DEPOSITIONAL ENVIRONMENTS, RESERVOIR TRENDS, AND DIAGENESIS OF THE RED FORK SANDSTONE

WESTERN

IN GRANT AND EASTERN KAY COUNTIES, OKLAHOMA

By

JON LAWRENCE GLASS

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1978

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1981

OKLAHOMA STATE UNIVERSITY LIBRARY

DEPOSITIONAL ENVIRONMENTS, RESERVOIR TRENDS, AND DIAGENESIS OF THE RED FORK SANDSTONE IN GRANT AND EASTERN KAY COUNTIES, OKLAHOMA

Thesis approved:

Gary F. Stewart
Thesis Adviser

Zuhair al-Shaieb

Lawrence M. Hoffman

Norman N Durham
Dean of the Graduate College

1089276

PREFACE

This thesis concerns the depositional environments, reservoir trends, and diagenetic sequences of the Desmoinesian Red Fork sandstone. Electric logs and gamma-ray logs were used to construct stratigraphic cross-sections, structural geologic maps, log maps, and an isopach map. Analyses of cores, cross-sections, isopach and log maps were used to interpret depositional enviornments and trends of reservoirs. Study of thin sections and scanning-electron photomicrographs of selected samples permitted interpretation of the diagenetic history.

The writer wishes to thank Dr. Gary Stewart and Dr. John W. Shelton, co-advisors, for their guidance and assistance during this study. Thanks for critical review of maps go to Mr. Laurence M. Wilson of Texaco U.S.A. Suggestions concerning diagenesis made by Dr. Zuhair Al-Shaieb are greatly appreciated.

Information and material came from the Oklahoma Geological Survey, which provided cores, and Texaco U.S.A. which provided access to well logs and production data.

Special appreciation is extended to Texaco U.S.A., Tulsa Division, for their unlimited patience and their financial support in the completion of this study. The writer's parents, Bob and Marie Glass, along with Tom and Jane Palmer deserve special recognition for their encouragement an financial support.

The writer is especially thankful to his wife, Marian, for her constant encouragement and endless patience.

TABLE OF CONTENTS

LIST OF FIGURES

Figure Page

Figure Page

TABLE

LIST OF PLATES

Plate

CHAPTER I

ABSTRACT

The Red Fork sandstone is believed to have been deposited on the northern shelf of the Anadarko Basin as a complex of meandering streams in a lower alluvial plain environment. Two distinct phases of sand deposition are represented by the upper and lower units of Red Fork sandstone. Evidence for this interpretation is based on characteristics shown by the Red Fork sandstone in cores and in thin sections, in combination with geometry, trend, and sandstone relationship to laterally equivalent sedimentary rocks.

The structural geology of the study area is that of gentle southwestward dip at less than 0.5 degrees per mile. In the eastern third of the area this dip is interrupted by an anticlinal trend sub-parallel to the Nemaha Ridge.

Based on composition of the lower Red Fork sand, trends of channel-form sands, and regional paleogeology it is concluded that the source area for the Red Fork sandstone probably was from the positive features to the north, namely the Central Kansas Uplift, Pratt Anticlines, and the Nemaha Ridge.

Oil and gas fields in the Red Fork are combination structural and stratigraphic traps. This circumstance leads to variation in gas-oil and oil-water contacts.

Diagenesis of the lower Red Fork is believed to have occurred in three stages, namely (1) compaction and cementation, (2) replacement and corrosion of overgrowths and detrital grains by calcite, and (3) development of secondary porosity.

CHAPTER II

INTRODUCTION

The area for investigation of the Desmoinesian "Cherokee" strata consists of 21 townships (T.26, 27, and 28N., R.2 to 8W.) within parts of Grant and Kay Counties, Oklahoma (Fig. 1). The interval of interest, the Red Fork sandstone, is defined as the zone between the Pink (Tiawah) and Inola Limestones (Fig. 2). Where the Inola and older strata are absent owing to onlap, the base of the Red Fork interval is unconformable upon the Mississippian surface.

Objectives and Methods

The objectives of this study are: (1) to infer reliably the depositional environments of the Red Fork sandstones, (2) to estimate the effects (if any) of structural geology and paleotopography on deposition of the Red Fork sediments, and (3) to define the nature and sequence of diagenetic changes that have affected the Red Fork sandstones.

Trends, geometry, and boundaries of the Red Fork sandstones were determined through examination of gamma-ray and induction logs of 608 wells. These data were used in preparation and interpretation of nine stratigraphic cross-sections,

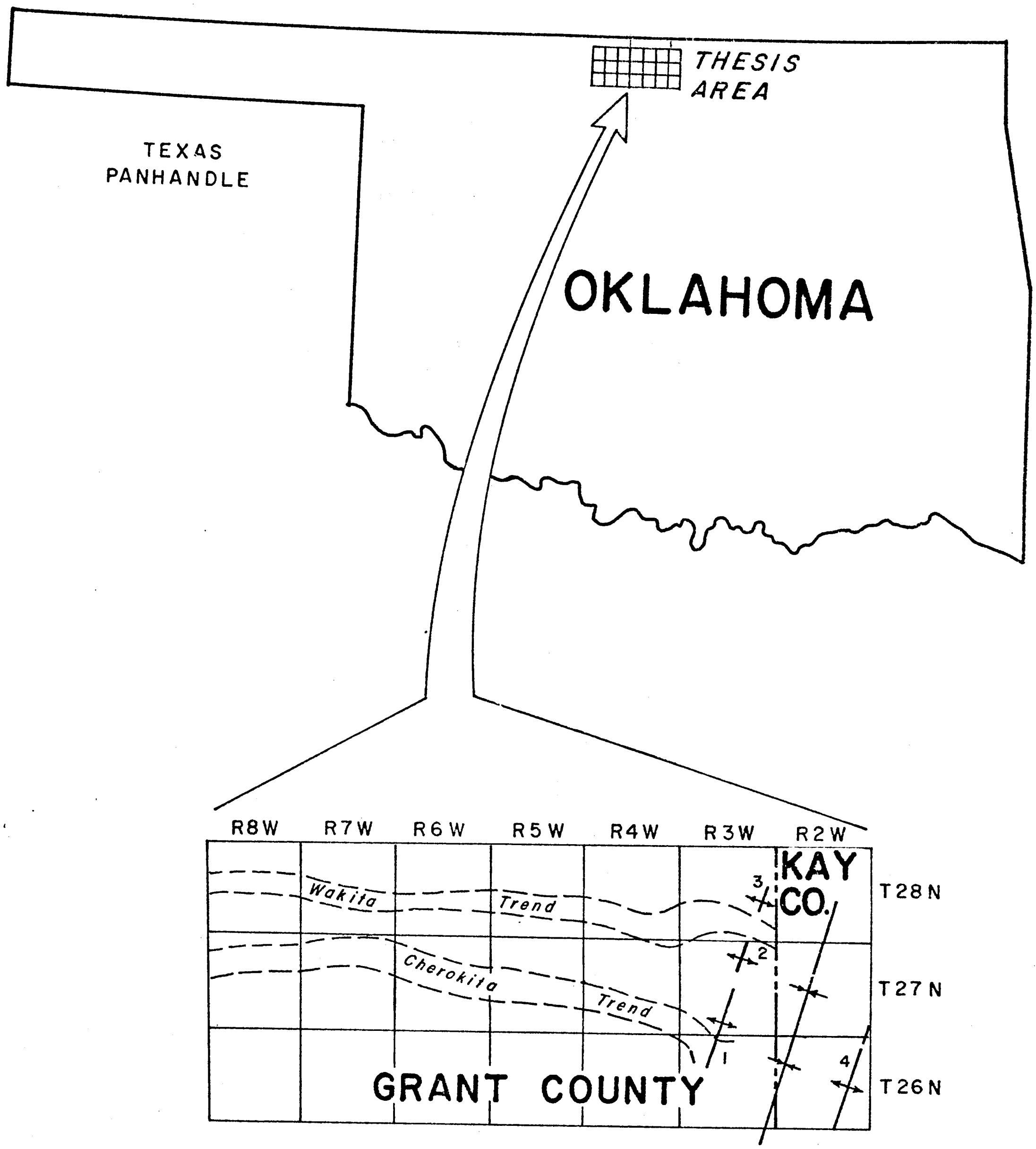

Fig. 1--Location map of study area and local structures of importance, namely the (1) Deer Creek Anticline (2) Webb Anticline (3) North Webb Anticline, and (4) the west flank of the Nemaha Ridge.

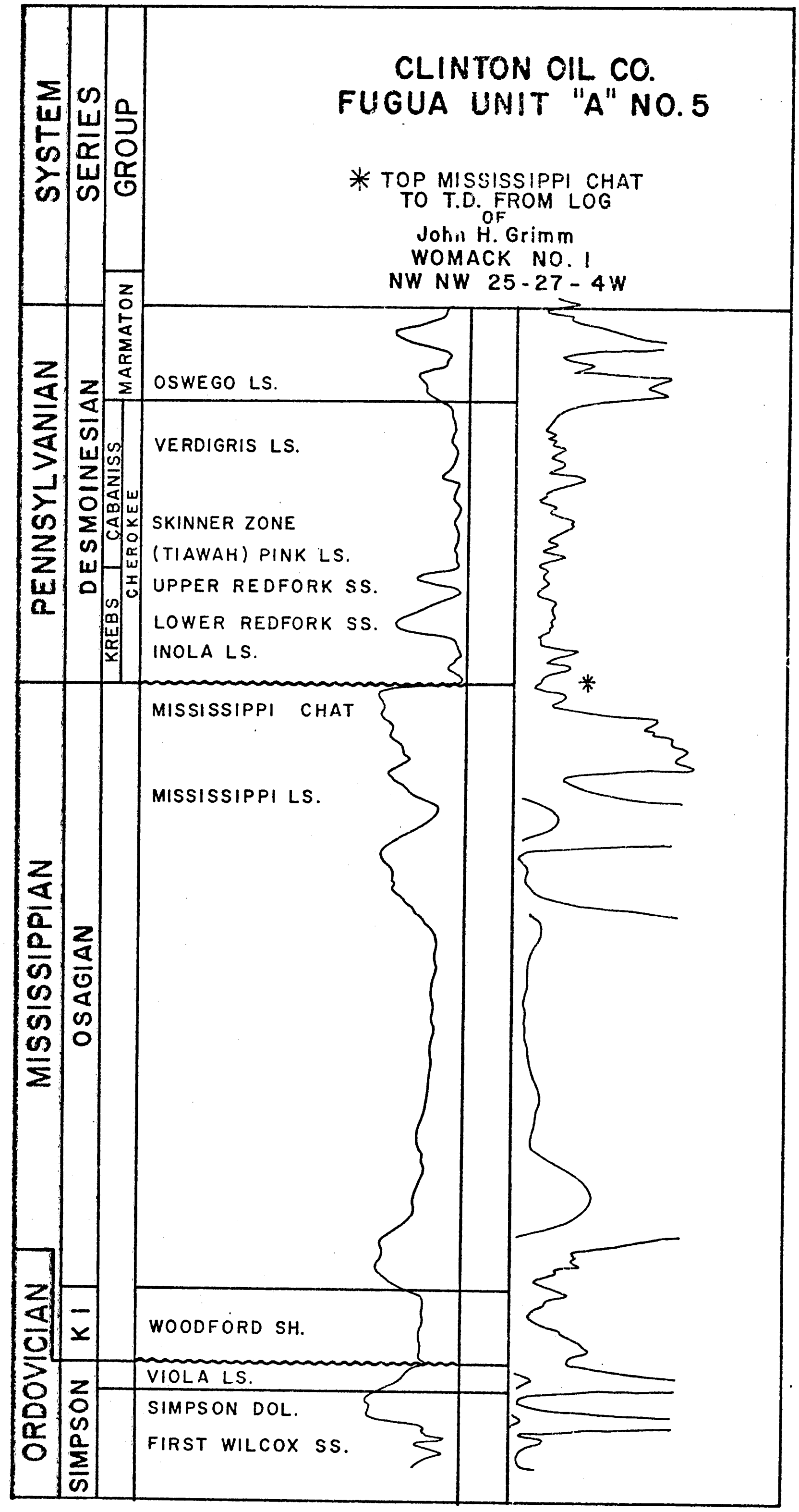

Fig. 2--Type electric log

a net-sand isopach map of the lower Red Fork sandstone, and log maps of the upper and lower parts of the Red Fork sandstone.

Three cores of the lower Red Fork were analyzed to describe vertical sequences of sedimentary structures, textures, and visual constituents. Interpretation of these data was essential in forming conclusions on environments of deposition. Petrographic composition and diagenetic alterations were determined from examination of 35 thin sections.

Present structural configuration of the Red Fork interval is shown by a structural contour map on top of the Pink limestone. As another aid a contour map was constructed on top of the Pennsylvanian-Mississippian unconformity surface. This map was used to make judgments about possible paleotopographic or paleostructural control on sedimentation of the Red Fork.

Previous Investigations

The Red Fork sandstone is equivalent to the Taft sandstone (upper Boggy Formation) at the surface and to the Chicken Farm sandstone (also called the Chicken Ranch sand) of Oklahoma County and the Earlsboro sand of Pottawatomie County (Jordan, 1957) in the subsurface. The Burbank sandstone of Osage County was originally thought to be a Red Fork equivalent in the upper Boggy Formation. Recent stratigraphic work suggests that it could be equivalent to the "lower part of Boggy Formation or both the Red Fork and Bartlesville"

(Jordan, 1957, p.30). The name "Cherokee" first was used by Haworth and Kirk (1894) for a sequence of black shale between the Pennsylvanian Oswego (Fort Scott) limestone and Mississippian rocks in Cherokee County, Kansas (Withrow, 1968). This term was applied to the same interval in northern Oklahoma until 1954. At this time the Oklahoma Geological Survey (Branson, 1954), removed the term "Cherokee" from the official stratigraphic nomenclature and replaced it with the terms "Krebs Group" and "Cabaniss Group" (Withrow, 1968). In 1956 the term "Cherokee" was readopted for Kansas and Missouri with Krebs and Cabaniss being reduced to rank of subgroups (Howe, 1956).

The Red Fork sandstone was named by Hutchinson (1911). The name described a shallow producing sandstone in the Red Fork field, near the town of Red Fork, southwest of Tulsa, Oklahoma (Red Fork was named for the color of a tributary of the Arkansas River).

In a subsurface study of the "Cherokee Group" in Grant County and a portion of Alfalfa County, Stanbro (1960) interpreted the Red Fork of the Wakita and Cherokita Trends (Fig. 1) to be "strike valley sands." Based on sandstone trends, stratigraphic relationships and lithologic characteristics, Withrow (1968) interpreted these lineations (Fig. 1) to have been "offshore bars" and Berg (1969) agreed with Withrow's findings. Bryan (1950) described the subsurface geology of selected oil fields on the Deer Creek, Webb and North Webb anticlines of eastern Grant County (Fig. 1). Dana (1954) describes the stratigraphic relationships and general structural geology of the area. McElroy (1961) investigated the stratigraphic relations of the formations and their relationships to structural geology of the region. Krumme (1975) discussed evidence of a mid-Pennsylvanian source reversal on the northern shelf of the Anadarko Basin.

CHAPTER III

STRUCTURAL FRAMEWORK

Regional Setting

The study area is located on the northern flank of the Anadarko Basin (Fig. 3), which is called more precisely the Northern Basin Platform (Wheeler, 1947). The regional features that influenced the area were the Anadarko Basin to the south and the Nemaha Ridge to the east.

Structural geology of the region is that of gentle dip to the southwest. These southwest-dipping beds are in part the Prairie Plains Homocline (Dana, 1954). Regional dip varies from approximately one degree in the Mississippian strata to less than one degree in the post-Mississippian strata. In the eastern part of the area an anticlinal trend parallels the Nemaha Ridge, which is approximately six miles farther east. This anticlinal trend strikes slightly east of north and on its flanks beds dip 4 to 5 degrees.

Local Setting

Structural contour maps were constructed of the top of the Pink limestone and of the Pennsylvanian-Mississippian unconformity. These surfaces were used as references because

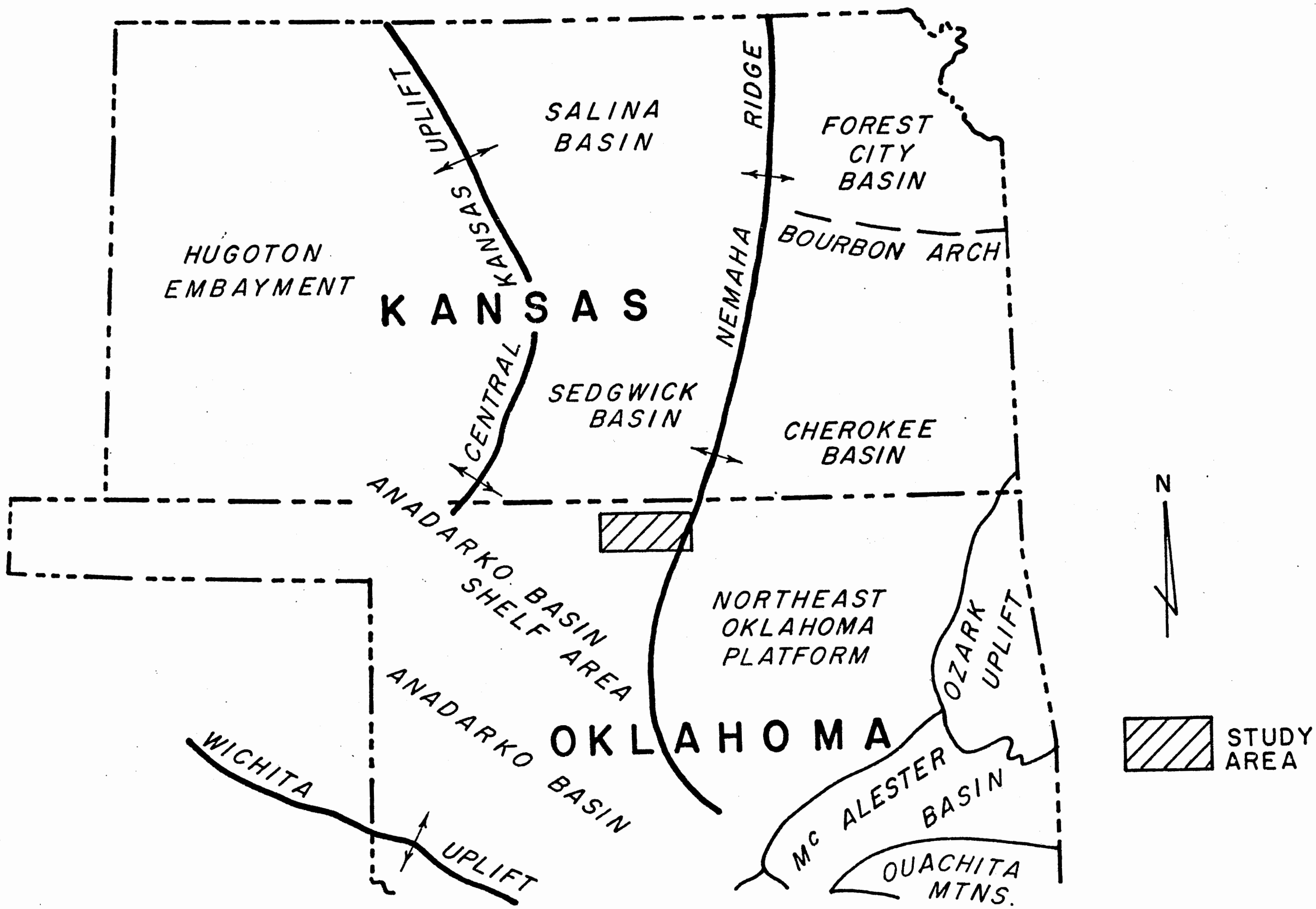

Fig. 3--Generalized tectonic map of Oklahoma and Kansas

of their stratigraphic positions above and below the Red Fork interval.

The Pink limestone is a thin but consistent marker directly above the Red Fork sandstone. A contour map on this marker provides the best representation of the structural configuration of the Red Fork interval.

The contour map of the Pennsylvanian-Mississippian unconformity does not constitute a true structural geologic map. This map reflects not only present structural geology, but also paleotopography of the Mississippian unconformity surface. Combination of the Pink structural map and the top-of-Mississippian contour maps allows one to infer how much of the structural geology on the Pink limestone marker is due to folded strata and how much is reflective of paleotopography on the Mississippian erosional surface.

Structure of the top of the Pink limestone shows that the regional dip is interrupted by flexures that are oriented generally north-south (Pl. 7). These are most obvious in the area that coincides with the Wakita and Cherokita Trends (Pl. 7, T.27N, and T.28N., R.2 to 8W.). Many of the prominent features set out on the Mississippian-unconformity map are coincidental with structures detectable on the Pink limestone structural map (i.e., Pl. 7 and 8, Sec. 23-26, T.27N., R.4W.; SE¼ of T.28N., R.7W.; T.26N., R.5W.). Compaction of strata over thick Red Fork sand accumulations may have been the cause of some of these minor folds (Pl. 7., SW¼ of T.27N., R.5W.), but by comparison of Plates 7 and 8, it is observable that this was not a major factor in development of structure on or above the Red Fork interval. This is evident by the fashion in which the majority of Pink lime structures conform to features observed on the Pennsylvanian-Mississippian contour map.

The dominant structural features of the area are found along the previously mentioned anticlinal trends in eastern Grant County (Fig. 1). This trend is composed of a series of anticlines, the Deer Creek, Webb and North Webb anticlines (Pl. 7 and 8, T.26N. to 28N., R. 3W.) which are sub-parallel and structurally related to the Nemaha Ridge (Dana, 1954). This horst block forms an anticlinal chain flanked by high-angle normal faults dipping approximately to the east and west. A secondary set of normal faults cuts the structure at angles ranging from 15 to 35 degrees with strikes west and east of north. These secondary faults dip at high angles and probably are complementary faults that border the saddles between the previously-mentioned anticlines. Maps of the top of the Pink limestone and Mississippian unconformity show that where the study area extends across the Nemaha Ridge, in the E½ of T.26N., R.2W., a similar type of faulting pattern can be demonstrated.

Many of the faults along the horst were rejuvenated periodically before deposition of the Red Fork. Evidence for this is seen in truncation of Ordovician and Mississippian beds on the flanks of the fault block (Pl. 3, cross-section F-F', and Pl. 5, cross-section I-I').

CHAPTER IV

STRATIGRAPHIC FRAMEWORK

The Red Fork in the Anadarko Basin (Fig. 3) is in the middle of the Cherokee Group (Fig. 2). The Cherokee Group includes rocks from the base of the Pennsylvanian to the base of the Late Desmoinesian Oswego limestone (Jordan, 1957) and consists of interbedded sandstone and shales. The Verdigris, Pink, and Inola limestones (Fig. 2) are thin marker beds; they provide the basis for subdivision of the Cherokee Group.

The Red Fork is defined as the interval from the top of the Inola limestone to the base of the Pink limestone. In northwestern and extreme eastern portions of the study area the Inola is absent, owing to onlap of the Pennsylvanian sediments on the Mississippian erosional surface (Fig. 4). In these areas of onlap, Red Fork rocks lie on a weathered Mississippian limestone, the Mississippi chat (Jordan, 1957).

