GEOPHYSICAL INTERPRETATION OF UPPER STRAWN (PENNSYLVANIAN) DEPOSITIONAL SYSTEMS AND SANDSTONE HYDROCARBON PRODUCING UNITS IN COKE AND RUNNELS COUNTIES, TEXAS

By

Stanley Mark Schachter

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University of Miami

Coral Gables, Florida

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Thesis Approved:

Arthur W. Cleaves
Thesis Adviser

Mangat R. Thapar

Zuhair al-Shaieb

Cary T. Stewart

Wm. R. Duffey

Norman N. Durham
Dean of the Graduate College

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CHAPTER I

ABSTRACT

The Upper Strawn Group of Coke and Runnels Counties, located within the Eastern Shelf of the Midland Basin, is dominated by marine transgressive limestones with two prominent fluvial-deltaic episodes located within the lower part of the Upper Desmoinesian and in the lowest part of the Missourian Series. These carbonates and clastic rocks comprise the five major depositional systems present within the study area.

The principal sources of data for this study were 529 electric logs and seven seismic lines. Using this data the distal most edge of a high constructive elongate cratonic delta; transgressive marine limestones; a carbonate shelf-edge reef system; a carbonate barrier reef system; and a back reef lagoon system were delineated.

The high-constructive elongate cratonic deltas located within the inner shelf of the study area are the result of decreased subsidence within the Fort Worth Basin during the Desmoinesian and Missourian Epochs, allowing Strawn fluvial-deltaic facies to prograde westward across the westward dipping Concho Platform. Concurrently, on the outer shelf of the study area, carbonate buildups were being deposited

along the shelf-edge and along a north-south trend separated from the shoreline by an elongate body of water (lagoon). The same limestones extended well onto the inner shelf in the form of thin transgressive limestones. Correlation of these transgressive limestone are the only means by which regional correlation across the study area was accomplished.

CHAPTER II

INTRODUCTION

Location

The study area comprises two counties (Coke and Runnels) located in North Central Texas (Figure 1). These two counties equal an area of approximately two thousand and fifty-five square miles. This area is recognized as being located within the Eastern Shelf of the Midland Basin.

Problem

The problem set fourth was to evaluate the depositional systems present within the two county study area. Only the systems present during Upper Strawn time, Pennsylvanian (Desmoinesian) were of interest to this study.

Purpose

The purpose of defining the depositional systems present in Coke and Runnels Counties was considered necessary for the following reasons:

1. A more complete understanding of the regional structural and stratigraphic setting during the Desmoinesian System was needed within Coke and Runnels Counties.

