cherokee" sandstones in the study area are various elements of deltaic complexes; the sandstones are categorized as distributary channel and delta-fringe (non-channel) deposits.

8. All sandstones show much variation in orientation; Prue, Red Fork, and Bartlesville sandstones contain prominent north-south trends; the dominant Upper Skinner trend is east-west.

9. Early "Cherokee" regressions in the area of study were from the craton and/or Appalachian uplift to the northeast, whereas the Ouachita uplift became more important as a source area with time.

10. Fields producing from the "Cherokee" reservoirs are stratigraphic and structural-stratigraphic traps.

11. Primary porosity has been reduced by secondary clays, carbonate, and quartz overgrowths. Fine- to medium-grained sandstones exhibit some secondary porosity.

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# APPENDIX

## LOCATIONS OF ELECTRIC LOGS USED IN PREPARATION OF CORRELATION SECTIONS

| No. | Operator and Well Number | Location |
|---|---|---|

## North-South Correlation Section A-A'

| No. | Operator and Well Number | Location |
|---|---|---|
| 1. | Tompson & Lee Co., Telford #1 | NW SW NE Sec. 5-13N-4E |
| 2. | Bryant-Hayward Co., & Woods Petroleum Corp., Oliphant #1 | NW NW SE Sec. 8-13N-4E |
| 3. | Harper & Turner, Cansler #1 | NE NE SW Sec. 17-13N-4E |
| 4. | Wood Oil Co., Gardner #A-1 | NW SW NW Sec. 20-13N-4E |
| 5. | Allied Materials Corp., Gibson #1 | C NE SW Sec. 29-13N-4E |
| 6. | The Texas Co., McGehee #1 | NW NW NE Sec. 32-13N-4E |
| 7. | Flynn Oil Co., Thompson #1 | C SW NE Sec. 5-12N-4E |
| 8. | Percy Butler, Shaw #1 | NE NE NW Sec. 8-12N-4E |
| 9. | Mid-Continent Petroleum Co., Hall #1 | NW NW SE Sec. 17-12N-4E |
| 10. | Deardorf Oil Co., Wilborn #1 | SW SW NW Sec. 28-12N-4E |
| 11. | Gulf Oil Corp., Christian Stewardship #1 | C NE NE Sec. 32-12N-4E |
| 12. | Kingwood Oil Co., Williams #1 | SE SW NW Sec. 33-12N-4E |
| 13. | Great Basin Petroleum Co., Boulson #1 | NW SE SW Sec. 33-12N-4E |
| 14. | Kingwood Oil Co., Scott #1 | C NE NW Sec. 4-11N-4E |
| 15. | Falcon-Seaboard Drilling Co., Dawkins #1 | SW SW NW Sec. 9-11N-4E |
| 16. | Continental Oil Co., Griggs #2 | C NE NE Sec. 20-11N-4E |
| 17. | Continental Oil Co., Zwifel #1 | C NE SE Sec. 20-11N-4E |
| 18. | Continental Oil Co., Bernard #1 | C NE SE Sec. 29-11N-4E |
| 19. | Robert M. Jordan, McCellan #1 | SE SW NE Sec. 32-11N-4E |

## North-South Correlation Section B-B'

| No. | Operator and Well Number | Location |
|---|---|---|
| 1. | Earl E. Barns, Winship #1 | NW NE SW Sec. 2-13N-4E |
| 2. | Wil-Mac Oil Corp., Allenbaugh #A-1 | NE NW NW Sec. 11-13N-4E |
| 3. | Nadel & Gussman, Miller #1 | NW NE NW Sec. 14-13N-4E |
| 4. | Nadel & Gussman, Reed #1 | SE SE SW Sec. 14-13N-4E |
| 5. | Fred Morgan, Koos #1 | SW NW SE Sec. 23-13N-4E |
| 6. | Globe Oil & Refining Co., Lightfoot #1 | SW NW SE Sec. 26-13N-4E |
| 7. | Gulf Oil Corp., Goodell #1 | SW NE SE Sec. 35-13N-4E |
| 8. | Gulf Oil Corp., Wood #7 | SW SW NE Sec. 2-12N-4E |
| 9. | Sunray & General Drilling Co., Pollard #1 | SE SE NW Sec. 14-12N-4E |
| 10. | W.O. Schock Co., Markwell #1 | NE SW NE Sec. 26-12N-4E |
| 11. | Harper-Turner & C.L. Carlock, Inc., Sherwin #1 | SE SW SE Sec. 26-12N-4E |
| 12. | Cameron Oil Co., Martin #1 | SE NE NW Sec. 2-11N-4E |
| 13. | Sterling Oil Co., Youngblood #2 | SE SE NW Sec. 11-11N-4E |
| 14. | Clark & Cowden, Garrett #1 | SW SW SE Sec. 23-11N-4E |

| | |
|---|---|
| 15. Davon Oil Co., Rod & Gun Club #1 | NW NW SE Sec. 23-11N-4E |
| 16. Davon Oil Co., Cherokee Woman #1 | SW SE SW Sec. 36-11N-4E |