Correlations

To insure accurate correlation and to illustrate certain structural, stratigraphic, and sedimentological relationships, two west-east and seven north-south stratigraphic

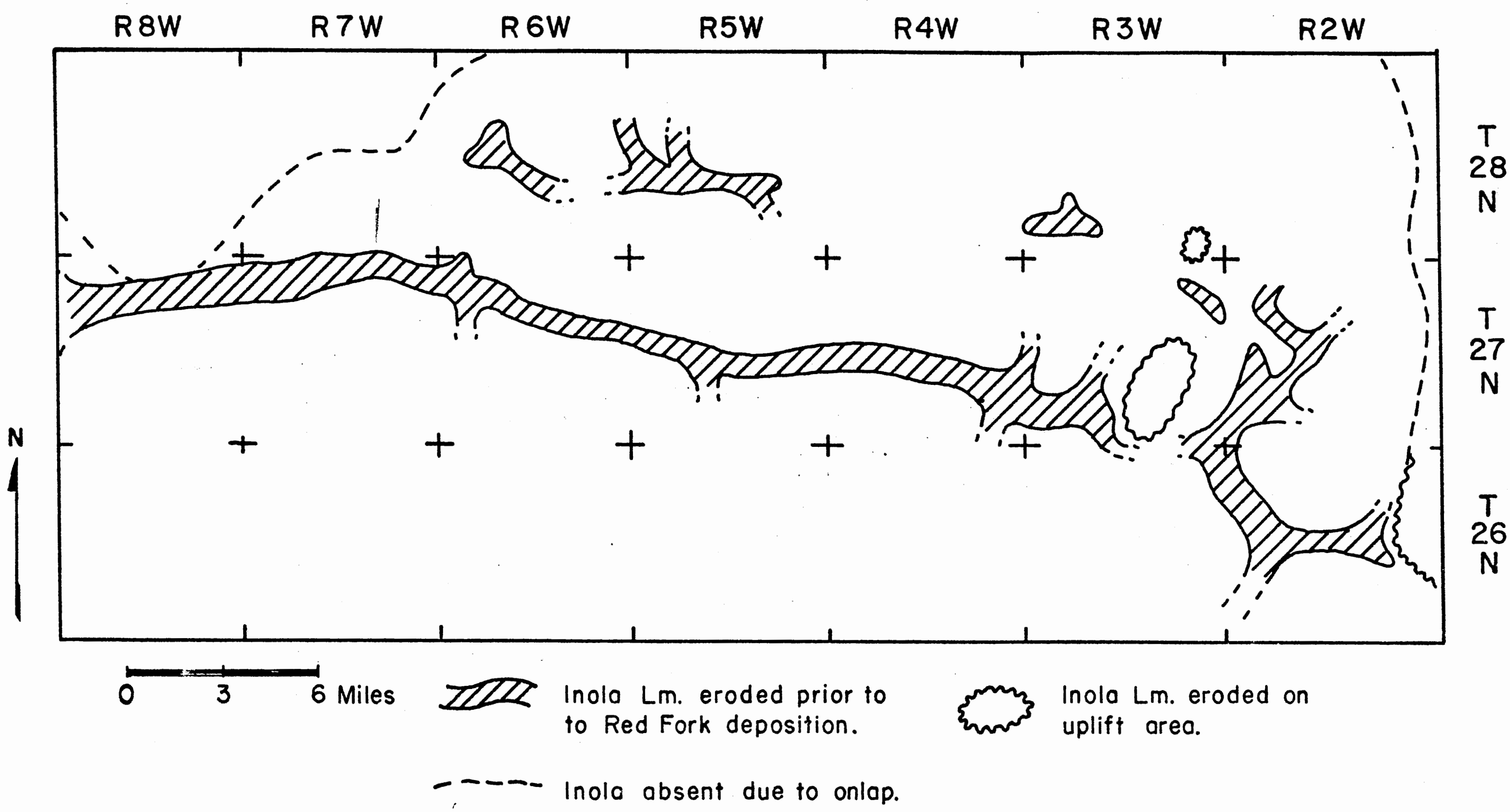

Fig. 4--Inola limestone distribution map

cross-sections were constructed with the Pink limestone as datum. Locations of these sections are shown in Figure 5.

The Pink and Inola limestones were used as markers to delineate the boundaries of the Red Fork interval. The upper marker, the Pink limestone, is a gray, tan or buff to light brown, fine- to medium-crystalline limestone containing characteristic pink crystals of calcite. The average thickness is about 10 feet (Jordan, 1957). Underlying the Red Fork interval is the Inola limestone, which is white to gray, fine- to medium-crystalline, compact, and fossiliferous. Its average thickness is also about 10 feet (McElroy, 1961). These limestone markers are transgressive units, and the Red Fork records a regressive depositional phase. This sequence of strata is believed to be indicative of a transgressive-regressive couplet (Forgotson, 1957).

In this study, sandstones were classified initially by their electric log and gamma-ray log characteristics as probable channel or nonchannel deposits. Channel deposits are considered to be represented by abrupt basal and lateral contacts, suggesting erosion of underlying units, and by channel-like cross-sectional shapes. Nonchannel-overbank deposits are considered as having sharp basal contacts but gradational lateral and upper contacts.

Stratigraphic Cross-Sections

The north-south cross-sections show thickness of the Red Fork interval to range between 60 and 90 feet. The

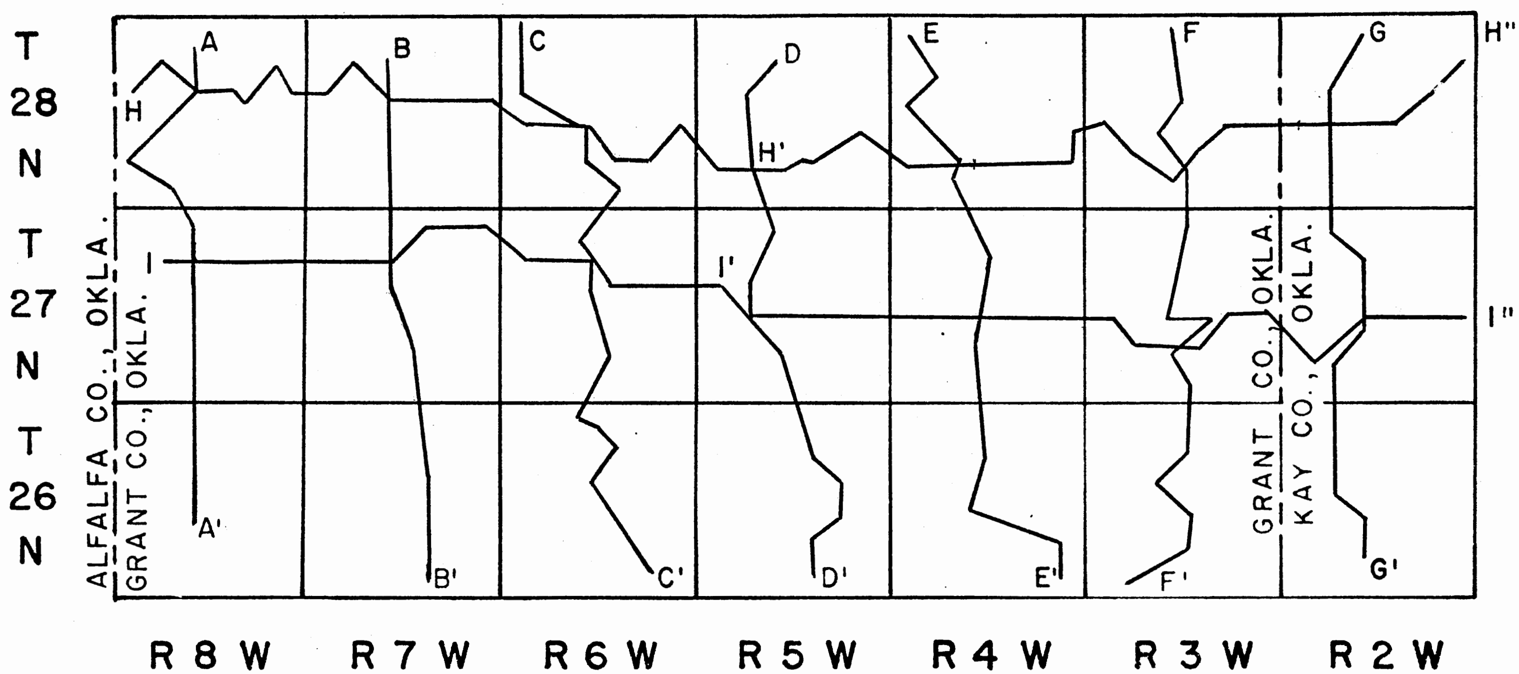

Fig. 5--Index map of stratigraphic cross-sections.

southward increase in thickness of the interval is considered to be minor, the rate being less than 2 feet per mile (Pl. 1-4). From the western boundary of the study area eastward to a line common with the eastern flank of the Deer Creek, Webb and North Webb anticlines (Fig. 1), variations in thickness of the Red Fork interval also are minor (Pl. 5 and 6). However, east of this line is a west-dipping normal fault; the Red Fork and younger "Cherokee" units abut the uplifted Mississippi and Ordovician formations (Pl. 6, I-I' wells 177-180). An east-dipping normal fault forms the eastern flank of the uplift and marks the line from which the Red Fork extends eastward (Pl. 6, I'-I"). Toward the eastern edge of the study area, slight thinning of the Red Fork interval reflects the approach onto the western flank of the Nemaha Ridge (Pl. 6, H'-H" and I'-I").

The Red Fork sandstone can be divided into an upper and a lower unit. The upper Red Fork sandstone generally is separated from the Pink limestone by silty to sandy shales. At some localities the base of the Pink limestone is difficult to define on electric logs (for example, see Pl. 6, I'-I", wells 167 and 168). On Plate 9 the upper Red Fork sandstone is shown to be present only in approximately the eastern one-third of the study area. In cross-sectional view the upper Red Fork sandstone is lenticular, exhibits a sharp basal contact in places, and shows signs of development at the expense of the underlying units (Fig. 6). From areas such as the Wakita Trend, where the upper Red Fork is

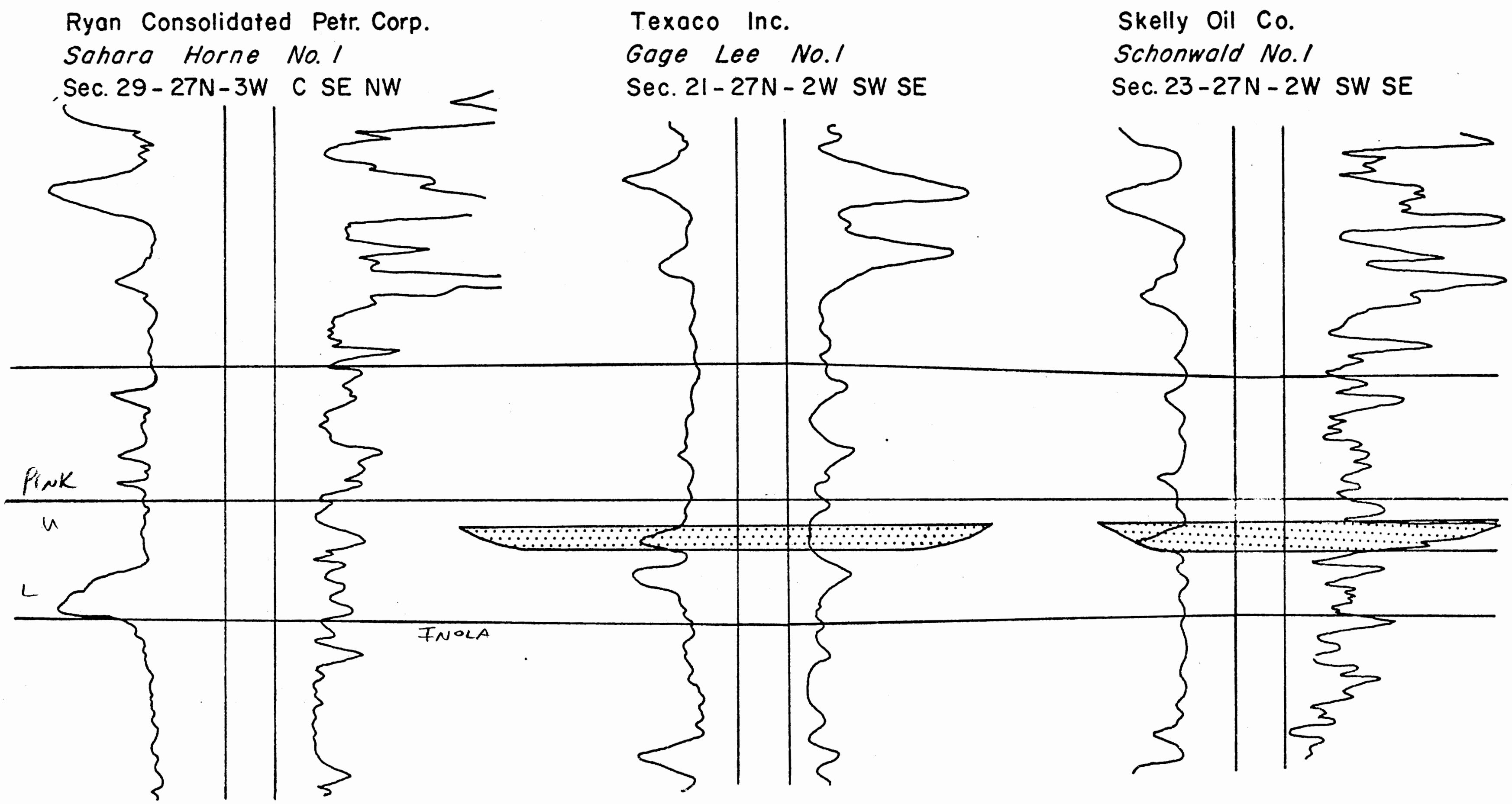

Fig. 6--North-south correlation section showing lower and lateral contacts of the upper Red Fork sandstone. Lateral extent of trends is interpreted from log map (Pl. 9).

absent, Withrow (1969) (from a core in the Vierson and Cochran No. 1 Landreth, NW NE SE, Sec. 12, T.28N., R.9W.) described the equivalent facies as variegated, red and green shale containing mud cracks filled with silty material at the tops of the beds. This unit was not observed in the core analyzed by the author, but was found to be one of the most consistent markers of the area.

The lower Red Fork sandstones are much better developed and are believed to be multilateral and multistoried. At some localities the Inola limestone is absent because lower Red Fork channels cut below the marker from 10 feet in the Wakita Trend to more than 50 feet in places along the Cherokita Trend (Fig. 7). Shale stratigraphically equivalent to the lower Red Fork sandstone is dark gray to black. Generally it is silty to sandy, calcareous, and contains mica and pyrite (Withrow, 1968).

Paleotopographic and Paleostructural Influences on Red Fork Sandstone Deposition

In consideration of the possible effects of paleotopography and paleostructural geology on deposition of the Red Fork, it is necessary to consider the interval from the top of the Pink limestone to the post-Mississippian unconformity (from now on referred to as the "gross interval"). As indicated by the north-south stratigraphic sections (Pl. 1-4) the gross interval thickens from approximately 75 feet

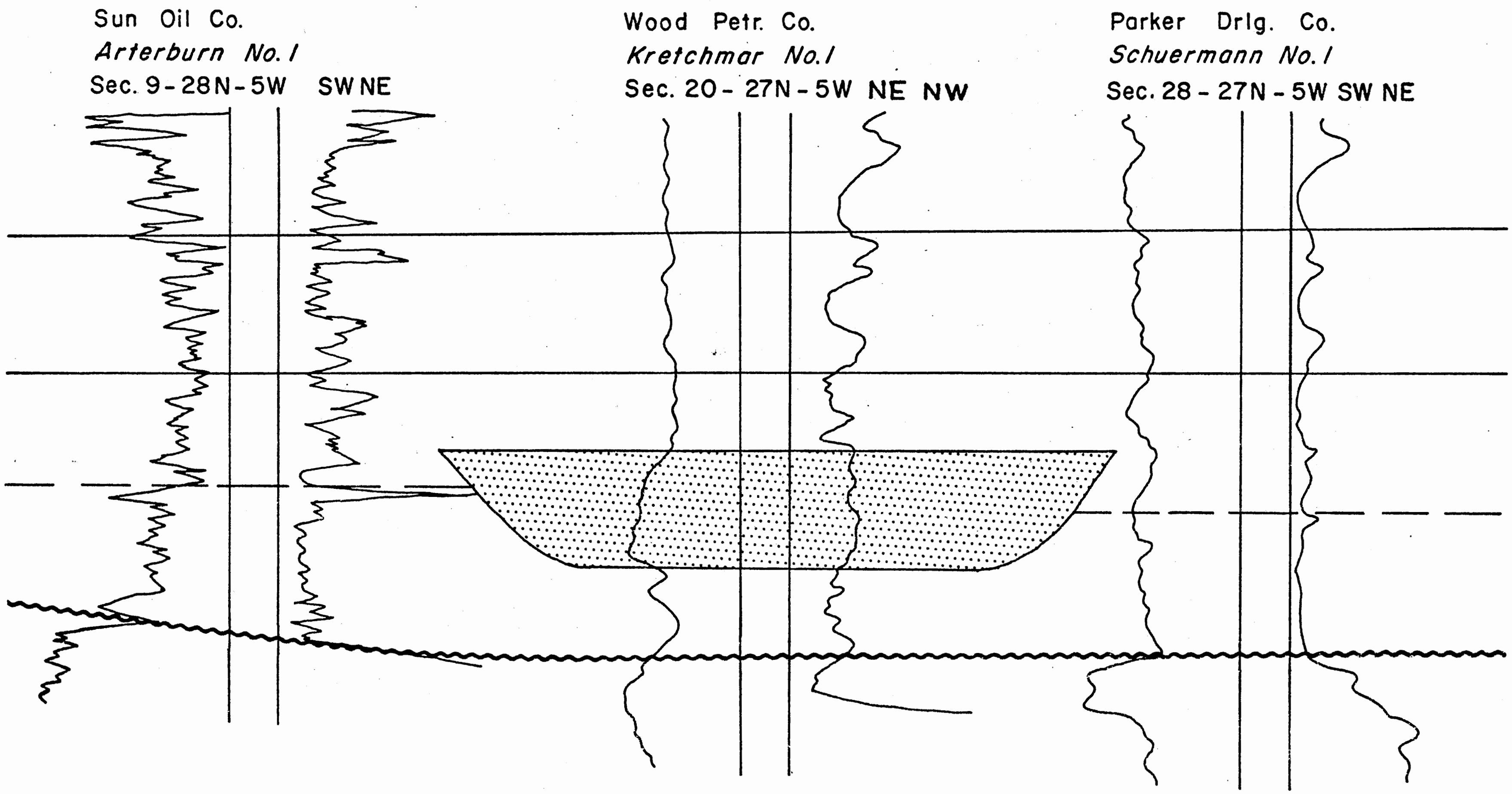

Fig. 7--North-south correlation section showing lower and lateral contacts of the lower Red Fork sandstone. Lateral extent of trends as interpreted from log maps (Pl. 10).

in northwestern Grant County to more than 250 feet in the southern half of T.26N., R.4W. (Pl. 1-3). This thickening is due primarily to development of Pennsylvanian shales and siltstones below the Inola limestone, not to a marked increase in thickness of the Red Fork interval itself.

As can be observed on Pl. 1-6, local variations in thickness of the gross interval are due to "highs" and "lows" on the pre-Pennsylvanian erosional surface. In many places the low areas on the paleosurface are sites of deposition of lower Red Fork sandstone.

An isopach map of the "Cherokee" interval (Fig. 8), is used to show that Red Fork sandstone patterns correlate very closely with thick linear trends in the "Cherokee" section. These thick "Cherokee" trends bifurcate northward, thicken southward, and seem to be evidence of a paleodrainage system with a southward gradient. Also in the area are "ridges" that are not related genetically to the thick linear trends of the "Cherokee" interval (Pate, 1959; Stanbro, 1960). These low ridges are sub-parallel and probably were roughly perpendicular to the paleo-regional dip. The ridges probably developed by truncation of alternating resistant and non-resistant Mississippian units, all of which dipped homoclinally southward (Pl. 12). The ridges were described by Pate (1959) and Stanbro (1960) as resembling cuestas with Red Fork strata deposited in adjacent east-west striking valleys, similar to the "strike valley sands" described by Busch (1973). However, examination of cross-sections and

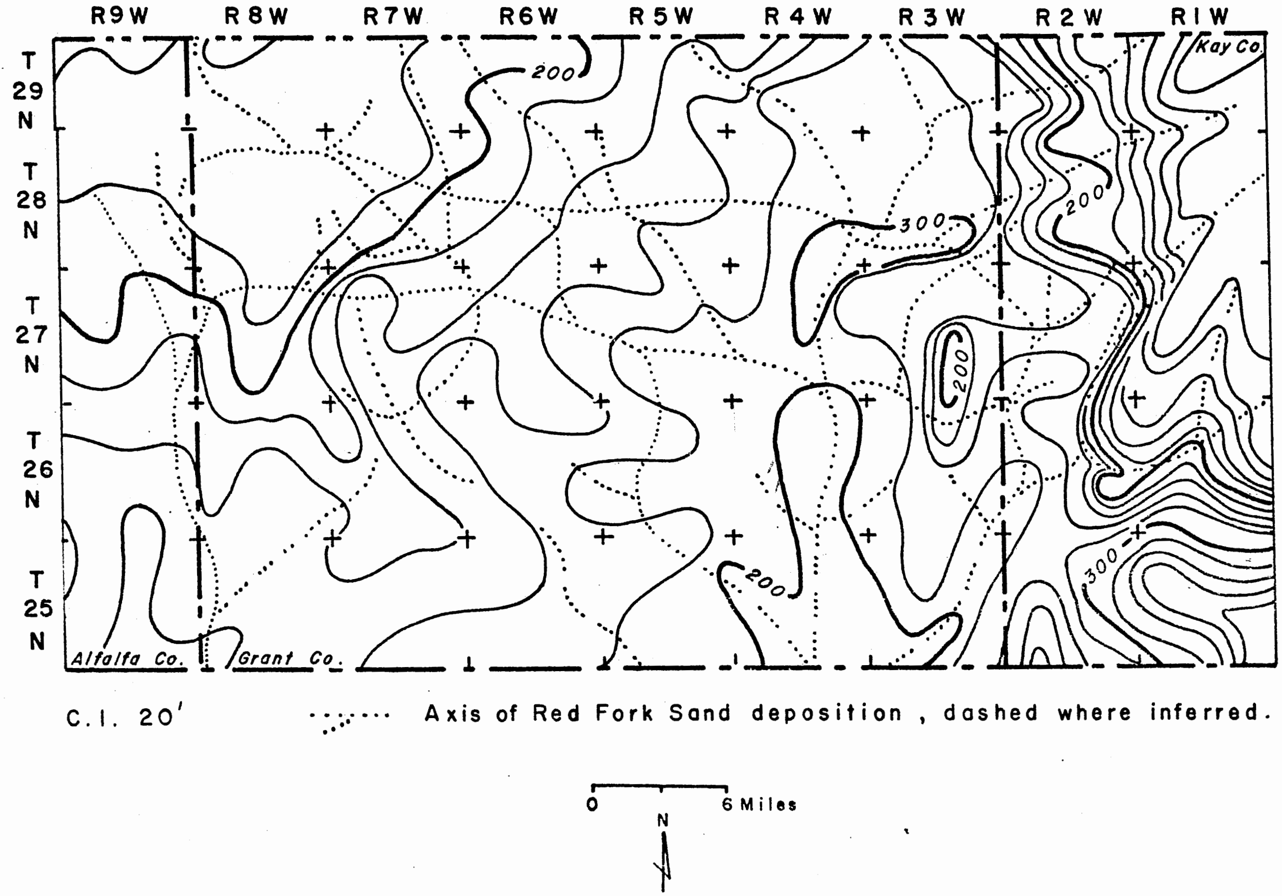

Fig. 8--Isopach of the "Cherokee Group" in the general area of study (modified after Berg, 1968) showing relationship of lower Red Fork sand deposition to lows in the paleotopography.

lack of evidence of such features on the "Cherokee" isopach map (Fig. 8), led to the conclusion that these ridges never developed into true cuestas. The ridges probably did not exceed the stage of development depicted in Fig. 9 before transgression and deposition of basal Pennsylvanian shales and siltstones. With compaction of the thick accumulations of shales and siltstones in the lows, the east-west trending ridges should have reflected as "highs" on the Red Fork depositional surface. If so, these ridges could have been influential in development of a semi-trellis drainage pattern (indicated by sub-parallelism in the Wakita and Cherokita Trends) with the dominant control on sand deposition still being the south-oriented paleodrainage system.

In the eastern portion of the study area, between the Deer Creek, Webb, North Webb horst and the Nemaha Ridge (Fig. 1), paleostructure was the dominating factor in controlling deposition of the Red Fork sandstone. A "trough" is present which is evident by thickening of the interval (Pl. 6, ~~I'-I"~~ H'-H", wells 134-140, and ~~H'-H"~~ I'-I", wells 180-185) between the top of the Verdigris limestone and the Pennsylvanian-Mississippian unconformity. The axis of this trough (Fig. 1) has a general northerly strike and is tilted very gently to the south. This influenced local development of a north-south drainage pattern which is evident by the orientations shown in the lower Red Fork sandstone trends (Pl. 10, T.26N. to 28N., R.2W.).

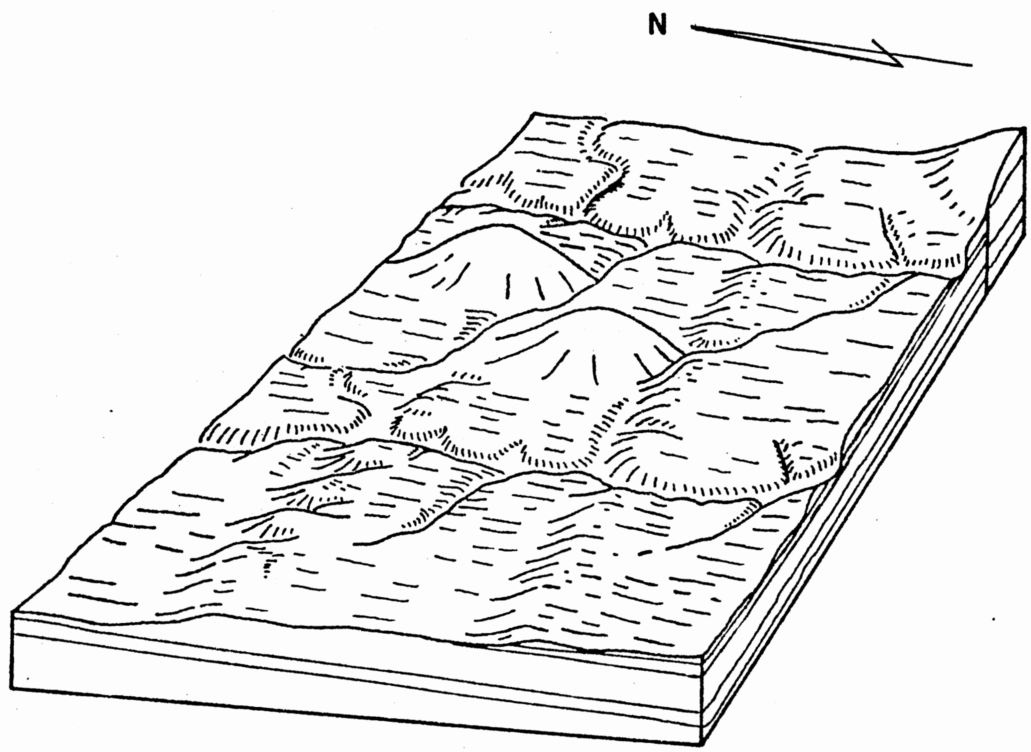

Fig. 9--Diagram depicting the landscape which is believed to have developed on the Mississippian erosional surface. (Modified after Thornbury, 1961.)

CHAPTER V

GEOMETRY OF THE RED FORK SANDSTONES

An isopach map and a log map of the lower Red Fork sandstone, a log map of the upper Red Fork sandstone were used to delineate and predict trends and distribution of sandstone. The isopach map shows net thickness of the Red Fork sandstone, defined here as units with deflection from the shale base line greater than 20 millivolts on the self-potential curve or greater than 20 A. P. I. units on the gamma-ray curve.

Log maps were used as interpretative devices, based on the characteristics of electric log and gamma-ray logs in sandstone sections. The log shapes define sandstone edges and trends better than the numbers used on isopach maps. Log maps permit easy comparison of sandstone variations, which is essential in estimating sandstone lineations and inferring depositional environments.

Red Fork sandstones are below the Pink limestone and above the Inola limestone, as described previously (Fig. 2). This interval contains two sandstones. Immediately below the Pink limestone is the upper Red Fork sandstone, poorly developed and restricted to the eastern portion of the study area; the top of the lower Red Fork sandstone lies a short distance above the Inola limestone.

On the net-sandstone isopach map of the lower Red Fork (Pl. 11) notice should be taken of areas where it is difficult to differentiate between the upper and lower units (Pl. 11; areas outlined). In these areas there is no distinct shale break separating the two units; therefore it is difficult to assign sand thicknesses to the upper and lower Red Fork.

Trends and Widths

Both the upper and lower units show complex patterns of elongated sandstone trends across the area (Pl. 9 and 10). The trends of the upper Red Fork show a dominant north-south orientation and range in width from about 1000 to about 3500 feet. The most nearly continuous of these trends extends southward across the study area (18 mi.) and likely extends into the adjacent counties to the south.

The lower Red Fork unit is more complex in overall pattern; it consists of two dominant east-west oriented belts along with secondary sets of north-south sandstone trends. The dominant east-west lineations are present in Alfalfa County and strike eastward through Grant County (to approximately T.27 and 28N., R.3W) where the dominant depositional axis are reorientated to a north-south direction (Pl. 10). In the western two-thirds of the area widths of the lower Red Fork belts range from 4000 feet in the minor north-south trends to approximately 7500 feet in the dominant east-west trends. In the north-south belts of eastern Grant and western Kay counties widths vary from 4500 feet to 8000 feet (Pl. 10). As in the upper Red Fork, the lower Red Fork extends beyond the study-area boundaries. Sands of the lower Red Fork have been mapped to the south in Garfield County (Berg, 1968) but their extent north of the study area is unrecorded.

Thickness

Lower Red Fork sandstones are thickest in the Cherokita Trend (T.27N., R.2W. to 8W.) and in one of the north-south-oriented lineations observed in the eastern part of the study area (Pl. 10, T.26N. to 28N., R.2W.). Net thickness of the lower Red Fork sandstone ranges from 0 to 110 feet.

Because of the restricted extent and poor development of the upper Red Fork, a net-sand isopach of the unit was not constructed. However, by examination of the log map (Pl. 9) it is evident that the sand is best developed in the main north-south trending belts of T.26N., to 28N., R.2 to 3W. Net thickness of the upper Red Fork, as estimated from the log map, ranges from 0 to about 15 feet.

Boundaries

Both the upper and lower Red Fork are lenticular sandstone bodies with sharp lateral and basal contacts with less abrupt upper contacts (Figs. 6 and 7). In areas where the lower Red Fork is well developed, the lower Inola marker is absent owing to erosion before deposition of the sandstone (Fig. 4).

CHAPTER VI

INTERNAL FEATURES

Characterization of internal features of the Red Fork sandstone is based primarily on examination of three cores (Fig. 10-12), one of which is located outside the study area (Appendix A).

All of the cores are from the lower Red Fork sandstone in the Cherokita Trend.

Sedimentary Structures

Common sedimentary structures observed in the cores, in the approximate order of overall abundance, are: horizontal laminations and bedding, flowage, massive bedding, interstratification of sandstone and shale, graded bedding, medium- and small-scale cross-bedding, erosional-reactivation surfaces, and low-angle initial dip (Fig. 10-12). General vertical sequences of sedimentary structures that are characteristic of the Red Fork sediments are: (1) A lower zone of massively bedded sandstone containing pebble-size mud-clasts. This grades upward into horizontally laminated and bedded sandstones that may show fining-upward sequences within the bedded and laminated intervals. Minor amounts of low-angle initial dip were also observed. (2) A middle zone of

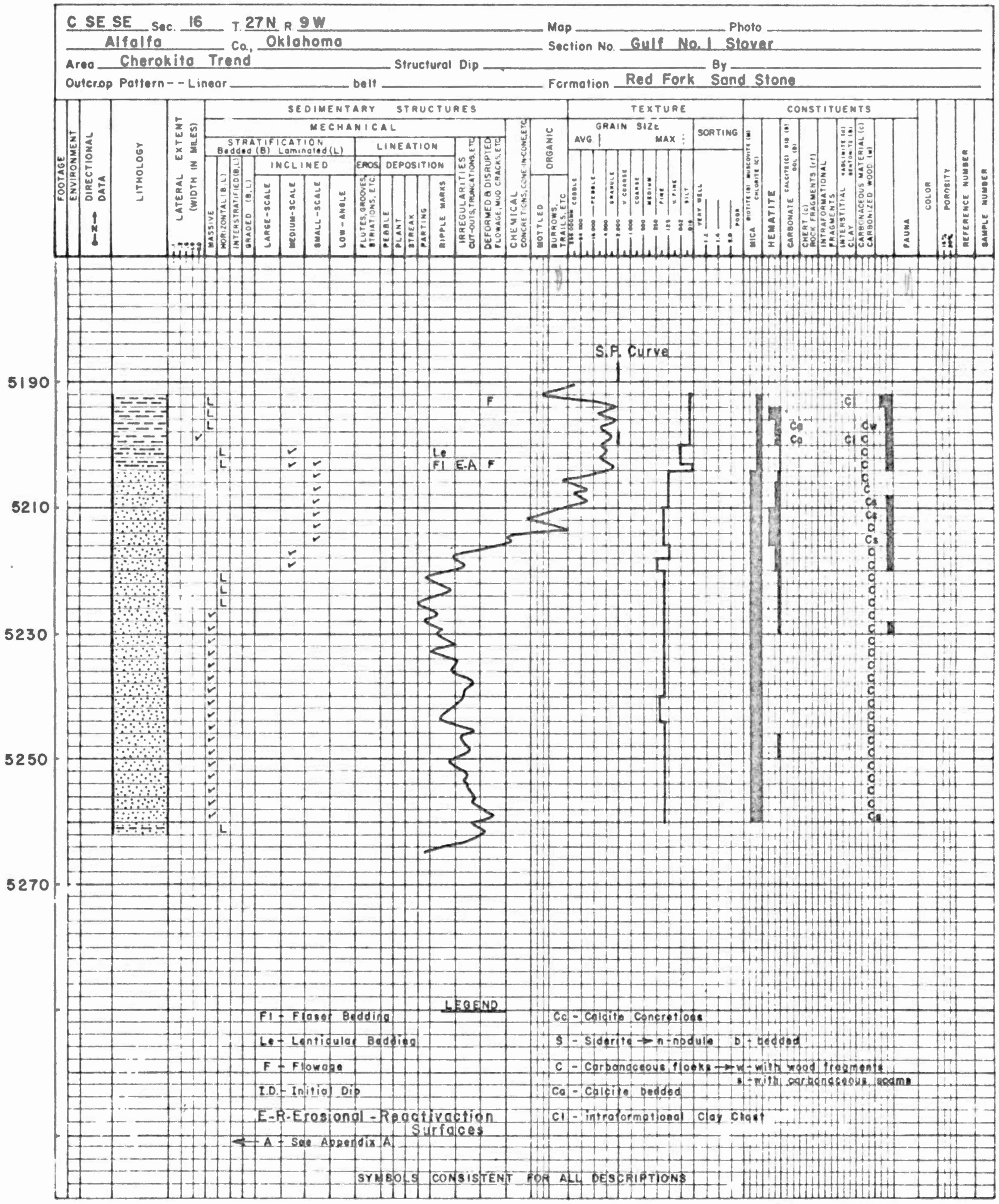

Fig. 10--Core description of Gulf No. 1 Stover, Sec. 16, T.27N., R.9W.

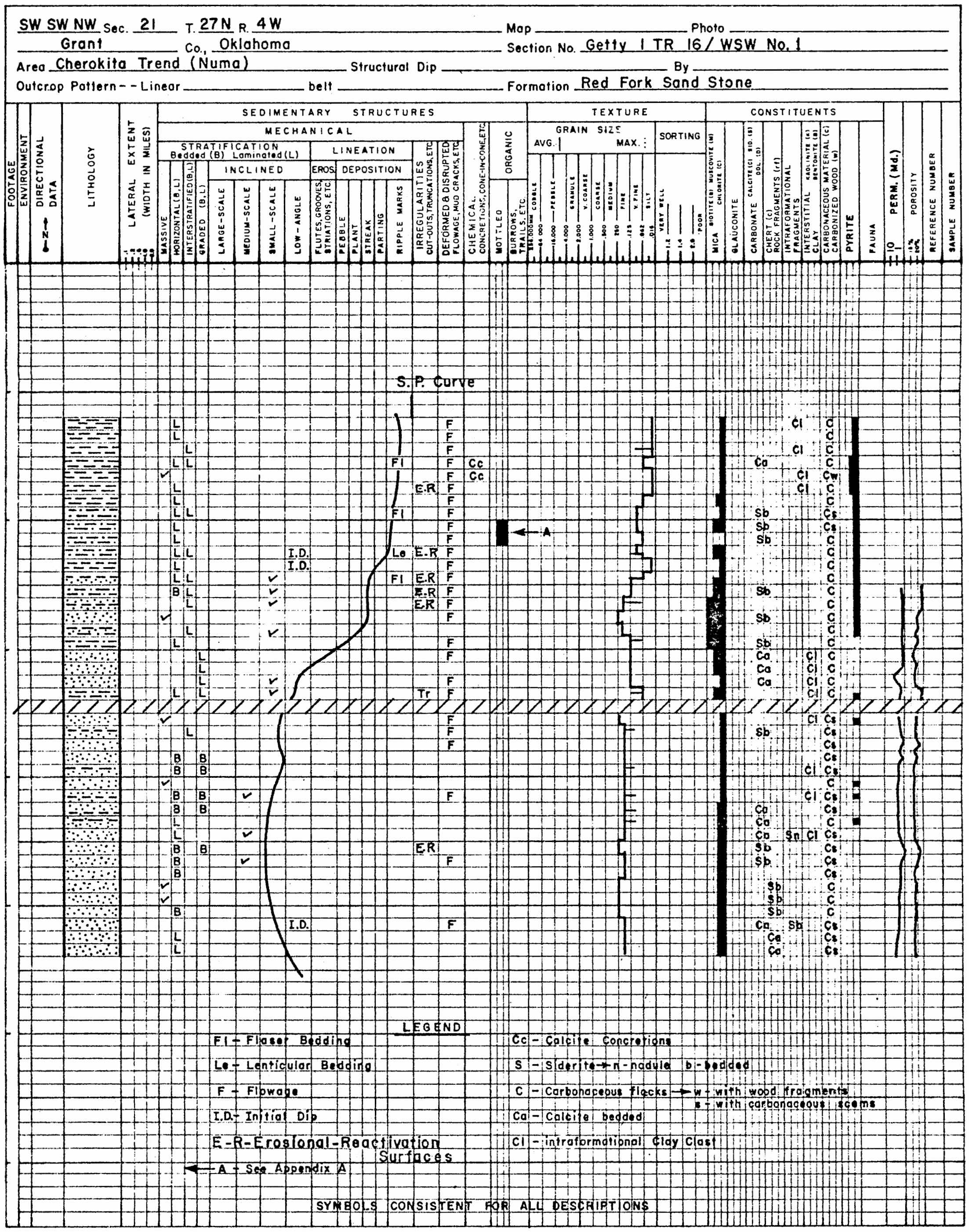

Fig. 11--Core description of Getty No. 1 T. R. 16/WSW, Sec. 21, T.27N., R.4W.

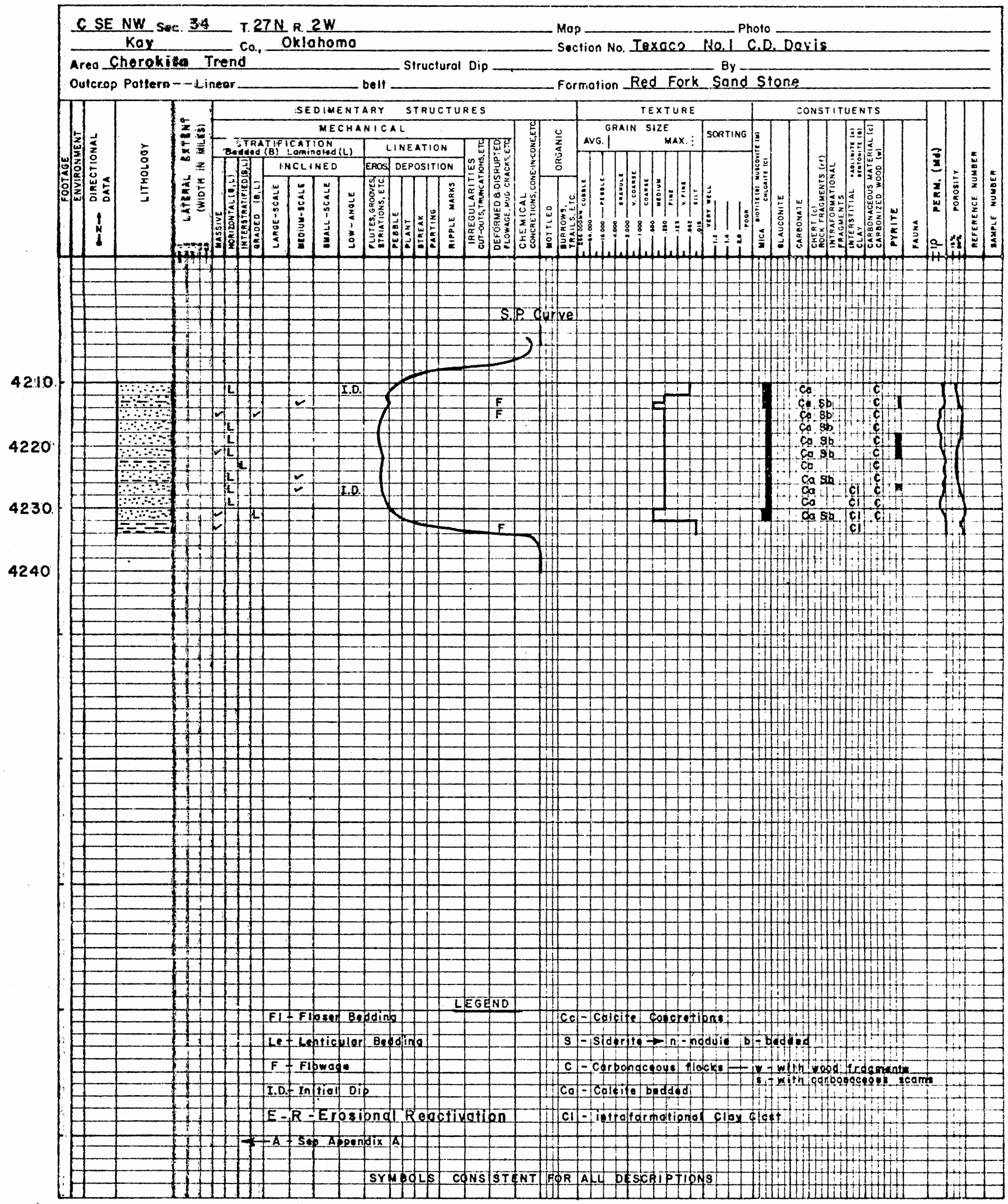

Fig. 12--Core description of Texaco No. 1 C. D. Davis, Sec. 34, T.27N., R.2W.

laminated and cross-bedded siltstone and shales with minor interstratification. Initial dip is found in a few restricted zones as are erosional-reactivation surfaces along some of the bedding-planes. (3) An upper zone of horizontally laminated shales with minor interstratification of siltstone and shale; rare occurrences of mottling and calcite concretions are also present.

Flowage features are common throughout the cored Red Fork interval but are most abundant in the upper two zones.

Horizontal Lamination (and Bedding)

Horizontal laminations and bedding are the most common sedimentary structure observed; they are in all three cores. While horizontal lamination is abundant in zones composed of silt and clay, it also is in some sandy zones. Horizontal bedding is restricted to zones of well developed sand; at some places the bedding is graded (Fig. 13 and 14).

Flowage

Flowage was present in all three zones within the Red Fork cores but it is most visible in silty and clayey beds (Fig. 10-12). In the interstratified and laminated zones it is shown as contorted and irregular laminae, injection features and micro-faults. In other zones it is evident by irregularly shaped mud clasts, folded and contorted laminae and soft-sediment faulting (Fig. 15-16).

Fig. 13--Horizontally laminated sandstone. From the Getty No. 1 T. R. 16/WSW; depth 4833 ft.

Fig. 14--Horizontally bedded sandstone. From the Texaco C. D. Davis No. 1; depth 4232 ft.

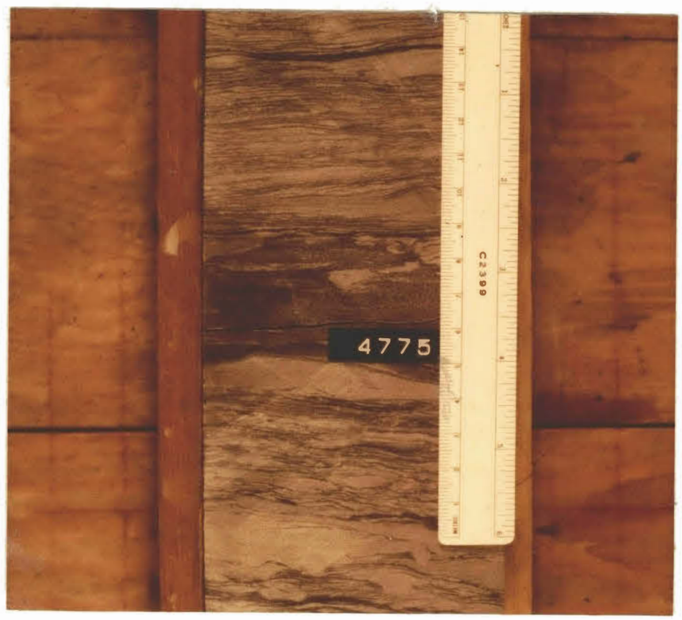

Fig. 15--Flowage in an interstratified shale and sand, note the contorted laminae. From the Getty No. 1 T. R. 16/WSW; depth 4775 ft.

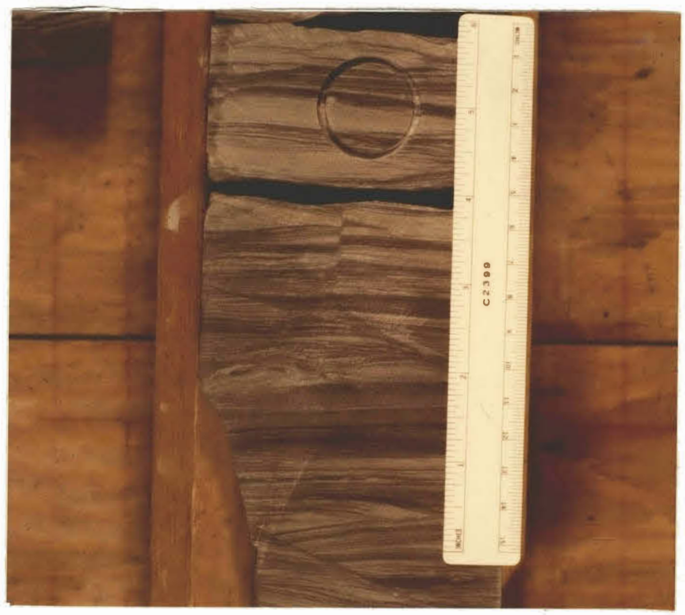

Fig. 16--Interstratified zone which shows flaser bedding in middle along with soft-sediment faulting. Small-scale cross-bedding is evident in the lower part of the photo. From the Getty No. 1 T. R. 16/WSW: depth 4780 ft.

Massive Bedding

Massive bedding is also in all the cores (Fig. 10-12) but is most abundant in the Gulf No. 1 Stover (Fig. 10). Nearly 50% of the Gulf core is massively bedded sandstones. In the other two cores massive bedding is restricted in occurrence and is observable only in a few of the bedded sandstone units.

Interstratification

Interstratification is most common in the Getty No. 1 T. R. 16/WSW (Fig. 11), with minor occurrences in the Gulf No. 1 Stover well (Fig. 10). Interstratification typically is restricted to the upper shale and siltstone layers. Occasionally initial dip is recorded; this is thought to have been developed in bank-slope deposits.