North-South Correlation Section
C-C'

| | |
|---|---|
| 1. R. J. Wilson & Deer Fork Drilling Co., Quinn #1 | SW NW NE Sec. 6-13N-5E |
| 2. Aurora Gasoline Co., Collier #1 | SW SW NE Sec. 7-13N-5E |
| 3. Gulf Oil Corp., Hamm #1 | SW NE SE Sec. 19-13N-5E |
| 4. Falcon Seaboard Co., Bierman #1 | SW NE NE Sec. 30-13N-5E |
| 5. Target Drilling Corp., Foth #1 | SW NE NE Sec. 6-12N-5E |
| 6. Vierson & Cochran, Martin #3 | NE SW SW Sec. 5-12N-5E |
| 7. Vierson & Cochran, S. Payson Unit #18-4 | SW SE SW Sec. 8-12N-5E |
| 8. Earl Barnes, Flemming #1 | SE SE NW Sec. 17-12N-5E |
| 9. N.V. Duncan & Anderson-Prichard, Graper #1 | SE SW SE Sec. 20-12N-5E |
| 10. Buttram Petroleum Co., Lovell-Barnes #1 | SE SE SE Sec. 29-12N-5E |
| 11. McElreath & Harvey, Meier #1 | NE NE NE Sec. 5-11N-5E |
| 12. Finley Co., Good #1 | NW NW SW Sec. 4-11N-5E |
| 13. E.F. McDonald, Davis #1 | SE SE NW Sec. 9-11N-5E |
| 14. Sun Oil Co., Land #1 | NE NE SW Sec. 16-11N-5E |
| 15. Ashland Oil Co., Clemmens #1 | SE NW SW Sec. 21-11N-5E |
| 16. G.B. Suppes, Kubicek #1 | NW NW SW Sec. 28-11N-5E |
| 17. Hall & Wise, Clearman #1 | SE SW SE Sec. 32-11N-5E |

North-South Correlation Section
D-D'

| | |
|---|---|
| 1. Pelican Production Corp., Barrett #1 | SE SE NW Sec. 1-13N-5E |
| 2. Herbert J. Schmitz Davis #1 | SW SW SW Sec. 1-13N-5E |
| 3. McElroy Ranch Co., Grimes #1 | NW SE SE Sec. 11-13N-5E |
| 4. Anderson & Prichard Oil Corp., Marshall #1 | NE NE SE Sec. 14-13N-5E |
| 5. Christie-Stewart Drilling Co., Kirkpatrick #1 | C SE NE Sec. 23-13N-5E |
| 6. Allied Materials Corp., Meier #1 | C SE SE Sec. 23-13N-5E |
| 7. Davidor & Davidor, Hardesty #2 | SW NE SE Sec. 26-13N-5E |
| 8. Davidor & Davidor, Jackson #1-B | SW SE NE Sec. 35-13N-5E |
| 9. Four States Oil & Gas Co., Bailey #A-2 | NE NW NE Sec. 2-12N-5E |
| 10. Mohawk Drilling Co., Meier #1 | NW NE SE Sec. 2-12N-5E |
| 11. Parker Drilling Co., Royalty #1 | NW NE SE Sec. 11-12N-5E |
| 12. Pellow Oil Co., et al., Brockman #1 | NE NE SE Sec. 14-12N-5E |
| 13. Powel Briscoe Inc., Jezek #1 | NE NW SW Sec. 24-12N-5E |
| 14. Robert Kerr, England #1 | SE NW SE Sec. 25-12N-5E |
| 15. H.F. Wilcox Oil & Gas Co., Gully #1 | C SE SW Sec. 36-12N-5E |

| | | |
|---|---|---|
| 16. | Laffoon Oil Co. Turner #1 | SW NE SW Sec. 1-11N-5E |
| 17. | B.B. Blair Oil Co., McCosato #1 | NW NW NW Sec. 13-11N-5E |
| 18. | Wise & Phillips Petroleum Co., Clemence #1 | NW NE NE Sec. 23-11N-5E |
| 19. | Sojourner Drilling Corp., Crain #1 | SE NW NW Sec. 25-11N-5E |
| 20. | J.S. Wise, Carr #1 | NW NE NW Sec. 36-11N-5E |
| 21. | Trans-Viking Petroleum, Inc., Newell #1 | NE SE SW Sec. 36-11N-5E |