Parallel interstratification is the most dominant form of interstratification. However, flaser (Fig. 16) and lenticular bedding are also evident in a few zones.

Within some of these interstratified sequences, beds and laminae of differing grain size have abrupt erosional-contacts (Fig. 17).

Medium- and Small-Scale Cross-Bedding (and Laminations)

Medium- and small-scale cross-bedding are present in all three cores examined. Small-scale cross-bedding (Fig. 16)

Fig. 17--Sharp contacts between rocks of differing lithology mark an erosional-reactivation surface. From the Getty No. 1 T. R. 16/WSW; depth 4775 ft.

Fig. 18--Medium-scale cross-bedding which shows fining upward in the cross-bedded foresets. From the Getty No. 1 T. R. 16/WSW; depth 4796 ft.

and cross-lamination are in the upper zones and are best shown in the places of interstratification. Medium-scale cross-bedding generally is in zones of better developed sandstones. In a few instances cross-bedded foresets show definite fining upward sequences (Fig. 18).

Graded Bedding

Graded bedding is most common in the Getty No. 1 T.R. 16/WSW, but it is also within isolated zones of the Texaco No. 1 C. D. Davis core.

Graded bedding is limited mostly to zones where sandstones are well developed, however, restricted occurrences of graded bedding can be observed in some of the silty zones (Fig. 12).

Erosional-Reactivation Surfaces

Erosional-reactivation surfaces were recorded in cores of the Gulf and Getty wells. This feature is most common to the interstratified layers and makes sharp boundaries between sediments of differing lithology. In a few isolated zones of the well-developed sand, erosional-reactivation surfaces define the boundaries of multistacked sandstones with fining upward sequences within the units.

Other Sedimentary Structures

Low-angle initial dip was observed in the Getty and Texaco cores, but was relatively sparse.

Mottling and calcite concretions are restricted to the shaley zone in the Getty No. 1 T. R. 16/WSW core. The specific circumstance leading to development of mottling (Fig. 19) was not determined (Appendix B). Calcite concretions were in one 4-foot thick interval of the Getty core. The concretions were roughly spherical; and could possible be of a pedogenic origin (Fig. 20).

Texture

In the Gulf and Getty cores, there is a general upward decrease in grain size (Fig. 10 and 11). The fining-upward sequence ranges from coarse-to fine-grained sand at the base of units to very fine-grained and silt-sized particles in the upper zones (excluding clay). In the Texaco core no significant vertical changes in grain size (Fig. 12) were detected; the sandstone appeared to be of coarse- to fine-grained.

For the most part the Red Fork sandstone is moderately sorted to well sorted, with rounded to subrounded grains.

Where secondary porosity is well developed, porosities are 14 to 20% with permeabilities of 2 to 20 millidarcys. Those zones which have porosities less than 10%, the permeabilities range from 0.1 to 1.1 millidarcys (Table I).

Constituents

Based on the examination of 35 thin sections taken from cores of the Getty No. 1 T. R. 16/WSW and the Texaco C. D. Davis No. 1 (Fig. 11 and 12), major components of the sandstone

Fig. 19--Mottled texture in shale zone. From the Getty No. 1 T. R. 16/WSW; depth 4779 ft.

Fig. 20--Calcite concretions, note coalescence of the concretions in some areas. From the Getty No. 1 T. R. 16/WSW; depth 4763 ft.

(in approximate order of abundance) are monocrystalline and polycrystalline quartz, rock fragments, potassium feldspar, and sodium plagioclase.

Quartz is the dominant framework mineral with amounts ranging from 60 to 81%. Monocrystalline quartz is the more abundant type by a ratio of approximately 8:1.

Rock fragments make up 14 to 30% of the framework grains. The majority of the rock fragments are deformed mud clasts, most of which are allogenic clays; however, some authigenic clays (discussed in Chapter VIII) also were detected. Appreciable amounts of chert were observed and were recorded as part of the rock-fragment fraction. Muscovite schist and phyllites are present in very minor amounts.

Sodic plagioclase composes 1 to 4% of the grains. Potassium feldspar is slightly more abundant, varying from 2 to 15%. Total feldspar composition in the Red Fork sandstone varies from 3 to 18%.

Accessory minerals include muscovite, pyrite, and minor amounts of biotite, hematite, and phosphatic coated grains.

Cement of the Red Fork sandstone is dominantly silica overgrowths. Locally, ferroan-dolomite, ferroan-calcite, and authigenic clays compose a significant portion of the cement. Siderite is a cement in bedding planes and also occurs as nodules.

Common to the Red Fork sandstone is gilsonite, a solid asphalitic residue. It fills and lines pores in zones where porosity and permeability are best developed.

Carbonaceous material is also very abundant in the Red Fork sandstone. Randomly oriented flecks are the most typical form of the carbonaceous material present; however, large fragments of carbonized wood are on many bedding planes. Carbonaceous "seams" are also common, especially in the better developed sand intervals.

According to the classification proposed by Folk (1968) sandstones of the Red Fork interval are dominantly feldspathic litharenites. Sublitharenites and litharenites were also observed, but only in isolated zones (Fig. 21).

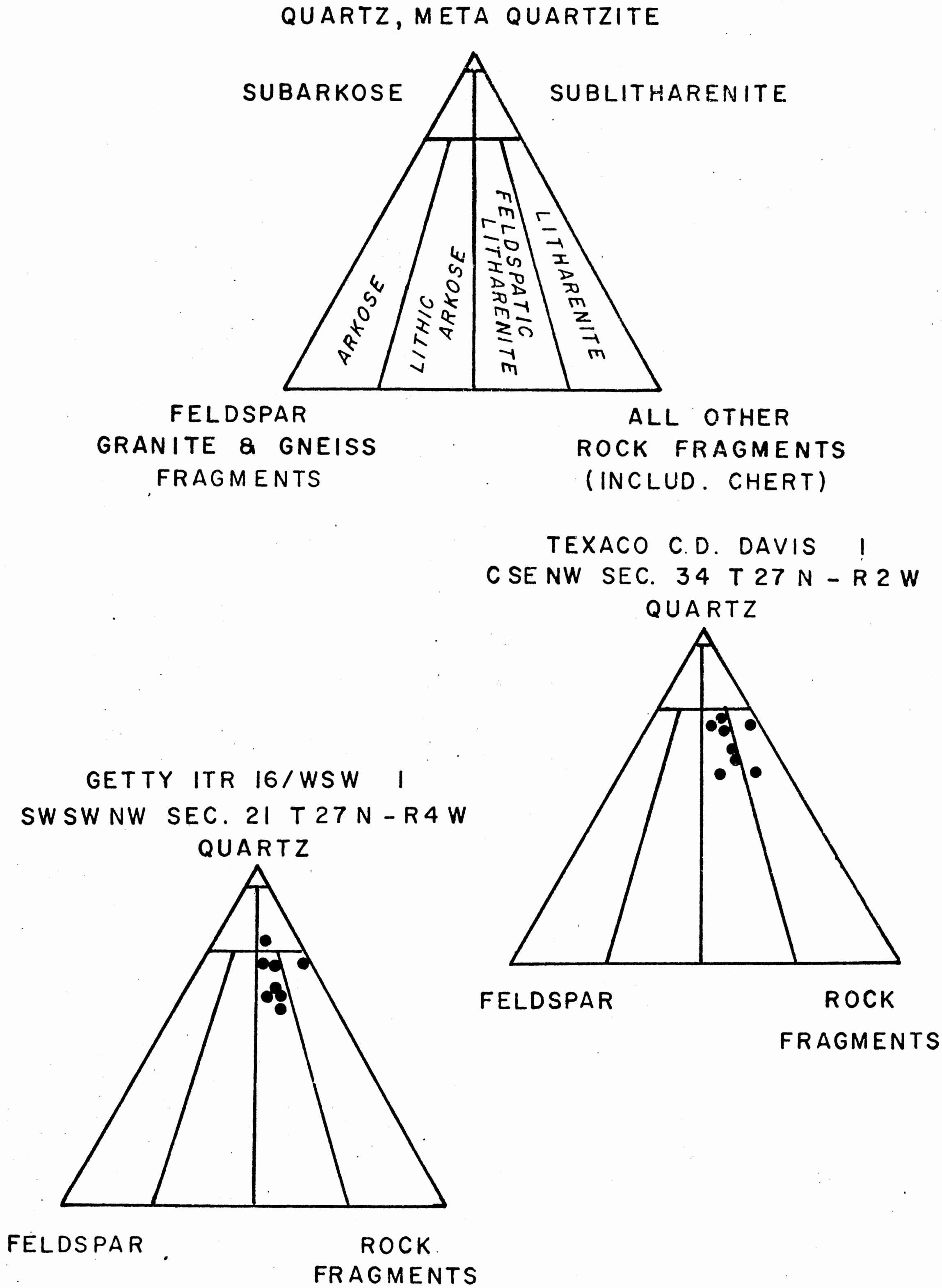

Fig. 21--Classification of Red Fork sandstones (modified after Folk, 1963).

CHAPTER VII

DEPOSITIONAL ENVIRONMENT

Lower Red Fork Sandstone

In a study of the lower Red Fork sandstones in Grant and Alfalfa Counties, Withrow (1968) concluded that the major environment of deposition was a series of offshore bars. Evidence cited for such conclusions are: (1) "en-chelon" arrangement of sand bodies, (2) gradational lateral contacts, and (3) the elongated, narrow, and seemingly parallel characteristics of the Wakita and Cherokita Trends.

This evidence and the subsequent conclusions differ greatly from those of the present author. Examination and interpretation of the data reveals: (1) the lower Red Fork is in elongated trends that are bifurcating to dendritic (Pl. 10), and (2) local absence of the basal Inola marker due to erosion (Fig. 7), along with sharp basal and lateral contacts indicate that the sandstone was deposited at the expense of underlying and adjacent sediments. These lines of evidence plus sedimentary structures and accessory lithologies in cores lend strong support for the interpretation of deposition in a fluvial channel complex.

Analysis of grain-size distributions clearly shows a general fining upward sequence in two of the examined cores

(Fig. 10 and 11). This is the textural arrangement viewed in typical point-bar sequences of meandering streams and distributary channels. A third core (Fig. 12) revealed a uniform grain size throughout. While this is not definitive of a depositional environment, it is a common feature in channels which experience periodic flooding. The abrupt increase in grain size near the top of the Texaco core (Fig. 12) could indicate one of these episodes of flooding.

Texturally as well as mineralogically, the sands of the lower Red Fork are submature. The sand-size fraction typically is moderately sorted, subrounded, and displays coarse-grained to very fine-grained sand (this excludes pebblesized mud clasts. silt and clay-size particles). In conjunction with the textural parameters, the sand commonly shows an assemblage of metastable constituents consisting of detrital feldspars and muscovite with muscovite schists and phyllites. Phosphatic coated grains are present in trace amounts.

The above evidence is indicative of sands deposited in channels of a lower alluvial plain. Dominance of fine and very fine sand (Fig. 10-12) in combination with the subrounded nature and moderate degree of sorting indicates deposition a significant distance from an uplifted source or from a provenance of uniform, submature sediments. Abundance of metastable constituents and presence of the detrital phosphate grains indicate a relatively immature sediment assemblage environment.

The vertical sequence of sedimentary structures observed compares favorably with those associated with meander belts of alluvial plains (Shelton, 1973). Massive bedding and pebble-size mud clasts along with a coarse sand (Fig. 12) should mark the zone near the base of the channel. The abundance of medium- and small-scale cross-bedding and cross-laminations, along with horizontally bedded and laminated sandstones is also common in alluvial plains. Initial dip represents deposition on the slopes of point bars, and the associated flowage features are records of the instability of the slope during deposition. Abundance of intraformational mud clasts in the upper portion of the well developed sand zone (Fig. 11) probably is indicative of limited transportation of disrupted clay drape. Erosional-reactivation surfaces associated with graded bedding observed in the Getty core (Fig. 11) are not diagnostic of a point-bar sequence, but possibly represents flooding stages in the channel cycle. Upward the sequence grades into overbank deposits of horizontally laminated and small-scale cross-laminated, interstratified, very-fine grained sandstones, silts, and shales. Interstratification approaches lenticular to flaser-type bedding in a few zones, which display erosional-reactivation surfaces at some places. In the upper zones siderite is found as cement and as nodules. Pyrite is found disseminated throughout the cored interval, and in the shaley zone it is also seen replacing fossilized plant matter. Calcite concretions are in the shales of the upper zones; some of the concretions coalesce to form thin laminae. The well-preserved wood fragments on some of the bedding planes are a significant feature of channel deposits in alluvial plains, according to Visher (1963).

Composition of the sandstones, their areal distributions and regional paleogeology provide information concerning provenance. Framework grains are dominantly of stable polycrystalline and monocrystalline quartz, with metastable constituents of Na-rich and K-rich feldspar, muscovite schist, and phyllites. Abundance of these metamorphic fragments and detrital feldspar, in association with trend and distribution of the lower Red Fork (as shown on Pl. 10 and 11) suggest that the source was from a northerly direction in the form of the Nemaha Ridge, Central Kansas Uplift and the Pratt Anticline (Fig. 22). The Nemaha Ridge has a core of granite and could have supplied ample amounts of feldspars. The Central Kansas uplift and its southern extension, the Pratt Anticline, are known to have been abundant in quartzite, which is common to the Red Fork sands (Merriam, 1963). Evidence that these structures were positive during Red Fork deposition is in the onlapping nature of the Cherokee sediments on their flanks (Merriam, 1963). To the east and flanking the Central Kansas Uplift is the Sedgwick Basin, an elongated syncline between the Central Kansas Uplift and the Nemaha Ridge (Fig. 22). This syncline is an extension of the Anadarko Basin (Merriam, 1963); its axis trends

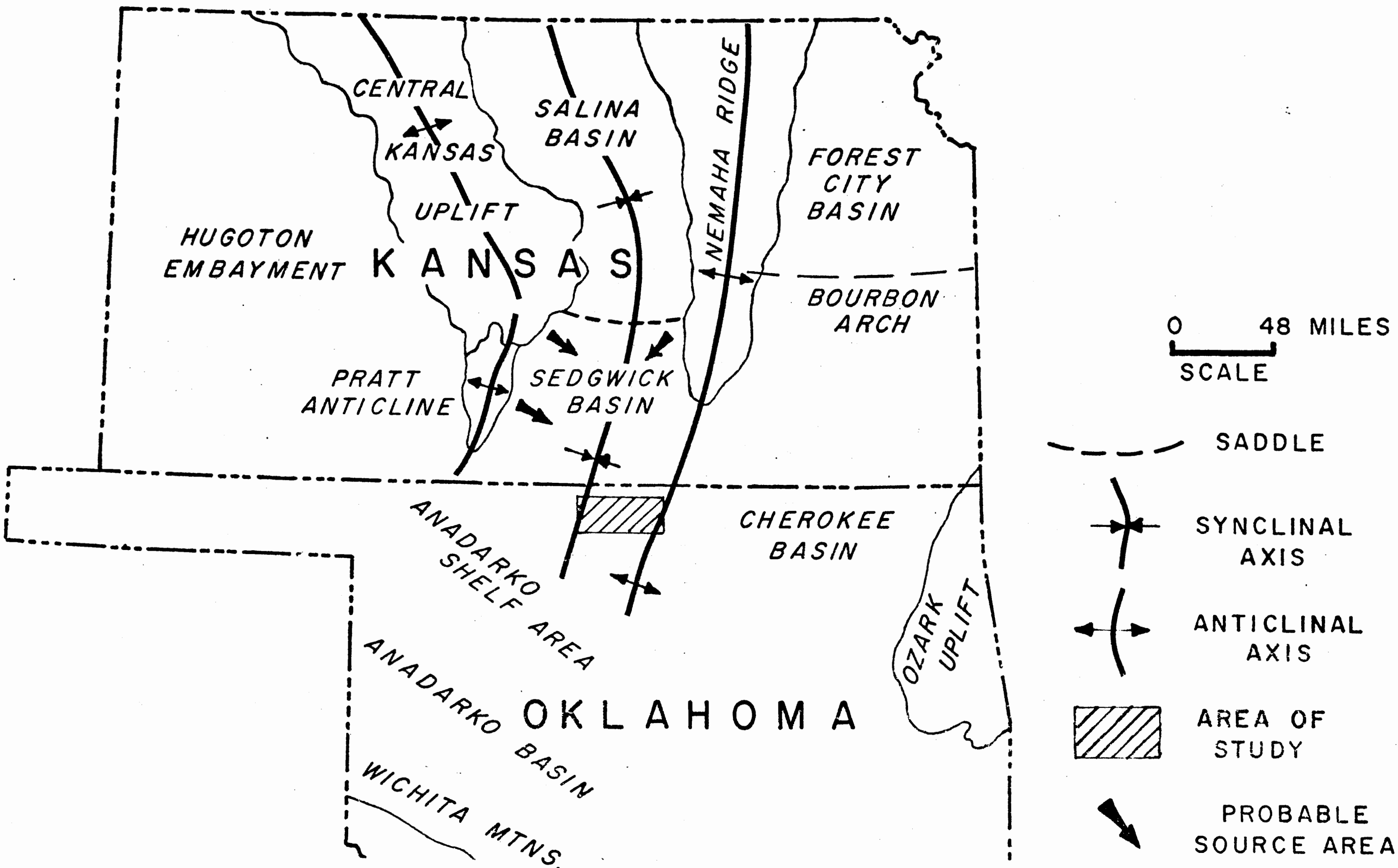

Fig. 22--Major post-Mississippian, pre-Desmoinesian structural features of Kansas and northern Oklahoma.

slightly east of north. The lower and middle Pennsylvanian sections thicken toward the axis of the syncline and southward (Merriam, 1963). These basic circumstances imply that the source of Desmoinesian sediments was from the north.

Examination of the log map of the lower Red Fork reveals that the eastern two-thirds of the study area is dominated by a bifurcating sandstone pattern best described as semi-trellis (Pl. 10). Figure 23a shows that the first stage of channel development probably was dominated by streams that flowed from north to south. Headward erosion may have caused pirating and ultimate abandonment of the lower-gradient tributaries. This may have resulted in the development of the drainage pattern in stage II (Fig. 23b). In the western third of the study area the drainage pattern seems to have been mainly dendritic throughout the presumed fluvial cycle of Red Fork deposition.

A transgression terminated lower Red Fork cutting and filling with thin beds of marine shale covering the entire project area and beyond.

Upper Red Fork Sandstone

Sands of the upper Red Fork are of similar environments of deposition, but the sands are not as well developed as those of the lower Red Fork. As the log map reveals (Pl. 9), the upper Red Fork shows thin elongated north-south trends that mostly are dendritic. In cross-sectional view (Fig. 7) the sand bodies are lenticular with sharp lateral and basal

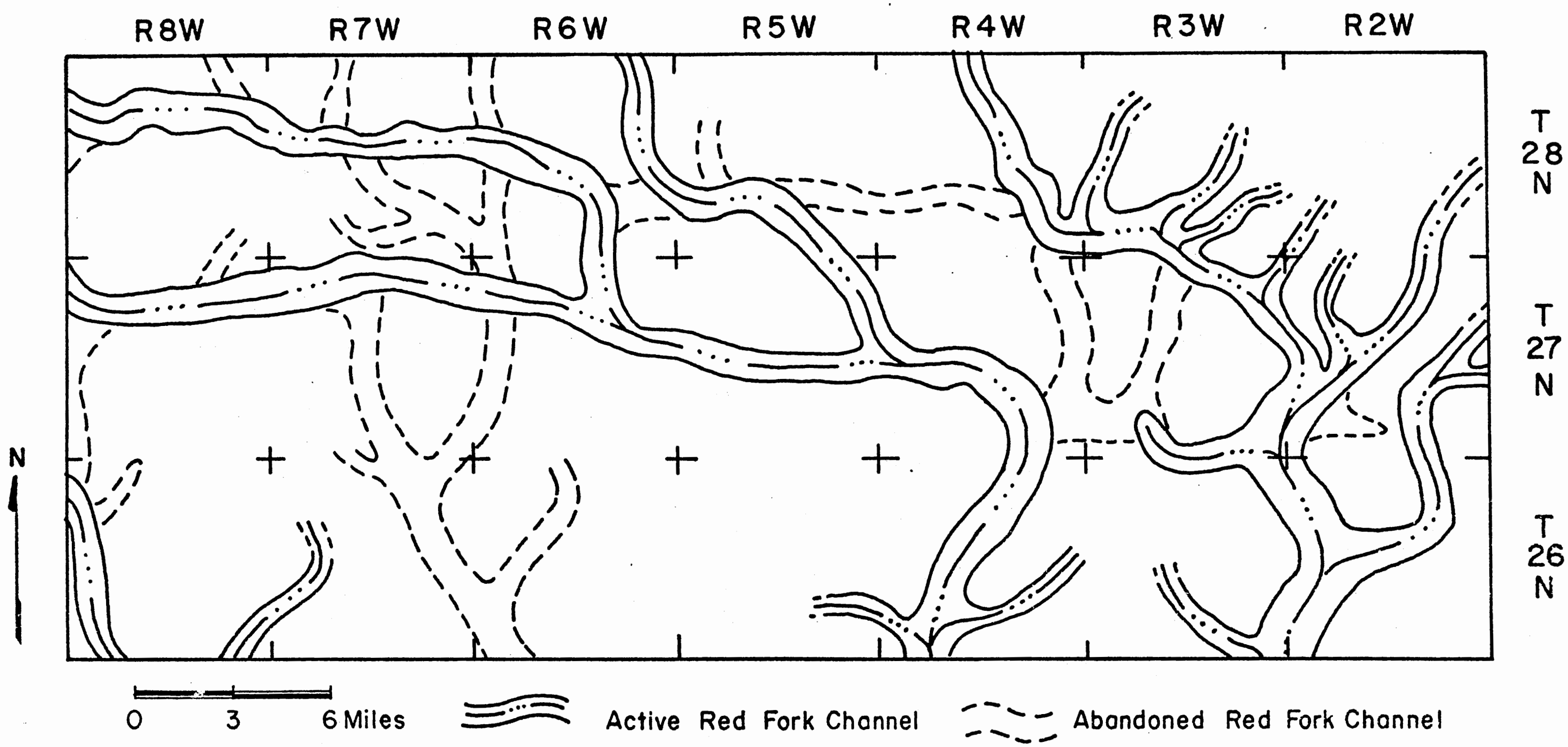

Fig. 23a--Diagram showing stage I in the development of Red Fork channel system. Note that the major channels are oriented north-south (inferred from Pl. 10).

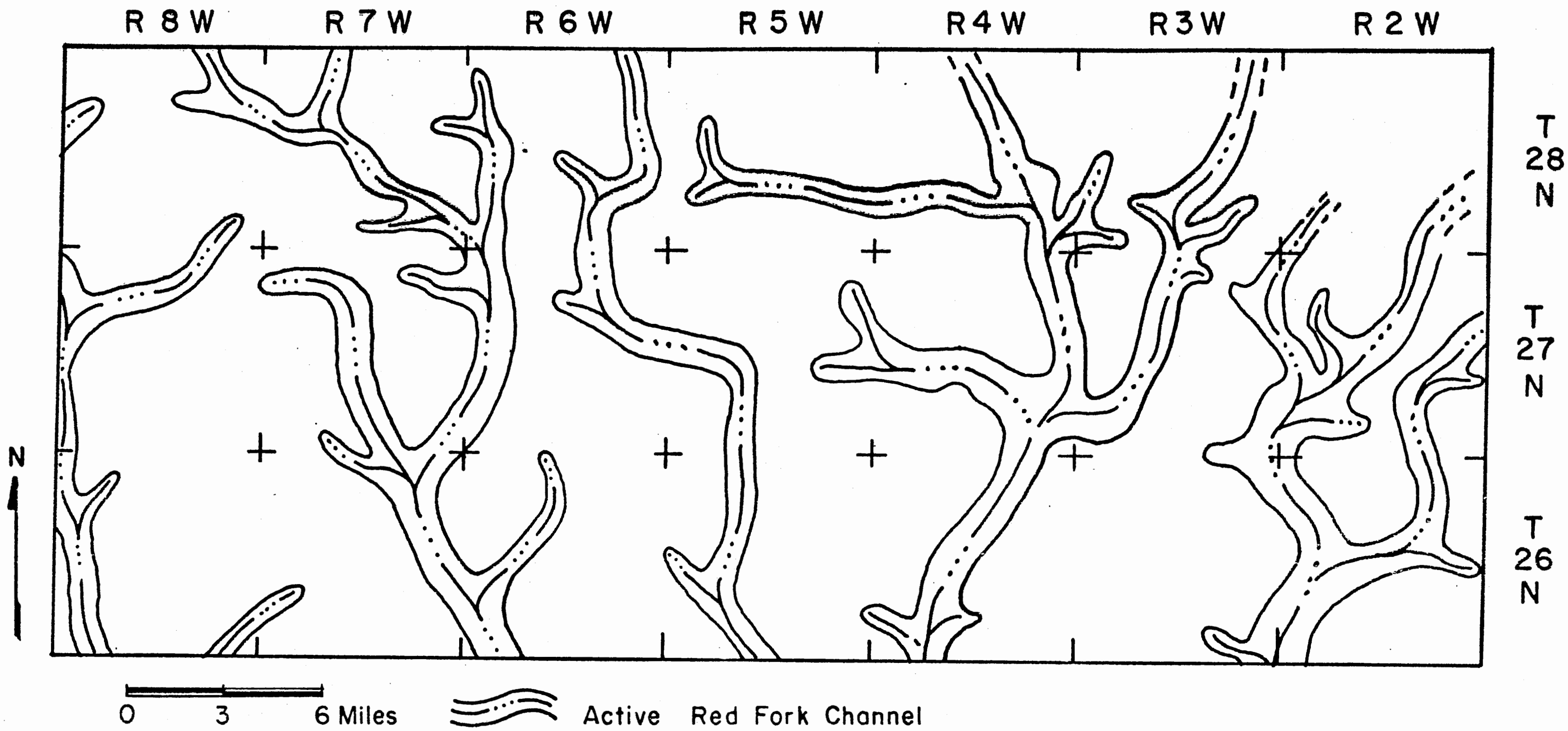

Fig. 23b--Diagram depicting a later stage in Red Fork channel development. The dominant east-west trend (T.27N. to 28N., R.4 to 8W.) have evolved through pirating and abandonment of less active channels. The eastern third of the area still exhibits a dendritic drainage pattern (inferred from Pl. 10).

contacts. According to Withrow (1968) the shales of lateral equivalency are variegated red and green and contain mud-cracks filled with silt. The presence of silty-sand and shale is thought to represent overbank deposits.

In some areas where thick accumulations of lower Red Fork are present, the upper Red Fork can be observed to be in cutouts in the underlying sands. Incising of the upper Red Fork into the lower has brought about the undifferentiated nature shown by the sands in some wells of the study area (Pl. 10, outlined areas). Deposition of the upper Red Fork ended with another transgression, recorded by the Pink limestone.

CHAPTER VIII

DIAGENESIS

Petrographic analysis of the Red Fork sandstone yielded evidence of a sequence of diagenetic events that can be described as follows:

Stage I: Reduction of primary porosity in large part was due to compaction and cementation. Loss of primary porosity by compaction is shown by plastic deformation of mud clasts (Fig. 24 and 25). Compaction resulted in clogging of pore apertures and by a pseudo-matrix.

Cementation due to syntaxial overgrowth of quartz and feldspar was the most effective agent in reduction of primary porosity. Locally the quartz is a mosaic of framework grains and their overgrowths; the quartz may show only minor modification due to later diagenetic changes (Fig. 26). The interlocking texture can be mistaken as pressure-solution contacts between framework grains. However, the margins of the quartz framework grains commonly contain small particles of dust which help to distinguish the detrital grain boundary. As viewed in Figure 27, essentially all the contacts are among the cement and not the framework grains. This indicates the minor importance of pressure solution in destruction of the primary porosity.

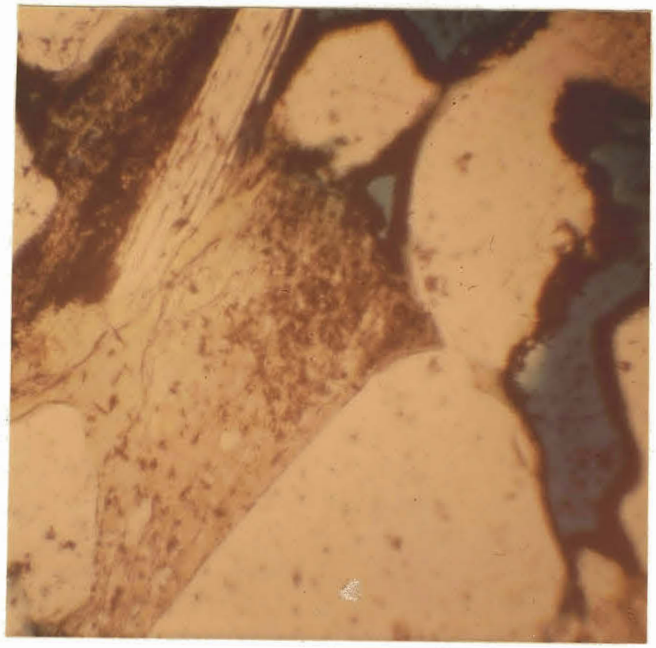

Fig. 24--Sign of deformation as detrital shale clasts have flowed between adjacent grains of quartz. This material can resemble dispersed matrix. Magnification 40X.

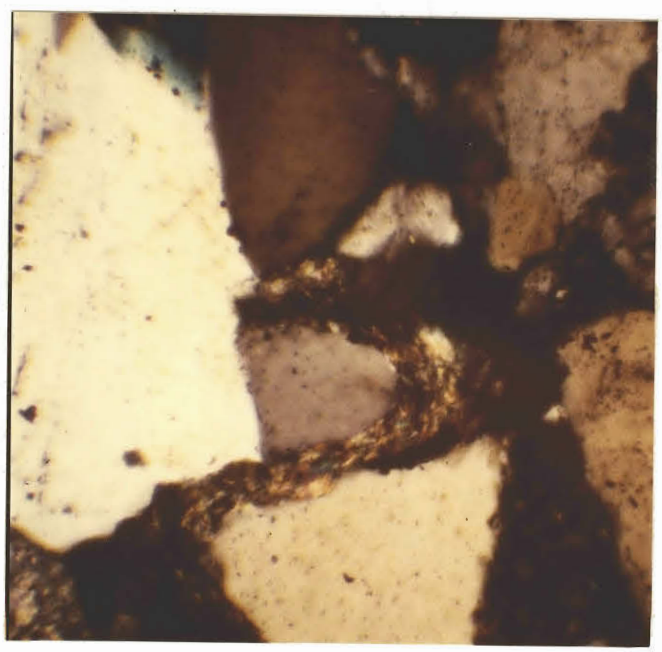

Fig. 25--Ductile deformation of muscovite schist fragment. Magnification 40X.

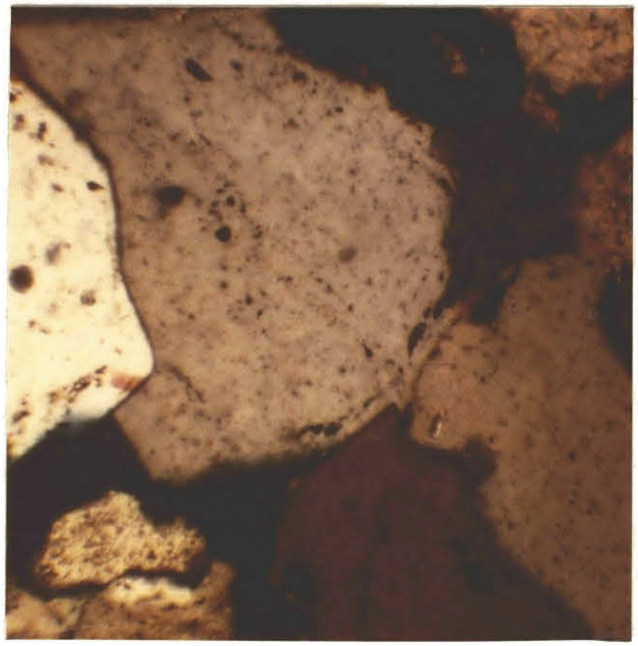

Fig. 26--Mosaic texture developed in advanced stages of quartz cementations. Magnification 40X.

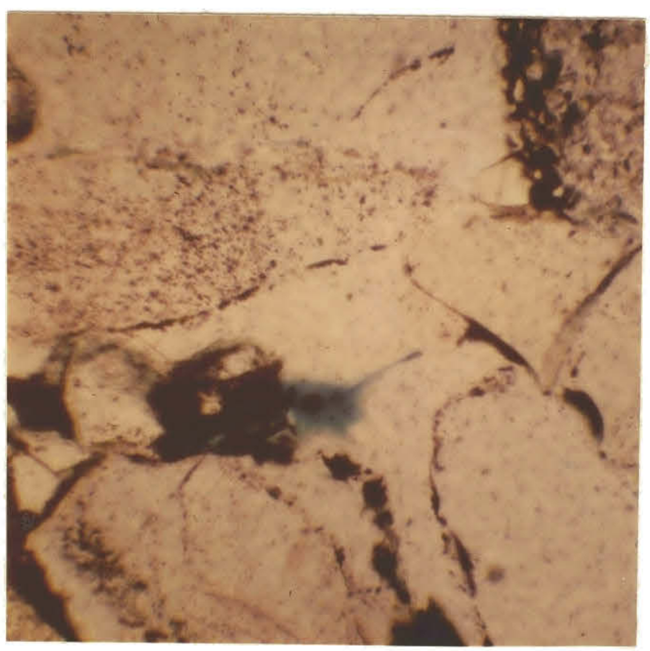

Fig. 27--Dust rim clearly defines framework grains. Note the dead oil (upper right) impregnating the partially dissolved grain of feldspar, and filling the pore (lower left). Magnification 40X.

Albite cement, showing a preference for albite grains as seed crystals, also is present. Commonly, twinning of the framework grain propagates into the overgrowth and optical continuity is viewed.

Stage 2: Extensive replacement and corrosion of overgrowths and detrital grains are typical of this stage. This is seen in the ragged edges exhibited by the cement and framework grains of quartz and feldspars (Fig. 28 and 29). Locally, carbonate minerals are unaffected and are still tightly cementing the sand. The carbonate is predominantly of ferroan-dolomite with some ferroan-calcite.

Stage 3: From the standpoint of economics, the most important stage is the development of secondary porosity. Secondary porosity is due primarily to the alteration of detrital mud fragments into authigenic clays. A smaller percentage of the secondary porosity was developed from the dissolution of detrital feldspar grains and authigenic carbonate cements.

Examination of core samples under scanning-electron microscopy show the alteration of the detrital mud fragments to authigenic chlorite. This alteration results in a volume reduction of the mud fragment and a corresponding increase in the secondary intergranular porosity (Fig. 30). Chlorite can be seen lining pores and detrital grains as well developed pseudo-hexagonal plates. These plates commonly arrange themselves in an end-to-face habit (Fig. 31).

Kaolinite is present in isolated areas as booklets

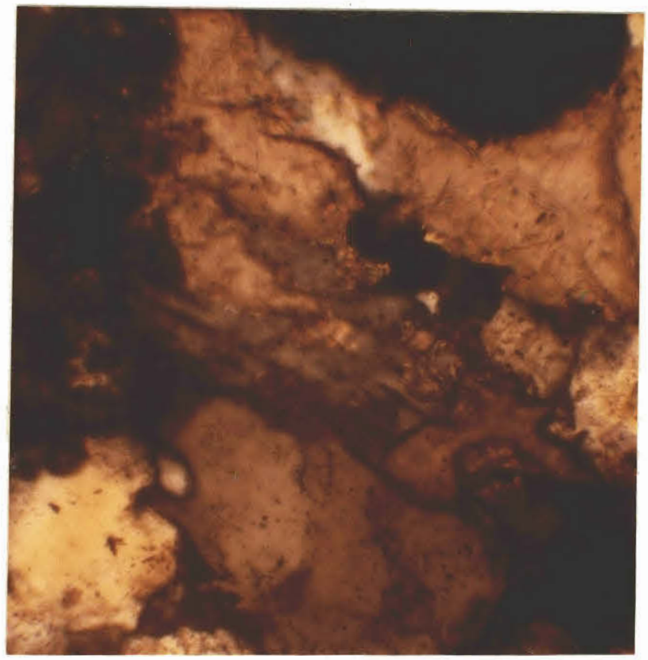

Fig. 28--Calcite cement is shown replacing quartz. Calcite cement is patchy from partial dissolution. Magnification 40X.

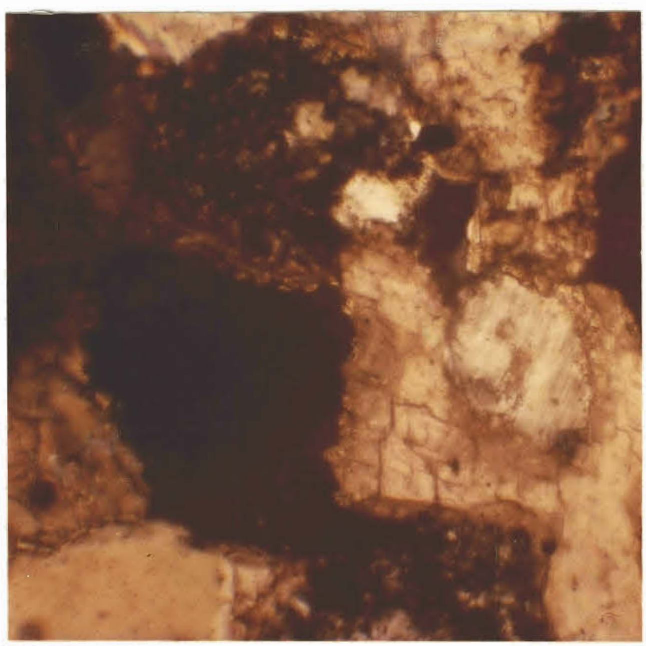

Fig. 29--Calcite replacement of detrital plagioclase grain by corrosion of outer edges and intercrystalline replacement. Magnification 40X.

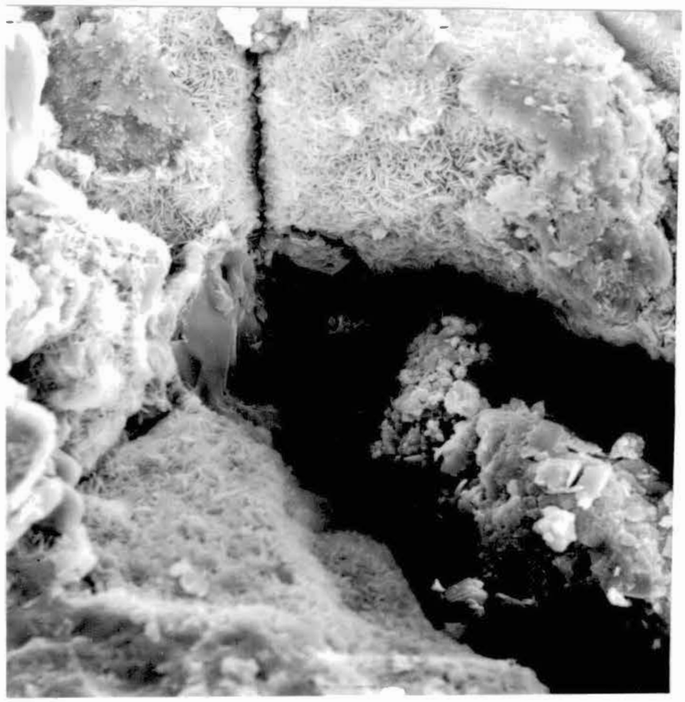

Fig. 30--Authigenic chlorite lining a pore. Chloritization of a mud fragment has caused the fragment to shrink producing secondary porosity. From the Texaco C. D. Davis No. 1; 4220 ft.; Magnification 540X.

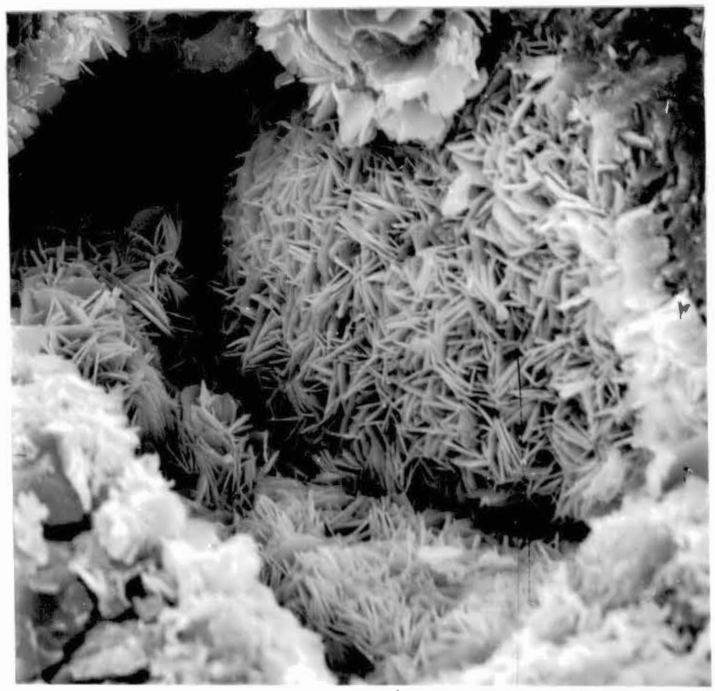

Fig. 31--Authigenic chlorite lining a pore in its typical end-to-face habit. From the Texaco C. D. Davis No. 1; 4220 ft.; Magnification 1500X.

of pseudo-hexagonal crystals lining pores (Fig. 32). This delicate morphology would indicate the authigenic nature of the Kaolinite.

Removal of feldspar grains has led to the development of dissolution porosity. Permeability resulting from this type of porosity ranges from poor to moderate depending on the amount of porosity and interconnection of the pores.

Removal of secondary ferroan-dolomite and ferroan-calcite also helped enhance development of secondary intergranular porosity. This type of porosity ranges from trivial (Fig. 33) to well developed (Fig. 34).

Clues of secondary porosity in the sandstone are:

(1) Scattered patches of undissolved carbonate cement.

(2) Partially dissolved "skeletal" detrital grains.

(3) Oversized pore spaces.

(4) Corroded grains where margins were replaced by calcite.

Large pores, many of which contain fragile relict grains within a strongly compacted sandstone, suggest that dissolution took place after burial and compaction (Hartman, 1968 and Parker, 1974).

As Figure 35 shows, the largest percentage of secondary matrix porosity is of the intergranular type. It should be noted, however, (by comparison of Fig. 35 and data on Table I) that the type of secondary porosity in an interval does not dictate the amount of matrix permeability shown in the rock. This observation is based on a

Fig. 32--Minor amounts of kaolinite were detected by the S.E.M. Here the kaolinite is in vermicular stacks of pseudohexagonal plates. From the Texaco C. D. Davis No. 1; 4220 ft.; Magnification 600X.

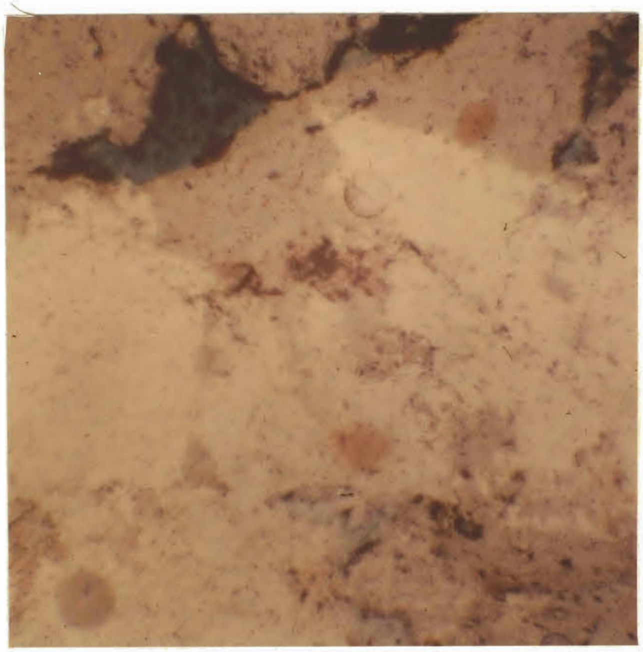

Fig. 33--Secondary porosity is not well developed and the grains are still well cemented by silica. This gives rise to poor porosity and permeability.

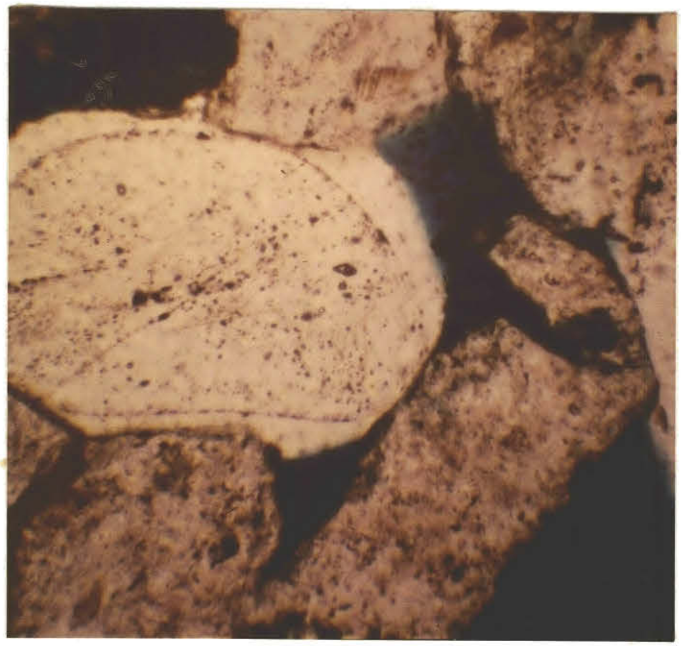

Fig. 34--Extensive development of secondary intergranular porosity is evident by the partial dissolution of quartz overgrowths and corroded nature of the feldspars. Note the dead oil lining and filling many of the pores.