## East-West Correlation Section E-E'

| | | |
|---|---|---|
| 1. | Potts-Stephenson, McMinn #1 | C NE SW Sec. 19-13N-4E |
| 2. | Wood Oil Co., Gardner #A-1 | NW SW NW Sec. 20-13N-4E |
| 3. | Mid-Continent Petroleum Corp., Fair #1 | NE NW SE Sec. 21-13N-4E |
| 4. | Fred Morgan, Koos #1 | SW NW SE Sec. 23-13N-4E |
| 5. | Portable Drilling Co., Murray #1 | C NW SE Sec. 24-13N-4E |
| 6. | Gulf Oil Corp., Hamm #1 | SW NE SE Sec. 19-13N-5E |
| 7. | Wilcox & Magnolia, Sparks #1 | SE NE SW Sec. 21-13N-5E |
| 8. | Delaney Drilling Co., et al., OCE #1 | NE SW SE Sec. 22-13N-5E |
| 9. | Trans-Viking Petroleum Co., Munzy #1 | NW SE SW Sec. 23-13N-5E |
| 10. | Allied Materials Corp., Meier #1 | S½ SE SE Sec. 23-13N-5E |
| 11. | Mohawk Drilling Co., Anness Estate #1 | NE SE NE Sec. 24-13N-5E |

## East-West Correlation Section F-F'

| | | |
|---|---|---|
| 1. | Gulf Oil Corp., Jenkins #1 | SE SW SE Sec. 6-12N-4E |
| 2. | Flynn Oil Co., Thompson #1 | C SW NE Sec. 5-12N-4E |
| 3. | Summit Drilling Co., et al., Clark #1 | SE SW NE Sec. 4-12N-4E |
| 4. | Pellow Oil Co., Lewis #1 | NE NE SW Sec. 3-12N-4E |
| 5. | Gulf Oil Corp., Goodell Wood #7 | SW SW NE Sec. 2-12N-4E |
| 6. | Gulf Oil Corp., Queenan #3 | SW SE NW Sec. 1-12N-4E |
| 7. | Vierson & Cochran, Kittredge #7 | SW NW NE Sec. 7-12N-5E |
| 8. | Vierson & Cochran, S. Payson Unit #18-4 | SW SE SW Sec. 8-12N-5E |
| 9. | Sterling Oil Co., Burchette #2 | NE NW SE Sec. 8-12N-5E |
| 10. | L.H. Armer, et al., Deans #1 | NE SW NE Sec. 9-12N-5E |
| 11. | Phillips Petroleum Co., Zimmerman #4 | NW SW NE Sec. 10-12N-5E |
| 12. | Parker Drilling Co., Royalty #1 | NW NE SE Sec. 11-12N-5E |

## East-West Correlation Section
## G-G'

| | | |
|---|---|---|
| 1. | Lee Evans Drilling Co., Fowler #1 | NW NW SE Sec. 31-12N-4E |
| 2. | Gulf Oil Corp., Christian Stewardship #1 | C NE NE Sec. 32-12N-4E |
| 3. | Olin Oil & Gas Corp., Williams #1 | NW NE NW Sec. 33-12N-4E |
| 4. | H.T.M. Oils Inc., Neighbors #1 | NW NE NW Sec. 34-12N-4E |
| 5. | C.L. Carlock Inc., Sherwin #1 | SE SW SE Sec. 26-12N-4E |
| 6. | Pelican Production Co., Goulker #1 | SE NE NE Sec. 36-12N-4E |
| 7. | Peppers Refining Co., Wadsack #1 | NW NW NE Sec. 32-12N-5E |
| 8. | Buttram Petroleum Co., Lovell-Barnes #1 | SE SE SE Sec. 29-12N-5E |
| 9. | Pellow Oil Co., et al., Tohanec #1 | NE NE NE Sec. 33-12N-5E |
| 10. | General Drilling Co., Lacquement #1 | NW NW NW Sec. 35-12N-5E |
| 11. | Robert Kerr, England #1 | SE NW SE Sec. 25-12N-5E |

## East-West Correlation Section
## H-H'

| | | |
|---|---|---|
| 1. | Sun Oil Co., Allenbaugh #1 | NW SE SE Sec. 18-11N-4E |
| 2. | Continental Oil Co., Griggs #2 | C NE NE Sec. 20-11N-4E |
| 3. | An-Son Corp., Saequat #1 | C SW NE Sec. 21-11N-4E |
| 4. | Clark & Cowden, Washington #1 | SE SE SE Sec. 22-11N-4E |
| 5. | Clark & Cowden, Garrett #1 | SW SW SE Sec. 23-11N-4E |
| 6. | Atlantic Refining Co., Abernathy #1 | SE SW NE Sec. 24-11N-4E |
| 7. | Ashland Oil & Ref. Co., Clemmens #1 | SE NW SW Sec. 21-11N-5E |
| 8. | James S. Wise, Clemence #1 | SE SW NW Sec. 22-11N-5E |
| 9. | Kewanee Oil Co., Klab #1 | NW SW NE Sec. 22-11N-5E |
| 10. | Wise & Phillips Petroleum Co., Clemence #1 | NW NE NE Sec. 23-11N-5E |
| 11. | Trans-Viking Petroleum Inc., Crain #1 | NE NW SE Sec. 24-11N-5E |

2

VITA

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