TABLE 1. Porosity and permeability data corresponding to thin-section samples

Core: Getty 1 T.R. 16/WSW No. 1

Thin Section Numer	Core Depth (ft.)	Permeability (millidarcys)	Porosity (percent)
2	4214	0.2	17.2
3	4218	20.0	23.4
4	4220	2.1	19.6
5	4222	2.9	14.1
7	4226	0.2	17.5
8	4229	2.1	20.7
9	4232	3.5	12.9
29	4216	8.0	19.6
30	4221	2.1	19.6
32	4231	20.0	16.0

Core: Texaco C. D. Davis No. 1

Thin Section Number	Core Depth (ft.)	Permeability (millidarcys)	Porosity (percent)
13	4782	0.1	10.6
18	4801	1.1	14.7
19	4810	0.2	10.2
20	4811	1.1	14.1
22	4822	0.2	9.9
23	4827	2.4	14.7
24	4830	2.5	14.0
25	4833	2.7	14.6
26	4835	7.5	16.1
27	4838	0.1	4.5

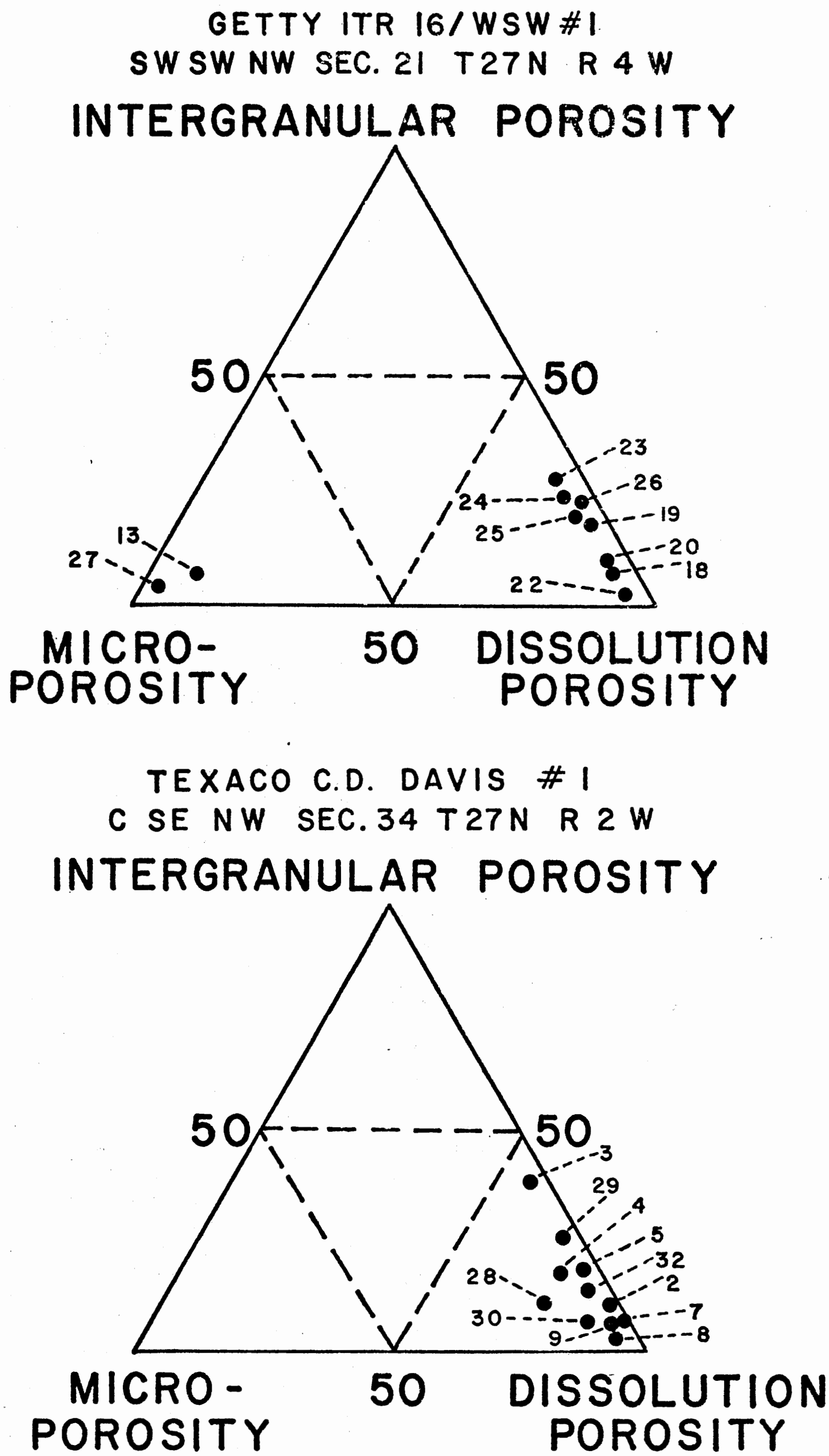

Fig. 35--Ternary classification diagram of matrix related porosity (after Pittman, 1968). See Table I for related porosities and permeabilities of posted thin-section samples.

relatively small number of samples and is not considered conclusive.

Migration of hydrocarbons also took place during stage III of diagenesis. Evidence of this migration is seen in dead oil in pore linings (Fig. 33) and oil impregnation of partially dissolved grains (Fig. 27).

The potential problems that are inherent in development of a reservoir containing the diagenetic suite of minerals as described in the Red Fork are mainly the migration of fines (kaolinite) and acid sensitivity (chlorite, ferroan-dolomite, and ferroan-calcite). Migration of the fines can be eliminated or minimized by the use of a commercial clay-stabilizing agent. In those cases where acid is used for procedural cleaning of the reservoir of mud, careful consideration must be taken due to the presence of iron-rich chlorite, dolomite, and calcite. If a strong acid is used (e.g., 15% HCl), it has the ability to liberate iron from the ferroan minerals. This iron will precipitate as a brown gelatinous mass of ferric hydroxide ($Fe(OH)_3$) which occludes pores and pore throats. Of course, the result would be a drastic reduction in permeability.

Hydroflouric acid should also be used with some discrimination in treatment of Red Fork reservoirs. In localized areas around the borehole, secondary calcium carbonate cement is abundant. Hydroflouric acid will react with the calcium carbonate to form the insoluble calcium floride, which clogs pore throats.

CHAPTER IX

PETROLEUM GEOLOGY

In the area of study, petroleum was discovered in the Red Fork sandstone in April, 1953. The first productive well was the Vierson and Cochran No. 1 Melchar, NE NE NW, Section 18, T.28N., R.8W. The discovery was in 22 feet of Red Fork sand in the Wakita Trend at a maximal depth of 4912 feet. A 75-minute drill-stem test of the sand resulted in an estimated flow of 1.5 MMCFGPD. The first oil production in the area was from the Vierson and Cochran No. 1 Burghardt NW NW NW, Section 7, T.28N., R.8W. The drill-stem test in a 22 foot interval of Red Fork sand yielded 4.7 MMCFG and 120 to 240 BOPD.

The Cherokita Trend, south of the Wakita Trend, was developed in 1956. This reservoir is about 5,000 feet deep with an average sandstone thickness of approximately 40 feet.

Cumulative Red Fork production of oil (Petroleum Information) and gas (American Gas Association) in the area of study is shown to December 31, 1979. More than 22,578,000 barrels of oil and 261.670 billion cubic feet of gas have been produced. At present, approximately 400 wells still produce oil and gas from the Red Fork in the area of study.

Most of the gas found within the Red Fork is present as as a "gas cap" or "free gas." In those reservoirs where the cap is situated over an oil pool, the oil is saturated with dissolved gas. The expansion of this dissolved gas along with the "gas cap" maintain the reservoir pressure as the oil rim is depleted (Levorsen, 1967).

Trapping mechanisms in the Red Fork are stratigraphic and structural. Updip loss of reservoir sand due to channel boundaries along with cap rock of transgressive shales encase the Red Fork in a relatively impermeable medium. Draping of Red Fork channels over paleo-highs along with minor differential compaction have created flexures that form local structural traps in the Red Fork sand trends. The combination of sandstone pinchouts and development of local structures along the Red Fork trends causes the gas-oil, oil-water contacts to vary among reservoirs.

Success in future exploration for subtle traps in the Red Fork sands lies heavily on the effective use of regional stratigraphy. Regional stratigraphic analysis can be in the form of isopach mapping of defined intervals. This method is effective in outlining where significant paleotopography existed, which could have affected deposition of the Red Fork. Interval isopach maps, log maps, and stratigraphic cross-sections are useful in outlining areas that were favorable for depositional sandstone. These data could be used in predicting and delineating sandstone trends not yet detected.

CHAPTER X

SUMMARY

Principal conclusions of this study are as follows:

(1) The regressive Desmoinesian Red Fork interval is delineated by the transgressive Pink limestone (above) and Inola limestone (below). In areas where the Inola is absent due to onlap, the Red Fork lies unconformably on the eroded Mississippian rocks.

(2) The Red Fork interval shows a gradual thickening to the south at less than 2 feet per mile.

(3) Rocks of the lower and upper Red Fork sandstones are elongated trends that are bifurcating to dendritic.

(4) The upper and lower Red Fork sandstones show sharp basal and lateral contacts. Local erosion of the basal Inola marker and lower Red Fork sand deposition in the eroded "lows" is strong evidence for channeling.

(5) Correlative thickening of the "Cherokee interval" and the Red Fork sandstone suggests that deposition was influenced by pre-existing topography.

(6) Lower Red Fork sandstones characteristically are multistoried and multilateral.

(7) Most structural geology of the top of the Red Fork interval is due to underlying paleotopography and to a lesser

extent to differential compaction over Red Fork Channel sands. The eastern one-third of the study area is dominated by a north-trending horst which is parallel and structurally related to the Nemaha Ridge.

(8) The vertical sequence of sedimentary structures viewed in cores of the lower Red Fork is similar to those in a point-bar sequence of a meandering stream.

(9) Texture, composition and distribution of sandstones indicates channel deposition in a lower alluvial-plain environment.

(10) Diagenesis of the Red Fork occurred in three principle stages: (1) destruction of primary porosity by compaction and silica cementation, (2) replacement of feldspars and quartz by carbonate cements, (3) development of secondary porosity.

BIBLIOGRAPHY

Berg, O. R., 1964, Quantitative study of the Cherokee Marmaton Group, west flank of the Nemaha Ridge, north-central Oklahoma: Okla. City Geol. Soc., Shale Shaker, v. 19, p. 94-110.

Billings, M. D., 1972, Structural geology: Prentice Hall Inc., Englewood Cliffs, New Jersey, p. 247-260.

Branson, C. C., 1954, Desmoinesian rocks of northeastern Oklahoma: Okla. Geol. Survey Guidebook 2, p. 41.

Bryan, R. C., 1950, The subsurface geology of the Deer Creek, Webb, and North Webb oil pools, Grant and Kay Counties, Oklahoma: Unpub. Masters Thesis, Univ. of Okla.

Busch, D. A., 1971, Stratigraphic traps in sandstones-exploration techniques: Am. Assoc. Petroleum Geol., Memoir 21, p. 174.

Caylor, J. W., 1956, Subsurface geology of western Garfield County, Oklahoma: Okla. Geol. Soc., Shale Shaker, v. 7, No. 4, p. 3-8; Shale Shaker Digest II, p. 202-221.

Dana, G. F., 1954, Subsurface geology of Grant County, Oklahoma: Okla. City Geol. Soc., Shale Shaker, v. 4, No. 10, p. 4-28.

Fath, A. E., 1920, The origin of faults, anticlines, and buried granite ridges in the northern part of the Mid-Continent oil and gas field: U. S. Geol. Survey, Prof. Paper 128-C.

Folk, R. L., 1968, Petrology of sedimentary rocks: Austin, Texas, Hemphill's Book Store, 170 p.

Forgotson, J. M., Jr., 1957, Nature, usage and definition of marker-defined, vertically segregated rock units: Am. Assoc. Pet. Geol. Bull., v. 41, p. 2108-2113.

Friedman, G. M., and J. E. Sanders, 1978, Principles of sedimentology: John Wiley and Sons, New York, New York, 788 p.

Galehouse, J. S., 1971, Point counting, in Carver, R. E., procedures in sedimentary petrology: Wiley and Sons, New York, New York, p. 385-407.

Hartman, J. A., 1968, The Norphlet Sandstone, Pelahatchie Field, Rankin County, Mississippi: Trans. Gulf Assoc. Geol. Sci., No. 18, p. 2-12.

Haworth, E., and M. Z. Kirk, 1894, A geologic section along Neosha River from the Mississippian Formation of the Indian Territory to White City, Kansas, and along the Cottonwood River from Wyckoff to Peabody: Kansas Univ. Quarterly, v. 2, p. 104-115.

Hayes, J. B., 1979, Sandstone diagenesis-the hole truth: Society of Economic Paleontologist and Mineralogist Special Publication No. 26, p. 127-139.

Howe, W. B., 1956, Stratigraphy of pre-Marmaton Desmonesian (Cherokee) rocks in southeast Kansas: Kansas State Geol. Survey Bull. 123, p. 123-132.

Hutchinson, C. S., 1974, Laboratory handbook of petrographic techniques: John Wiley and Sons, New York, New York, 527 p.

Hutchinson, L. L., 1911, Rocks asphalt, asphaltite, petroleum and natural gas in Oklahoma: Okla. Geol. Survey, Bull. 2, p. 230-260.

Ireland, H. A., 1955, Precambrian surface, northeast Oklahoma and parts of adjacent states: Am. Assoc. Petroleum Geol. Bull., v. 39, pt. 1, p. 468-483.

Jordan, L., 1957, Subsurface stratigraphic names of Oklahoma: Okla. Geol. Survey Guidebook VI, 220 p.

Krumme, G. W., 1975, Mid-Pennsylvanian source reversal on the Oklahoma Platform: Unpub. Ph D. Dissertation, Univ. of Tulsa, 1161 p.

Land, S. S., and S. P. Dulton, 1978, Cementation of a Pennsylvanian deltaic sandstone; Isotopic data: Journal Sed. Petrol., v. 48, p. 1167-1176.

Le Blanc, R. J., 1972, Geometry of sandstone reservoir bodies, in underground waste management and environmental implications: Am. Assoc. Pet. Geol., Memoir 18, p. 133-190.

Levorsen, A. L., 1967, Geology of petroleum: W. H. Freeman and Company, San Francisco, California, 724 p.

Lowman, S. W., 1933, Cherokee structural history in Oklahoma: Tulsa Geol. Soc. Dig., v. 1, p. 31-34.

McElroy, M. N., 1961, Isopach and lithofacies study of the Desmoinesian Series of north-central Oklahoma: Okla. City Geol. Soc., Shale Shaker, v. 12, p. 2-22.

Merriam, D. F., 1963, Geologic history of Kansas: State Geol. Survey of Kan., Bull. 162, 317 p.

Morgan, L. C., 1932, Central Kansas Uplift: Am. Assoc. Petrol. Geol. Bull., v. 16, p. 483.

Oakes, M. C., 1953, Krebs and Cabaniss Groups of Pennsylvanian age, in Oklahoma: Am. Assoc. Petrol. Geol. Bull., v. 37, p. 1523-1526.

Parker, C. A., 1974, Geopressures and secondary porosity in the deep Jurassic of Mississippi: Trans. Gulf Coast Assoc. Geol. Socs., No. 29, p. 69-80.

Pate, J. D., 1959, Stratigraphic traps along the northern shelf of the Anadarko Basin: Am. Assoc. Petrol. Geol. Bull., v. 43, p. 35-59.

Pettijohn, E. J., 1975, Sedimentary rocks: Harper and Bros., New York, New York, 628 p.

Pittman, E. D., 1979, Porosity, diagenesis and productive capability of sandstone reservoirs: Society of Economic Paleontologists and Mineralogists Special Pub. No. 26, p. 159-173.

Potter, E. D., 1966, Sand bodies and sedimentary environments: Am. Assoc. Petrol. Geol. Bull., v. 51, p. 337-365.

Querry, J. L., 1957, Subsurface geology of south-central Kay County Oklahoma: Okla. City Geol. Soc., Shale Shaker, v. 8, No. 7, p. 10.

Raymond, E. K., and D. K. Davies, 1979, Environments and diagenesis of the Morrow sands, Cimarron County (Oklahoma), and significance to regional exploration production and well completion practices: Tulsa Geol. Soc. Special Pub., No. 1, p. 169-193.

Reading, H. G., 1979, Sedimentary environments and facies: Elsevier North-Holland, New York, New York, 557 p.

Reineck, H. E., and I. B. Singh, 1975, Depositional sedimentary environments: Springer-Verlag Berlin, Heidelberg, New York, 439 p.

Scholle, P. A., 1978, A color illustrated guide to constituents, textures, cements, and porosities of sandstones and associated rocks: Am. Assoc. Petrol. Geol., Memoir 28, 201 p.

Selley, R. C., 1971, Ancient sedimentary environments: Cornell Univ. Press, Ithica, New York, 240 p.

Shelton, J. W., 1972, Correlation sections and log maps in determination of sandstone trends: Am. Assoc. Petrol. Geol. Bull., v. 56, p. 1541-1544.

------, 1973, Five ways to explore for sandstone reservoirs: The Oil and Gas Journal, v. 71, p. 126-128.

------, 1973, Model of sand and sandstone deposits: Okla. Geol. Survey Bull. 118, 122 p.

Stanbro, G. E., Jr., 1960, A subsurface study of the "Cherokee Group" Grant County and portions of Alfalfa County Oklahoma: Unpub. Master of Science Thesis, Univ. of Okla.

Thornbury, W. D., 1961, Principles of geomorphology: John Wiley and Sons Inc., New York, New York, p. 21-26.

Visher, G. S., 1964, Use of vertical profile in environmental reconstruction: Am. Assoc. Petrol. Geol., Reprint Series No. 8, p. 86-106.

Weimer, R. J., 1978, Deltaic and shallow marine sandstones: sedimentation tectonics, and petroleum occurrences: Am. Assoc. Petrol. Geol. Cont. Educ. Course, Note Series No. 2, 164 p.

Weimer, R. J., C. B. Land, and MacMillan, L. T., 1974, A stratigraphic model for distributary channels, (J) and Muddy sandstones; Rocky Mountain Region (abs.): Am. Assoc. Petrol. Geol. Ann. Meetings Abstracts, v. 1, p. 97.

Wheeler, R. R., 1947, Anadarko Basin geology and oil possibilities: Part 1: World Oil, v. 127, No. 5, p. 33-46.

Wilson, W. D., and E. D. Pittman, 1977, Authigenic clays in sandstones: recognition and influences on reservoir properties and paleoenvironmental analysis: Journal of Sed. Petrol., v. 47, No. 1, p. 3-31.

Withrow, P. C., 1967, The Red Fork sandstone in the Wakita Trend, Grant and Alfalfa Counties, Oklahoma: Okla. City Geol. Soc., Shale Shaker, v. 17, No. 10, p. 198-205.

------, 1968, Depositional environment of the Pennsylvanian Red Fork sandstones in north-eastern Anadarko Basin, Oklahoma: Am. Assoc. Petrol. Geol. Bull., v. 52, No. 9, p. 1638-1654.

------, 1968, Basis for Red Fork sandstone exploration in northwest Oklahoma (abs.): Tulsa Geol. Soc. Digest, v. 36, p. 97-98.

APPENDIX A

INCORPORATION OF CORE DATA
OUTSIDE STUDY AREA

Due to the inavailability of core in the study area, core from the Gulf No. 1 Stover, C SE SE, Section 16 T27N R9W (Fig. 12) was examined.

A vertical sequence of sedimentary structures, textural variations and visual constituents was noted, recorded, and used in conjunction with data collected from two other cores (Figs. 10 and 11) to aid in interpretation of depositional environment(s) of the Red Fork sands.

APPENDIX B

DISCUSSION OF MOTTLED TEXTURE

Examination of a thin section in this zone (Fig. 19, 4770-4774') yielded no clue as to the origin or the mottled texture. No significant grain size change, sorting, cementation or grain assemblage variations existed between the mottled and unmottled rock. The only noted difference was the massive appearance of the mottled area in thin section as compared to a micro-laminated texture shown elsewhere in the rock sample.

Some possible explanations as to the origin of the mottled texture are bioturbation, disturbance due to root growth, or a local diagenetic effect.

APPENDIX C

LOCATION OF ELECTRIC LOGS USED IN STRATIGRAPHIC CROSS-SECTIONS

No.	Operator and Well Number	Location	
	North-South Stratigraphic Section A-A'		
1.	Texolina Oil Co., Webber #1	C SW NE	Sec. 9-28N-8W
2.	J. A. Chapman, Miller #2	NW NW NW	Sec. 16-28N-8W
3.	Mid-Continent Oil Co., Hime #1	SE SE NE	Sec. 30-28N-8W
4.	Continental Oil Co., Connery #1	NE NE SW	Sec. 32-28N-8W
5.	Youngblood & Youngblood, Bartlett #1	C SW NE	Sec. 4-27N-8W
6.	Vierson & Cochran, Armstrong Unit #1	SE SW	Sec. 9-27N-8W
7.	Davon Drilling Co., Hendriks #1	NE NE NW	Sec. 21-27N-8W
8.	Russell T. Lund, C. Payne #1	SW/4	Sec. 28-27N-8W
9.	Morgan Petroleum Co., Shaffer #1	NW SW	Sec. 33-27N-8W
10.	Continental Oil Co., U. C. Loy #1	SE NW	Sec. 4-26N-8W
11.	George A. Carlson, Speldie #1	C NW NE	Sec. 9-26N-8W
12.	Marion Corp., Kuy Kendall #1	C SW NE	Sec. 16-26N-8W
13.	Sunray Oil Corp., Kent #1	C NE NE	Sec. 21-26N-8W
	North-South Stratigraphic Section B-B'		
14.	Gulf Oil Corp., Carrie Rixse #1	C SE NW	Sec. 9-28N-7W
15.	Woods Petroleum Co., Johnson #1	NW NW SE	Sec. 16-28N-7W
16.	Sunray Mid-Continent Oil Co., P. Cravens	C NW NW	Sec. 21-28N-7W
17.	Petroleum Explor. Inc. of Texas & G. M. Piggott, Williams #1	NW SW SE	Sec. 28-28N-7W
18.	Barrett Petroleum & Kay Gas Co., Lewis #1	C NW SE	Sec. 33-28N-7W
19.	C. J. Richard, Edsall #1	C NW SE	Sec. 4-27N-7W
20.	Vierson & Cochran, Leibli #1	NE NW	Sec. 9-27N-7W
21.	Arthur Finston, Leforce #1	C SW NE	Sec. 15-27N-7W
22.	Davon Drilling Co., Evans #1	SE SE SE	Sec. 27-27N-7W
23.	Barrett Petroleum Co., Ranson #1	C NE SW	Sec. 15-26N-7W
24.	Eason Oil Co., Leforce #1	C NW NW	Sec. 27-26N-7W
25.	Zapata Petroleum Corp., Kent #1	NE SE NE	Sec. 34-26N-7W

North-South Stratigraphic Section C-C'

26. Kewanee Oil Co., Holmes #1	NE NE NW	Sec.	6-28N-6W
27. Wood Petroleum, Regains #1	C SW SE	Sec.	18-28N-6W
28. Calbert Drilling Inc. et al., Breene Gas Unit #1	C NE SW	Sec.	21-28N-6W
29. The Atlantic Refining Co., Danlem #1	C NE NE	Sec.	28-28N-6W
30. Western Oil & Gas Co., Reneau #1	C SW NW	Sec.	34-28N-6W
31. Warren-Bradshaw Exploration Co., Irven #1	C NW NE	Sec.	9-27N-6W
32. Warren-Bradshaw Exploration Co., Yerian Unit A-1	C SE SE	Sec.	9-27N-6W
33. Warren-Bradshaw Exploration Co., Vernon Gas Unit #1	C NW NE	Sec.	16-27N-6W
34. The Texas Co., B. F. Cline #1	SE SE NW	Sec.	28-27N-6W
35. Falcon Seaboard Drilling Co., Jones #1	NW NW SE	Sec.	4-26N-6W
36. Apache Oil Corp., Jones Estate #1	SE SE SE	Sec.	4-26N-6W
37. Pure Oil Co., W. L. Simon #1	C NW NW	Sec.	10-26N-6W
38. The Redman Corp.-Basin Petroleum Co., Reiger "16" #1	SE SE SW	Sec.	16-26N-6W
39. Bartessa Oil Corp., Leforce #1	C SW SE	Sec.	35-26N-6W

North-South Stratigraphic Section D-D'

40. Union Oil Co. of California, Arterburn #1	SW SW NE	Sec.	9-28N-5W
41. H. J. Conham & Wood Oil Co., Kiliam #1	NW NW SE	Sec.	17-28N-5W
42. Sunray Mid-Continent Oil Co., Smetana #1	SW SW SE	Sec.	20-28N-5W
43. Petroleum Inc., Hoover #1	C NW SE	Sec.	29-28N-5W
44. Ivan Isreal, Zeman #1	C SW SE	Sec.	4-27N-5W
45. Sunray Mid-Continent Oil Co., Vernon #1	C SE	Sec.	17-27N-5W
46. Woods Petroleum Co., Kretchmar #1	C NE NW	Sec.	20-27N-5W
47. Parker Drilling Co., Schuermann #1	SE SW NE	Sec.	28-27N-5W
48. Amerada Petroleum Corp., Ruth Centrall #1	C SW SW	Sec.	10-26N-5W
49. Carter Oil Co., Schuermann #2	SW NW SW	Sec.	14-26N-5W
50. L. W. Barrett, Hodges Heirs #1	SW NE NW	Sec.	23-26N-5W
51. J. M. Huber, Sprague #1	NE SE	Sec.	27-26N-5W
52. Mid-Continent Petroleum Corp., Dan Bowling #1	NE NW SE	Sec.	34-26N-5W

North-South Stratigraphic Section
E-E'

53. Helmrich & Payne, Hajek #1	NE NE NE	Sec.	6-28N-4W
54. Toklan Production Co. & Lucey Products Corp., Bernice Duringer #1	SW NW NE	Sec.	8-28N-4W
55. J. A. Chapman, Unbehaven #1	NE NE NE	Sec.	18-28N-4W
56. Booker Oil Co., L. T. Klima #3	S/2 NE NW	Sec.	28-28N-4W
57. Reading & Bates, L. F. Klima #1	NE NE SW	Sec.	28-28N-4W
58. Wood Oil Co., Warlow #1	SW SW NE	Sec.	10-23N-4W
59. Woods Exploration Co., Covey #1	SW SW NE	Sec.	22-27N-4W
60. Anderson Oil & Gas Co., Skaggs #1	C SE SE	Sec.	22-27N-4W
61. Seneca Oil Co., Lavern Johnson #1	NE SW	Sec.	10-26N-4W
62. North American Royalties Inc., Whitehead #1	C NE NE	Sec.	21-26N-4W
63. Atmar Production Co., Hoffman #1	NE NE NE	Sec.	26-26N-4W
64. Helmrich & Payne Inc., Blazer #1	NW SW SE	Sec.	36-26N-4W

North-South Stratigraphic Section
F-F'

65. Walter Duncan, Lisk #1	SW SE SE	Sec.	4-28N-3W
66. Beach & Talbot, Grace Smith #1	C NW NW	Sec.	15-28N-3W
67. Walter Duncan, Forsythe #1	NE NW SE	Sec.	21-28N-3W
68. Wil-Mc Oil Corp., Reid #1	E/2 SW SE	Sec.	27-28N-3W
69. Wil-Mc Oil Corp., Fox #1	C SW SE	Sec.	34-28N-3W
70. Apache Corp., Stevens #1	NW NW NW	Sec.	3-27N-3W
71. Walter Duncan & Davis Wharton, Kretz #1	NW NW	Sec.	10-27N-3W
72. Appleton Oil Co., Lane B-1	NE NE NE	Sec.	22-27N-3W
73. Appleton Oil Co., Cities Service Martin #1	SW SW SW	Sec.	23-27N-3W
74. Appleton Oil Co., Dester #3	C NE SW	Sec.	27-27N-3W
75. Anderson Petroleum, Michael #1	C SW NE	Sec.	34-27N-3W
76. J. A. Chapman, Esser #1	SE NE SW	Sec.	10-26N-3W
77. Hall Jones Oil Corp., Patton #1	SE SE NE	Sec.	16-26N-3W
78. Trigg Drilling Co., Schmitz #1	NW NW SW	Sec.	22-26N-3W
79. J. N. Champlin, Hoffman #1	SW SE	Sec.	27-26N-3W
80. Bilinda Petroleum Corp., McGivney #1	C NE SE	Sec.	32-26N-3W

North-South Stratigraphic Section
G-G'

81. Herndon Drilling Co., Gurley #1	SE SE NW	Sec.	4-28N-2W
82. Ketal Oil Producing Co., Phipps #1	NW SE NE	Sec.	17-28N-2W
83. Midstates Oil Corp., H. I. Harris #1	NE NE NW	Sec.	20-28N-2W
84. Carl Anderson, Clark #1	C NE	Sec.	29-28N-2W
85. Wilcox & Henry, Farbaugh #1	C NE NW	Sec.	32-28N-2W
86. The Texas Co., Tolle Heirs #1	NE NW NE	Sec.	5-27N-2W
87. Anco, LTD, R. L. Luck #1	SE SW	Sec.	9-27N-2W
88. Amax Petroleum Corp., State #16-1	C SE SW	Sec.	16-27N-2W
89. The Texas Co., Gage Lee #1	NE SW SE	Sec.	21-27N-2W
90. Ryan Consolidated Petroleum Corp.. Sarah Horne #1	C SE NW	Sec.	29-27N-2W
91. Arthur Finston, Cassidy #1	SE SE SE	Sec.	32-27N-2W
92. Tenneco Oil Co., Priboth #1	SE NW	Sec.	5-26N-2W
93. Total Gas Co., Somers #1	SE SE NW	Sec.	8-26N-2W
94. Falcon Seaboard Drilling Co., Reid #1	NW NW NE	Sec.	17-26N-2W
95. The Wil-Mc Oil Exploration, Sledge #1	SW SE NW	Sec.	21-26N-2W
96. Pric Exploration Co., Kinsinger #1	SW SE NW	Sec.	28-26N-2W

East-West Stratigraphic Section
H-H'

97. Vierson and Cochran, Melcher "A" #2	NE SW	Sec.	18-28N-8W
98. Woods, Pete Corp. and Calvert Drilling Inc., Dietz #1	SE SW SW	Sec.	8-28N-8W
99. J. A. Chapman, Miller #2	NW NW NW	Sec.	16-28N-8W
100. Calvert Drilling Inc., Hertach #1	C NE NW	Sec.	15-28N-8W
101. Baker-Munday & Zephyr Drilling Co., Johanning #1	C NE SE	Sec.	15-28N-8W
102. Calvert Drilling Inc. & Woods Petr. Corp., Fiest #1	C SE SE	Sec.	11-28N-8W
103. Calvert Drilling Inc. & Woods Petr. Corp., Reneau #1	NE NE SE	Sec.	13-28N-8W
104. Wilcox Oil Co. & Calvert Drilling Inc.,Mathews #1	C NW SE	Sec.	18-28N-7W
105. Hall Jones Oil Corp., Miller-Stewart Unit #1	C SE SE	Sec.	8-28N-7W
106. Woods Petroleum Co., Johnson #1	NW NW SE	Sec.	16-28N-7W
107. Atlantic Refining Co., Laughlin #1	C NW SW	Sec.	15-28N-7W

108. Champlin Oil & Refining Co., J. W. Bilderback #1-A	C NW SW	Sec.	14-28N-7W
109. Kewanee Oil Co., Kunda #1	NW SW SE	Sec.	13-28N-7W
110. Kewanee Oil Co.. Dahlen #1	NW NW	Sec.	19-28N-6W
111. Calvert Drlg. Inc., et al., L. C. Albert #1	C NE NW	Sec.	20-28N-6W
112. Calvert Drgl. Inc., et al., Breene Gas Unit #1	C NE SW	Sec.	21-28N-6W
113. Calvert Drlg. Inc & White Eagle et al.	C NW NE	Sec.	27-28N-6W
114. Atlantic Refining Co., George F. Yerian #1	C NW NW	Sec.	26-28N-6W
115. Sun Oil Co., Samuel Thomas #1	C SE SE	Sec.	24-28N-6W
116. Sun Oil Co., Nollenberger #1	C NE SE	Sec.	30-28N-5W
117. Petroleum Inc., Hoover #1	C NW SE	Sec.	29-28N-5W
118. Continental Oil Co., Kretchmar #1	SE SE NE	Sec.	28-28N-5W

East-West Stratigraphic Section
H'-H"

118. Continental Oil Co., Kretchmar #1	SE SE NE	Sec.	28-28N-5W
119. Atlantic Refining Co., Kretchmar #1	C SW NW	Sec.	27-28N-5W
120. Atlantic Refining Co., O'Connor #1	SW NE	Sec.	27-28N-5W
121. Stephens Petroleum Co., Mckeeman #1	NE NE NW	Sec.	23-28N-5W
122. Petroleum Inc., Unbehaven #1	C SW NW	Sec.	25-28N-5W
123. Mercury Drilling Co., Selmat #1	NW NW SE	Sec.	30-28N-5W
124. Sterling Oil Co., Skrdla #1	NW NW SW	Sec.	29-28N-4W
125. Reading & Bates, L. F. Kilma #1	NE NE SW	Sec.	28-28N-4W
126. Champlin Refining Co., Mary Hajek #1	SE SE SE	Sec.	27-28N-4W
127. C. W. Smith & Associates, Inc., Lehrling #1	SE SW SW	Sec.	25-28N-4W
128. Dol Resources, Agnes #1	SE SW	Sec.	24-28N-4W
129. Cities Service Oil Co., Lehrling #1	SW SE SE	Sec.	19-28N-4W
130. Dyco Petroleum Corp.. Kuehny #A-2	NE NW SE	Sec.	29-29N-3W
131. Amis-Estes et al., Eberhn #1	NW SW NW	Sec.	33-28N-3W
132. The Wil-Mc Oil Corp., Reid #1	E/2 SW SE	Sec.	27-28N-3W
133. Dyco Petroleum Corp., Smart #B-2	SW SE	Sec.	23-28N-3W
134. British American Oil Prod. Co., Cornelia #2A	SE NE NW	Sec.	24-28N-3W
135. British American Oil Prod. Co., Balderston #A-2	SW NW NE	Sec.	24-28N-3W
136. R. A. F. Oil Co., Maruska #1	SW NW	Sec.	19-28N-2W

137.	Midstate Oil Corp., H. I. Harris #1	NE NE NW	Sec. 20-28N-2W
138.	Wilcox Inv. Co. & Ray & WOOH, Taylor #1	SW NW	Sec. 22-28N-2W
139.	Cayman Corp., Peetoom #1	SE NW SW	Sec. 14-28N-2W
140.	Raymond Oil Co., Payne #1	SW SE	Sec. 12-28N-2W

East-West Stratigraphic Section
I-I'

141.	Davon Oil Co., H. Donahue Unit #1	C NE SW	Sec. 18-27N-8W
142.	Anderson Prichard Oil Corp., Arnold #1	C SW SE	Sec. 8-27N-8W
143.	Vierson-Cochran, Armstrong Unit #1	SE SW	Sec. 9-27N-8W
144.	Continental Oil Co., H. Donahue Unit #1	NW SW	Sec. 10-27N-8W
145.	Atlantic Refining Co., Sand Creek Unit #1	C SE NE	Sec. 11-27N-8W
146.	Kirkpatrick Oil Co., Yerian #1	C NE NW	Sec. 12-27N-8W
147.	Kirkpatrick Oil Co., Reese #1	C NW NW	Sec. 7-27N-7W
148.	Sunray-DX Oil Co., SDX #4-A Connery	C NW NW	Sec. 8-27N-7W
149.	Vierson & Cochran, Leibli #1	NE NW	Sec. 9-27N-7W
150.	Gulf Oil Corp., Mitchell Heirs #1	SE NW SE	Sec. 3-27N-7W
151.	Earlsboro Oil & Gas Co., Inc., #1 Hadwiger-Johnson Unit	NW SW SE	Sec. 2-27N-7W
152.	Woods Petroleum Corp., Mitchell #1	SE SW	Sec. 1-27N-7W
153.	Sun Oil Co., Clara T. Smith #1	C NW SE	Sec. 7-27N-7W
154.	Solar Oil Co., Fowler #1	C NW SW	Sec. 8-27N-6W
155.	Imperial Oil Co. of Kansas, Yerian #1	NE SW	Sec. 8-27N-6W
156.	Vierson & Cochran, Yerian #1	NE SW	Sec. 9-27N-6W
157.	Warren Bradshaw Exploration, Yerian Unit #A-1	C SE SE	Sec. 9-27N-6W
158.	The Wil-Mc Oil Corp., Hula #1	C NW NW	Sec. 15-27N-6W
159.	The Wil-Mc Oil Corp., Waldie #1	W/2 NE	Sec. 15-27N-6W
160.	Woods Petroleum Corp., Zeman #1	C SE NW	Sec. 14-27N-6W
161.	Woods Petroleum Corp., Hein #1	C SE NE	Sec. 14-27N-6W
162.	Cummings & McIntyre. Blubaugh #1	SE SW NE	Sec. 13-27N-6W
163.	Thomas G. Wylie, Young #1	C SE SE	Sec. 18-27N-5W

East-West Stratigraphic Section I'-I"

163. Thomas G. Wylie, Young #1	C SE SE	Sec.	18-27N-5W
164. Woods Petroleum Co., Kretchmar #1	C NE NW	Sec.	20-27N-5W
165. Woods Petroleum Co., City of Medford #1	NE SW NW	Sec.	21-27N-5W
166. Kirkpatrick Oil Co., Schmitz #1	C NE SE	Sec.	22-27N-5W
167. Gulf Oil Corp., Maud Hendricks #1	C SW SW	Sec.	23-27N-5W
168. Provincial Oil Corp., Forrester #1	SE SE NW	Sec.	24-27N-5W
169. Charles J. Richard, Kretchmar #1	NE NE NW	Sec.	19-27N-4W
170. Texaco Inc., Haller #1	NE NE SW	Sec.	20-27N-4W
171. J. A. Chapman, Etta Bohan #4	SW NW NE	Sec.	21-27N-4W
172. Woods Petroleum Co., Covey #1	SW SW NE	Sec.	22-27N-4W
173. Provincial Oil Corp., Stebbins #1	SE SW NE	Sec.	23-27N-4W
174. E. F. Gooden Kauf, Gasslin #1	NW SW	Sec.	24-27N-4W
175. Youngblood & Youngblood, Sawyer #1	C SW SW	Sec.	19-27N-3W
176. Reading & Bates Inc., Joseph Franz #1	C NE SW	Sec.	28-27N-3W
177. Petroleum Inc., Lichti #1	C	Sec.	28-27N-3W
178. Appleton Oil Co., Dester #1	C NE SW	Sec.	27-27N-3W
179. Appleton Oil Co., Cities Service #1	SW SW SW	Sec.	23-27N-3W
180. Wilcox Oil Co., Mitchell #1	C NE SW	Sec.	24-27N-3W
181. Finston & Gulf, Girnaud #1	SW SW NE	Sec.	30-27N-2W
182. The Texas Co., Gage Lee #1	NE SW SE	Sec.	21-27N-2W
184. Skelly Oil Co., Schanwald #1	SW SE	Sec.	23-27N-2W
185. Mack Oil Co., Robinson #1	NW SE NE	Sec.	24-27N-2W

APPENDIX D

DATA USED IN PREPARING STRUCTURE AND ISOPACH MAPS

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
9-28N-9W, C SW NE	3607	21	0	3685
9-28N-8W, C SE NW	3605	---	---	3673
9-28N-8W, C SE SE	3639	18	0	3709
9-28N-8W, C SW SW	3644	11	0	3714
8-28N-8W, SE SE	3642	8	0	3712
8-28N-8W, C SE NE	3580	18	0	3649
8-28N-8W, SE SW SW	3644	10	0	3715
7-28N-8W, C SE NE	3624	6	0	3692
7-28N-8W, NW NW SW	3623	20	0	3691
6-28N-8W, SW SW SE	3600	0	0	3656
18-28N-8W, NW NE NW	3624	29	0	3703
18-28N-8W, NW SW NE	3624	---	---	3693
18-28N-8W, NE SW	3656	18	0	3739
17-28N-8W, NE NW	3645	8	0	3719
17-28N-8W, NE NE	3659	—	—	3755
17-28N-8W, SE NW SE	3676	0	0	3741
16-28N-8W, NE NE NW	3645	0	0	3717
16-28N-8W, NW NW	3651	0	0	3720
15-28N-8W, NE NE	3648	5	0	3721
15-28N-8W, C NE NW	3649	21	0	3719
15-28N-8W, C NE SE	3680	0	0	3748
15-28N-8W, C NW NW	3649	15	0	3723
10-28N-8W, C SE SE	3653	18	0	3721
10-28N-8W, C SW NE	3613	23	0	3685
10-28N-8W, C SW NW	3613	---	---	3693
14-28N-8W, C NE NW	3635	4	0	3711
14-28N-8W, C NE SE	3637	12	0	3711
11-28N-8W, C SE SE	3586	16	0	3657
13-28N-8W, C SE NE	3603	25	0	3688
13-28N-8W, NE NE SE	3651	18	0	3692
24-28N-8W, C NE NW	3634	0	0	3710
28-28N-8W, C NE SE	3748	0	0	3822
12-28N-8W, C SW SE	3587	18	0	3659
12-28N-8W, C SE NW	3557	6	0	3627
30-28N-8W, SE SE NE	3739	—	—	3807
32-28N-8W, NE NE SW	3788	0	0	3875
4-27N-8W, C SW NE	3815	0	0	3887
3-27N-8W, SW SW	3826	0	0	3898
3-27N-8W, C SE SE	3832	—	—	3932
2-27N-8W, SE SE SE	3823	—	—	3916
2-27N-8W, C S/2 NW	3816	6	0	3894
1-27N-8W, SE NW SW	3815	10	0	3927
1-27N-8W, SW NE SE	3808	34	0	3912
12-27N-8W, C NE NW	3827	72	0	3942
12-27N-8W, C NW SW	3845	---	---	3946
11-27N-8W, C SE NE	3827	52	0	3952
11-27N-8W, C NW SE	3854	63	0	3960
11-27N-8W, NW/4	3840	---	---	3948
10-27N-8W, SE NE	3853	45	0	3949
10-27N-8W, C NW SW	3847	75	0	3942
9-27N-8W, C SE NE	3835	28	0	3928
9-27N-8W, SE SW	3853	38	0	3940
21-27N-8W, NE NE NW	3890	0	0	3980
8-27N-8W, C SW SE	3858	---	---	3959
7-27N-8W, SE	3810	---	---	3943
7-27N-8W, S/2 S/2 NE	3842	10	0	3935

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness (ft.)	U. Red Fork Thickness (ft.)	Penn-Miss uncon. (subsea elev.)
5-27N-8W, SW SE SW	3835	0	0	3962
18-27N-8W, SW NE	3862	35	0	3960
18-27N-8W, NE SW	3869	63	0	3973
17-27N-8W, C NE SW	3890	0	0	3968
17-27N-8W, NW NE	3869	---	---	3952
19-27N-8W, NW NE	3894	0	0	2984
20-27N-8W, NW SE	3865	0	0	4021
24-27N-8W, SW NW SW	3816	—	—	4036
29-27N-8W, C SE SE	3882	0	0	4069
28-27N-8W, SW/4	3887	—	—	4054
28-27N-8W, C SE SE	3885	—	—	4053
31-27N-8W, SE NE	3916	---	---	4085
32-27N-8W, NW SE	3964	0	0	4095
33-27N-8W, NW SW	3898	—	—	4088
34-27N-8W, NW SW	3912	0	0	4089
4-26N-8W, SW NW	3931	0	0	4116
9-26N-8W, C NW NE	3943	0	0	4117
5-26N-8W, C SE NW	3953	0	0	4133
3-26N-8W, NW NE	3920	0	0	4090
2-26N-8W, SE NW	3927	0	0	4092
11-26N-8W, NW NE	3945	0	0	4131
10-26N-8W, C NW NW	3899	—	—	4068
9-26N-8W, NW NW	3951	—	—	4142
25-26N-8W, NE SW	4051	0	0	4265
16-26N-8W, SW NE	3984	0	0	4200
30-26N-8W, NW SE	—	17	0	—
21-26N-8W, NE NE	4003	0	0	4216
18-28N-7W, NW SE	3546	—	—	3723
18-28N-7W, C NW NE	3524	0	0	3667
18-28N-7W, NE SW	3540	15	0	3689
7-28N-7W, SW SW	3522	21	0	3661
17-28N-7W, C NE SE	3529	---	---	3680
17-28N-7W, SW NE	3510	17	0	3664
17-28N-7W, NW SW	3545	20	0	3710
8-28N-7W, SE SE	3495	—	—	3643
9-28N-7W, SE NW	3493	6	0	3628
9-28N-7W, SE NE	3475	0	0	3615
16-28N-7W, NW NW SE	3511	13	0	3671
16-28N-7W, N/2 NE NW	3486	0	0	3629
10-28N-7W, C NE	3532	0	0	3615
15-28N-7W, C SE NE	3575	15	0	3671
15-28N-7W, C NW SW	3589	---	---	3686
14-28N-7W, C NW SW	3599	20	0	3691
14-28N-7W, C SE NE	3604	22	0	3709
14-28N-7W, NE SE	3609	17	0	3700
11-28N-7W, SE SE	3594	0	0	3687
11-28N-7W, NE SE	3579	—	—	3679
13-28N-7W, SW NW	3604	20	0	3703
13-28N-7W, SW SE	3638	8	0	3738
24-28N-7W, NE NE	3651	---	---	3754
24-28N-7W, NE NW	3652	0	0	3747
23-28N-7W, NW NE	3634	—	—	3720
25-28N-7W, SE SE	3677	0	0	3786
22-28N-7W, NE NW	3632	3	0	3732
21-28N-7W, NW NW	3612	0	0	3704
27-28N-7W, SE NE	3645	5	0	3747

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
27-28N-7W, C SE	3667	0	0	—
26-28N-7W, SW SW	3661	0	0	3778
26-28N-7W, SW NW	3648	7	0	3746
28-28N-7W, NW SW SE	3682	—	—	3782
28-28N-7W, NE SW NW	3678	—	—	3775
29-28N-7W, NW NW SE	3674	—	—	3771
33-28N-7W, SE SW	3756	—	—	3861
33-28N-7W, NW SE	3726	18	0	3834
34-38N-7W, NE SW NW	3721	8	0	3874
35-28N-7W, C NW SE	3716	0	0	3828
35-28N-7W, NE NE	3693	18	18	3798
35-28N-7W, NW	3667	30	0	3769
4-27N-7W, SW NE NW	3749	48	0	3867
4-27N-7W, NW SW	3779	50	0	3887
4-27N-7W, SW NE	3757	---	---	---
4-27N-7W, NW SE	3768	---	---	3890
4-27N-7W, SE SE	3770	46	0	3890
4-27N-7W, SW SW	3789	---	---	3909
5-27N-7W, NW SE	3794	—	—	3914
5-27N-7W, SW SE	3810	---	---	3910
5-27N-7W, SE SW	3801	30	0	3914
3-27N-7W, SW SW	3756	---	---	3886
3-27N-7W, NE SE	3751	—	—	3881
3-27N-7W, SW NW	3732	18	0	3862
2-27N-7W, SW NW	3716	10	0	3838
2-27N-7W, SW SE	3713	—	—	3855
1-27N-7W, SE SE	3738	---	---	3867
1-27N-7W, SE SW	3730	20	0	3885
12-27N-7W, NE NE	3734	---	---	3886
12-27N-7W, NE NW	3757	42	0	3890
12-27N-7W, NE SW	3778	0	0	3910
11-27N-7W, NE NE	3781	3	0	3913
14-27N-7W, SE NW	3825	—	—	3959
10-27N-7W, NE NW	3786	15	0	3916
9-27N-7W, NE NW	3822	---	---	3932
9-27N-7W, NW NW	3812	50	0	3932
9-27N-7W, NW NE	3803	---	---	3935
8-27N-7W, NW NE	3826	—	—	3950
8-27N-7W, SE NW	3824	---	---	3948
8-27N-7W, NW NW	3811	—	—	3925
8-27N-7W, SW NW	3823	---	---	3938
7-27N-7W, NE NE	3816	42	0	3940
7-27N-7W, NE SE	3844	---	---	3944
7-27N-7W, SW NE	3833	—	—	3956
7-27N-7W, NW NW	3810	46	0	3925
6-27N-7W, SE SW	3803	---	---	3903
6-27N-7W, NW SE	3805	---	---	3910
15-27N-7W, NE SW	3855	0	0	3887
31-27N-7W, NE SW	3967	0	0	4078
27-27N-7W, SE SE	3939	0	0	4085
4-26N-7W, SW NW	3980	3	0	4113
7-26N-7W, SW SW	4021	0	0	4132
18-26N-7W, NE SE	4032	0	0	4140
24-26N-7W, SE SE	4045	—	—	4161
23-26N-7W, SE NE	4025	7	0	4165
27-26N-7W, NW NW	4071	0	0	4201

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
20-26N-7W, NW SE	4090	10	0	4194
31-26N-7W, NE NE	4137	——	——	4256
34-26N-7W, SE NE	4101	0	0	4238
6-28N-6W, NE NW	3520	50	0	3605
18-28N-6W, SW SE	3620	5	0	3720
18-28N-6W, SW SW	3643	30	0	3742
18-28N-6W, SW NW	3624	19	0	3699
19-28N-6W, NW NW	3655	0	0	3750
19-28N-6W, NE NE	3623	31	0	3671
17-28N-6W, SW SW	3606	28	0	3706
17-28N-6W, SW NE	3572	0	0	3675
20-28N-6W, SE NE	3607	3	0	3714
20-28N-6W, NE SE	3623	3	0	3737
20-28N-6W, NE NW	3618	---	---	3738
16-28N-6W, SW SW	3601	——	——	——
16-28N-6W, SE SE	3581	——	— —	3682
21-28N-6W, NE SW	3618	25	0	3732
21-28N-6W, SE SE	3622	31	0	3731
22-28N-6W, SW NW	3590	22	0	3708
28-28N-6W, NE NE	3611	13	0	3721
34-38N-6W	3654	0	0	3778
27-28N-6W, NW NE	3605	21	0	3719
26-28N-6W, NW NW	3583	10	0	3707
23-28N-6W, NE SE	3571	0	0	3696
24-28N-6W, SE SE	3546	21	0	3679
25-28N-6W, NE NW	3574	——	——	——
25-28N-6W, NE SW	3598	22	0	3725
36-28N-6W, NW NE	3617	11	0	3751
12-28N-6W, NE SW	3494	0	0	3610
9-27N-6W, NW NE	3726	9	0	3840
9-27N-6W, NE SW	3737	30	0	3867
9-27N-6W, SE SE	3719	26	0	3879
10-27N-6W, SW SW	3721	46	0	3862
15-27N-6W, W/2 NE	3707	37	0	——
11-27N-6W, NE SW	3708	——	——	——
14-27N-6W, NE NW	3724	20	0	3845
14-27N-6W, SE NW	3707	47	0	3857
13-27N-6W, SW NE	3689	38	0	3831
13-27N-6W, SW NW	3685	70	0	3830
16-27N-6W, NW NE	3737	——	——	3882
8-27N-6W, NE SE	3736	20	0	3886
8-27N-6W, NW SW	3747	86	0	3907
15-27N-6W, SW NW	3716	0	0	3830
7-27N-6W, NW SE	3754	27	0	3897
7-27N-6W, SE NE	3736	---	---	3886
7-27N-6W, SE NW	3740	82	0	3877
28-27N-6W, SE SW	3808	0	0	3933
29-27N-6W, SE NW	3826	0	0	3971
4-26N-6W, NW SE	3870	0	0	4001
4-26N-6W, SW NE	3851	0	7	3989
4-26N-6W, SW SE	3879	9	0	——
3-26N-6W, SW SW	3877	——	——	4023
3-26N-6W, NE NW	3853	0	0	3999
2-26N-6W, SW NE	3831	0	0	3968
5-26N-6W, SW NE	3897	0	0	4052
10-26N-6W, NW SW	3908	0	0	4039

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
10-26N-6W, NW NW	3888	0	0	4036
16-26N-6W, SE SW	3970	0	0	4030
24-26N-6W	3929	0	0	4092
25-26N-6W, SE SW	3991	0	0	4163
31-26N-6W, SE SE	4093	—	—	4268
35-26N-6W, SW SE	4038	0	0	4203
36-26N-6W, SE SE	4017	—	—	4206
20-28N-5W, SW SE	3533	0	0	3653
19-28N-5W, SW SW	3549	—	—	3682
19-28N-5W, SW NE	3546	—	—	3631
20-28N-5W, SW SW	3547	—	—	3677
30-28N-5W, NW NW	3562	0	0	t.s.
30-28N-5W, NE SW	3600	12	0	3722
30-28N-5W, NE SE	3593	15	0	3717
29-28N-5W, NW SW	3576	20	0	3703
29-28N-5W, SW NW	3568	—	—	3700
29-28N-5W, NW SE	3584	0	0	3715
29-28N-5W, NE NE	3570	—	—	3687
31-28N-5W, NE NW	3618	11	0	t.s.
17-28N-5W, NW SE	3568	—	—	3646
9-28N-5W, SW NE	3451	0	0	3587
22-28N-5W, SW SW	3516	20	0	t.s.
22-28N-5W, SW NE	3484	0	0	3613
15-28N-5W, SW SE	3503	0	0	t.s.
27-28N-5W, SW NW	3510	27	0	3661
27-28N-5W, SW NE	3519	9	0	3651
28-28N-5W, NW NW	3552	20	0	3692
26-28N-5W, NE NW	3500	30	0	3660
23-28N-5W, SW SE	3505	0	0	t.s.
23-28N-5W, NE NW	3505	0	0	3645
25-28N-5W, SW NW	3515	23	0	3665
34-28N-5W, NW NW	3537	9	0	3672
4-27N-5W, SW SE	3594	—	—	3525
18-27N-5W, SW NW	3698	0	0	t.s.
18-27N-5W, SE SE	3686	85	0	3826
19-27N-5W, NW NE	3717	3	0	t.s.
17-27N-5W, NE SW	3702	0	0	t.s.
17-27N-5W, C SE	3695	0	0	3823
20-27N-5W, NE NW	3698	42	0	3843
20-27N-5W, NE SE	3710	5	0	3850
21-27N-5W, SW NW	3696	67	0	3851
16-27N-5W, SE SW	3699	0	0	t.s.
22-27N-5W, NW SW	3709	30	0	3864
22-27N-5W, NE SE	3699	—	—	3847
23-27N-5W, SE NW	3687	0	0	t.s.
23-27N-5W, SW SW	3698	0	0	3855
13-27N-5W, SW SW	3675	—	—	3833
13-27N-5W, SW SE	3668	0	3	3824
13-27N-5W, SE SE	3674	—	—	t.s.
24-27N-5W, NW NE	3671	55	0	3833
24-27N-5W, SE NW	3662	38	0	3836
28-27N-5W, SW NE	3728	0	0	3880
10-26N-5W, SW SW	3821	0	0	4010
18-26N-5W, SW NE	3925	0	0	4100
8-26N-5W, SW NE	3812	0	0	3970
14-26N-5W, NW SW	3892	0	0	4055

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
23-26N-5W, SW NE NW	3893	0	0	4060
25-26N-5W, SW SE SW	3906	0	0	4096
26-26N-5W, C SE SW	3927	0	0	4125
27-26N-5W, NE SE	3912	0	0	4097
34-26N-5W, NW SE	3928	0	0	4118
35-26N-5W, NW NE	3938	0	0	4133
36-26N-5W, SW NE	3915	---	---	4115
32-26N-5W, SW SE	3991	0	0	4171
31-26N-5W, SW SE	3985	0	0	4157
30-26N-5W, NW SE	3975	0	0	4150
30-28N-4W, NW SE	3441	21	0	3598
30-28N-4W, SW¼	3443	19	0	3613
19-28N-4W, SW SE	3436	0	0	3585
19-28N-4W, NW NE	3428	0	0	3572
18-28N-4W, NE NE	3403	0	0	3557
8-28N-4W, NW NE	3356	0	3	3506
6-28N-4W, NE NE	3323	0	0	3477
15-28N-4W, NW SW	3389	0	0	3551
2-28N-4W, SW SW	3311	0	0	3481
24-28N-4W, SE SE	3388	——	——	t.s.
23-28N-4W, SE SE	3373	——	——	t.s.
23-28N-4W, SE SW	3418	28	4	t.s.
25-28N-4W, NE NE	3375	——	——	t.s.
25-28N-4W, NW NE	3371	---	---	t.s.
25-28N-4W, NE NW	3377	---	---	t.s.
25-28N-4W, NW NW	3376	25	0	t.s.
25-28N-4W, NE SE	3368	19	0	t.s.
25-28N-4W, NW SW	3410	0	0	t.s.
25-28N-4W, SW SW	3417	25	0	3587
26-28N-4W, SE SE	——	25	0	t.s.
26-28N-4W, SE NE	3419	——	——	t.s.
26-28N-4W, NE NE	3391	21	0	t.s.
26-28N-4W, NW NE	3410	30	0	t.s.
26-28N-4W, NE NW	3426	10	0	t.s.
36-28N-4W, NE NW	3420	10	0	t.s.
36-28N-4W, NE NE	3378	24	0	t.s.
36-28N-4W, NE SE	3419	6	0	3581
27-28N-4W, SE SE	3475	0	0	3644
27-28N-4W, NE SW	3456	30	4	t.s.
27-28N-4W, NE SE	3452	20	0	t.s.
28-28N-4W, SW NE	3462	---	---	t.s.
28-28N-4W, NE NW	3451	12	9	t.s.
28-28N-4W, NE SW	3476	0	0	3636
29-28N-4W, SE SE	3501	0	0	3662
29-28N-4W, NW SW	3489	20	0	3660
29-28N-4W, SW NW	3488	19	0	3655
32-28N-4W, NW SW	3523	0	0	3680
10-27N-4W, SW NE	3538	0	0	3725
18-27N-4W, NE SE	3653	——	——	t.s.
18-27N-4W, SW SE	3631	94	0	3841
19-27N-4W, SE NE	3669	52	0	t.s.
19-27N-4W, NE SE	3684	——	——	t.s.
19-27N-4W, SE NW	3665	——	——	t.s.
19-27N-4W, NE NW	3644	——	——	3839
17-27N-4W, NW SW	3650	0	0	4920
17-27N-4W, SE SW	3635	---	---	---

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
17-27N-4W, SE SE	3636	——	——	t.s.
20-27N-4W, NW SW	3671	50	0	t.s.
20-27N-4W, SW SW	3679	10	0	t.s.
20-27N-4W, NE SW	3649	55	0	t.s.
20-27N-4W, SE NE	3636	80	5	t.s.
20-27N-4W, NW NE	3638	---	---	t.s.
16-27N-4W, SW SW	3629	15	0	t.s.
29-27N-4W, NW NE	3677	10	0	t.s.
21-27N-4W, NW SE SW	3650	——	——	t.s.
21-27N-4W, SE SE	3627	14	0	3819
21-27N-4W, NE NE SE	3620	---	---	3800
21-27N-4W, NW NW SE	3634	——	——	3817
22-27N-4W, C SW SW	3619	14	0	——
22-27N-4W, SW NW	3606	55	0	t.s.
22-27N-4W, SW NE	3597	---	---	t.s.
22-27N-4W, SE SE	3590	70	0	3809
23-27N-4W, NW SW	3567	30	0	t.s.
23-27N-4W, SE SW	3562	72	0	t.s.
23-27N-4W, SE SE	3554	47	0	3755
23-27N-4W, NE SE	3555	---	---	3745
23-27N-4W, SW NE	3557	0	0	3737
24-27N-4W, NW SW	3590	0	0	3790
24-27N-4W, NW NW	3572	0	0	3737
25-27N-4W, NW NW	3589	40	0	3804
25-27N-4W, SE NE	3604	55	0	3819
26-27N-4W, NE NW	3569	42	0	3769
35-27N-4W, NE SW	3610	48	0	3820
10-26N-4W, NE SW	3755	35	5	3960
18-26N-4W, SE NW	3844	0	0	4064
21-26N-4W, NE NE	3840	2	0	4069
13-26N-4W, SW SE	3799	8	0	4032
26-26N-4W, NE NE	3842	3	0	4092
36-26N-4W, SW SE	3900	4	0	4147
19-28N-3W, SW SE SE	3318	0	0	3481
19-28N-3W, NE NE NW	3284	0	0	3420
18-28N-4W, NE SW	3256	0	0	3406
18-28N-3W, SW NW NE	3248	0	0	3407
7-28N-3W, SW SW SE	3248	——	——	3405
6-28N-3W, SE NE	3178	0	0	3339
6-28N-3W, SW NE NE	3164	0	0	3318
5-28N-3W, NE SW NW	3159	0	0	3324
8-28N-3W, NW NW NW	3226	0	8	3346
4-28N-3W, SW SE SE	3163	0	0	3354
15-28N-3W, NW NW	3227	0	0	3431
21-28N-3W, NW NW SE	3312	0	2	3502
3-28N-3W, SW SW NE	3037	——	——	3202
11-28N-3W, SW SW SW	3177	0	2	3358
12-28N-3W, SE NW	3118	0	0	3303
12-28N-3W, NE NE	3018	0	0	3168
12-28N-3W, NE SE	3037	0	3	3179
13-28N-3W, NE NE	3043	0	0	3191
13-28N-3W, NE SW	3028	——	——	3159
23-28N-3W, SW SE	3337	25	0	3155
24-28N-3W, NE NW	3025	0	0	3155
24-28N-3W, SW NE SW	3061	0	0	3213
24-28N-3W, SE SE NW	3118	0	0	3261
24-28N-3W, NE SW SE	3079	——	——	3256

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
30-28N-3W, NW NW	3355	0	5	3533
30-28N-3W, NE SW	3336	——	——	3502
30-28N-3W, NE SE	3365	0	0	t.s.
29-28N-3W, NW SW	3381	——	——	t.s.
29-28N-3W, SW SW NW	3379	——	——	t.s.
32-28N-3W, NE SW	3410	46	7	t.s.
32-28N-3W, SW NE	3397	55	0	t.s.
32-28N-3W, NE SW	3433	3	17	t.s.
31-28N-3W, NE SE	3459	——	——	t.s.
31-28N-3W, NE SW	3373	10	2	3558
31-28N-3W, NE NW	3346	38	0	3516
33-28N-3W, SW NW	3382	0	3	3572
33-28N-3W, NE NE	3320	27	1	t.s.
33-28N-3W, SE NE	3328	6	10	t.s.
33-28N-3W, SE SW	3405	18	0	3588
34-28N-3W, SW SE	3300	0	0	3476
27-28N-3W, SW SE	3304	——	——	t.s.
35-28N-3W, SW NW	3142	0	0	3292
35-28N-3W, SE NE NE	2920	——	——	2983
25-28N-3W, SW SW	3037	5	0	t.s.
35-28N-3W, SE NE SE	——	ab.	ab.	t.s.
35-28N-3W, SE SE SE	ab.	ab.	ab.	2887
36-28N-3W, SW SW SW	ab.	ab.	ab.	2882
36-28N-3W, SE SW NW	ab.	ab.	ab.	3966
3-27N-3W, NW NW	3329	0	0	3523
2-27N-3W, SE SE SW	3055	0	0	3142
2-27N-3W, NE SE SE	3042	8	0	3117
1-27N-3W, SW NE	3109	0	9	3274
12-27N-3W, SE NE	3109	16	0	t.s.
12-27N-3W, SE SE	3136	13	0	t.s.
12-27N-3W, NE SW	3135	21	0	t.s.
12-27N-3W, W/2 SW NW	3140	36	0	t.s.
11-27N-3W, NE NE NW	3089	18	0	3152
10-27N-3W, NW NW	3417	0	0	3591
4-27N-3W, SE NE	3382	---	---	t.s.
4-27N-3W, NE NE	3362	28	0	3554
5-27N-3W, SE NE	3429	5	0	3615
6-27N-3W, NE NE NE	3843	6	0	t.s.
14-27N-3W, NW SW SW	ab.	ab.	ab.	2928
13-27N-3W, SE NE	3154	21	3	——
13-27N-3W, NE NE	3140	35	0	——
13-27N-3W, NW NE	3133	17	0	t.s.
24-27N-3W, NE SW	3259	0	4	——
23-27N-3W, SW SW	ab.	ab.	ab.	ab.
22-27N-3W, SW NE SE	ab.	ab.	ab.	ab.
22-27N-3W, SE SE NE	ab.	ab.	ab.	ab.
22-27N-3W, NW NE NE	2937	——	——	2951
25-27N-3W, C NE	3321	60	0	t.s.
26-27N-3W, NW SE	3303	——	——	3445
26-27N-3W, SW SW NW	ab.	ab.	ab.	2933
27-27N-3W, SE NE	ab.	ab.	ab.	2911
27-27N-3W, SE SW	ab.	ab.	ab.	3084
27-27N-3W, NE SW	3115	——	——	3144
27-27N-3W, SW SW	3196	---	---	3205
34-27N-3W, NW NW	3194	---	---	3204
34-27N-3W, NE SW	3231	---	---	3275
34-27N-3W, SW NE	3157	---	---	3177
34-27N-3W, SW NW	3228	---	---	3239

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
36-27N-3W, SW SW	3356	63	0	3541
33-27N-3W, NW SE	3388	16	0	3525
28-27N-3W, SW SW	3577	101	0	3799
29-27N-3W, NE SW	3565	80	0	3783
29-27N-3W, NE SW SW	3516	100	0	3791
29-27N-3W, SW NW	3573	18	0	3774
30-27N-3W, SE SW	3595	56	0	3815
30-27N-3W, SE NW	3605	0	0	3786
19-27N-3W, SW SW	3596	15	0	3796
10-26N-3W, NE SW	3429	—	—	3554
10-26N-3W, NE NW	3420	0	0	3577
9-26N-3W, SW NE	3528	—	—	3706
8-26N-3W, SE SE NW	3576	0	12	3770
6-26N-3W, NE NE SW	3616	0	10	3815
5-26N-3W	3602	0	0	3817
17-26N-3W, NW NE NE	3652	0	14	3882
16-26N-3W, SE SE NE	3642	0	0	3859
15-26N-3W, SE SW	3566	0	0	3777
13-26N-3W, SE SW	3528	0	0	3753
12-26N-3W, SW NE	3412	0	7	3586
1-26N-3W, SE NW	3367	63	3	3568
2-26N-3W, NW NE	3419	3	0	3607
24-26N-3W, SE NW	3532	—	—	3741
22-26N-3W, NW NW SW	3580	—	—	3775
21-26N-3W, NW SE	3596	15	0	3805
27-26N-3W, SW SE	3631	5	0	3839
34-26N-3W, SW SW	3681	—	—	3770
33-26N-3W, SE NW	3690	—	—	3840
32-26N-3W, NE SE	3685	0	0	3869
19-28N-2W, SW NW	3085	0	0	3267
18-28N-2W, SE NW	3036	0	0	3180
18-28N-2W, NE SE	2991	0	0	3130
18-28N-2W, NE NE	2971	—	—	3053
17-28N-2W, SE NE	2942	—	—	3057
17-28N-2W, SE NW	2951	---	---	3097
17-28N-2W, SW NW SW	2973	—	—	3101
17-28N-2W, SW SW SE	2934	---	---	3055
17-28N-2W, SW NW NW	2957	—	—	3085
20-28N-2W, NE NW	2927	0	0	3045
7-28N-2W, NW SW	3037	—	—	3169
7-28N-2W, SW SW NW	3038	0	0	3159
7-28N-2W, NW NW	3005	0	0	3159
7-28N-2W, SE NW	3023	0	0	3168
6-28N-2W, NW SE	2985	—	—	3125
4-28N-2W, SE NW	2849	---	---	2962
4-28N-2W, SW SW	2877	---	---	2991
5-28N-2W, SE SE	2942	---	---	3071
11-28N-2W, SE SE	2831	0	0	2921
12-27N-2W, NE SE	2698	0	5	2733
12-28N-2W, SW SE	2741	0	5	2796
13-28N-2W, C SW	2777	—	—	2875
14-28N-2W, NW SW	2863	0	0	2979
16-28N-2W, SE SE	2896	0	0	3011
21-28N-2W, SW SW	2966	0	10	3096
29-28N-2W, C NE	2991	—	—	3124
28-28N-2W, NW SE	2966	—	—	3087

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
27-28N-2W, SW NE	2918	——	——	3038
26-28N-2W, SW SW NW	2899	0	0	3022
25-28N-2W	2808	0	5	2889
36-28N-2W, NW/4	2836	0	7	2979
35-28N-2W, SW NE	2877	30	0	3015
32-28N-2W, NE NW	3034	0	0	3170
5-27N-2W, NW NE	3016	0	0	3162
6-27N-2W, SW SE	3038	——	——	3239
7-27N-2W, NE SE	3077	21	0	3189
9-27N-2W, SW	3057	0	0	3196
3-27N-2W, SE NW SE	2969	0	3	3113
2-27N-2W, NE SW	2942	——	——	3082
16-27N-2W, SE SW	3054	52	0	3187
18-27N-2W, NE NE	3099	21	0	3230
18-27N-2W, NW SE	3159	10	0	t.s.
18-27N-2W, NW NW	3145	2	5	t.s.
18-27N-2W, SE SW	3175	——	——	t.s.
17-27N-2W, SE NW	3087	20	0	t.s.
19-27N-2W, C NW NE	3185	20	0	t.s.
19-27N-2W, NE SE	3170	12	3	t.s.
19-27N-2W, SE SE	3186	---	---	t.s.
20-27N-2W, SE SW	3155	41	0	t.s.
20-27N-2W, NW SW	3170	20	8	t.s.
20-27N-2W, SW NE	3114	47	0	t.s.
20-27N-2W, SW NW	3148	0	9	t.s.
21-27N-2W, SW SE	3100	16	9	3270
21-27N-2W, NW	3077	——	——	t.s.
23-27N-2W, SW SE	3021	——	——	3182
23-27N-2W, SW NE	2993	45	0	3132
24-27N-2W, NW SW	2946	——	——	3065
24-27N-2W, SE SW	2965	——	——	3079
13-27N-2W	2824	0	5	2966
14-27N-2W	2981	0	4	t.s.
36-27N-2W, NE NE	ab.	ab.	ab.	2551
28-27N-2W, NW NW	3149	---	---	3316
28-27N-2W, NW SW	3209	13	0	t.s.
27-27N-2W	3116	21	0	t.s.
29-27N-2W, SE NW	3194	---	---	3385
29-27N-2W, NW NW	3173	---	---	t.s.
29-27N-2W, NW NE	3156	---	---	t.s.
29-27N-2W, SE SE	3197	34	0	t.s.
30-27N-2W, SW NE	3238	30	0	3440
31-27N-2W, SE NE	3282	0	9	3490
32-27N-2W, SE SE	3245	0	0	3458
32-27N-2W, NE	3210	——	——	t.s.
34-27N-2W; SE NE	3127	25	5	3290
35-27N-2W, NW NW	3124	13	5	3274
6-26N-2W, SE NW	3341	25	0	3528
6-26N-2W, SW SW	3356	50	0	3546
3-26N-2W, SW SW	3264	6	0	3412
2-26N-2W, NE SW	3148	19	0	3296
11-26N-2W, SW NE	3035	18	2	3255
11-26N-2W, SE SE	2863	——	——	2887
13-26N-2W, C NW SE	2816	——	——	2887
14-26N-2W, SW NW	3284	36	0	3474
10-26N-2W, SW SW	3297	6	0	3445

Well Location	Top Pink Lm. (subsea elev.)	L. Red Fork Thickness(ft.)	U. Red Fork Thickness(ft.)	Penn-Miss uncon. (subsea elev.)
8-26N-2W, SE NW	3339	20	0	3524
7-26N-2W, SW SE	3392	50	0	3607
7-26N-2W, SW NW	3376	75	0	3576
17-26N-2W, NW NE	3374	—	—	3576
21-26N-2W	3472	16	0	3662
22-26N-2W	3139	10	0	3657
23-26N-2W, SW SE	3029	—	—	3252
23-26N-2W, NW SE	3096	---	---	3062
24-26N-2W, NW SW	3033	---	---	3163
27-26N-2W, SE NE	3437	8	0	3674
35-26N-2W, NW NW	3305	—	—	3782
28-26N-2W, SE NW	3524	0	7	3744

VITA

Jon Lawrence Glass

Candidate for the Degree of

Master of Science

Thesis: DEPOSITIONAL ENVIRONMENTS, RESERVOIR TRENDS AND DIAGENESIS OF THE RED FORK SANDSTONES IN GRANT AND EASTERN KAY COUNTIES, OKLAHOMA

Major Field: Geology

Biographical:

Personal Data: Born in Carroll, Iowa, December 8, 1955, the son of Mr. and Mrs. Robert F. Glass.

Education: Graduated from Kuemper High School, Carroll, Iowa, in May, 1974; received Bachelor of Science degree in Geology from Oklahoma State University in December, 1978; completed requirements for Master of Science degree at Oklahoma State University in July, 1981, with a major in Geology.

Professional Experience: Junior Member of American Association of Petroleum Geologist; Teaching Assistant, Oklahoma State University, 1979-80; Project Geologist, Sungas Co., Summer 1979; Teaching Assistant, Oklahoma State University, 1980-81; Geologic Assistant, Texaco U. S. A., Summer, 1980.