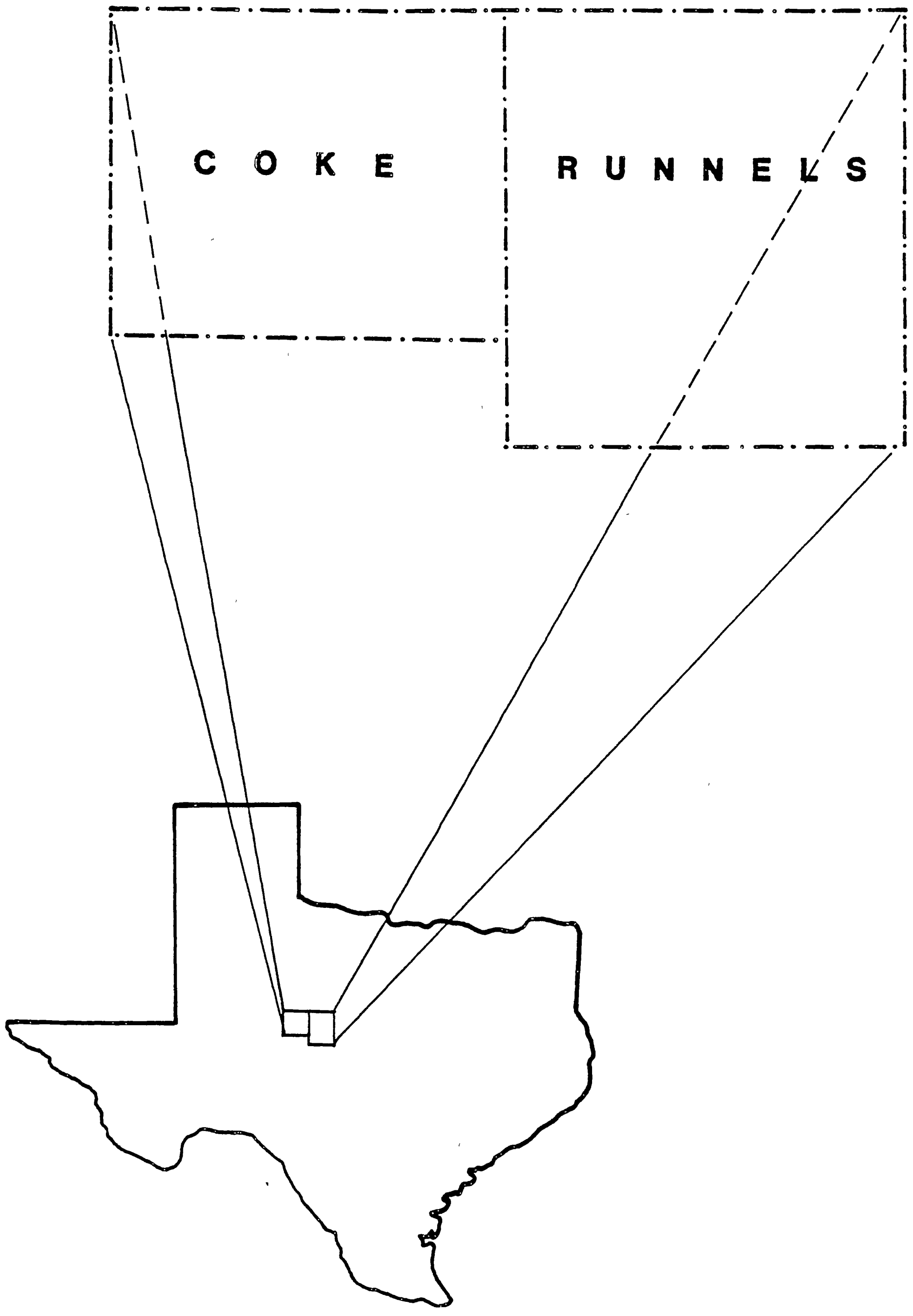

Figure 1. Index Map of Strawn Study Area in North-Central Texas

2. The geographical extent to which these systems were present was in question.
3. An understanding of the systems present would greatly aid ongoing oil and gas exploration in the area.

Methods

The following methods of investigation were used to define the depositional systems present within the Upper Strawn of Coke and Runnels Counties:

1. A review of previous structural and stratigraphic studies concerning the Eastern Shelf and associated areas;
2. Preparation of four dip oriented cross sections (figures 24, 25, 33 and 34);
3. Preparation of three strike oriented cross sections (figures 26, 27 and 35);
4. Preparation of regional structure maps based upon electric log data for three principal limestone markers (figures 18, 19, 20, 28, 29 and 30);
5. Preparation of sandstone isolith maps for two producing sandstones (figures 21 and 22);
6. Correlation and evaluation of seven seismic lines in Coke County;

Previous Investigations

Because this study is a subsurface study of the Upper Strawn in North-Central Texas only previous investigations dealing in part or in whole with subsurface data will be mentioned. This criterion will allow for the most pertinent previous works to be reviewed.

The earliest subsurface studies of the Strawn in North-Central Texas involved the application of rock-stratigraphic names to the stratigraphy encountered in the few oil fields present during the early 20th century (Bose, 1917; Cheney, 1921; Reeves, 1923; Bowen and Gibbs, 1932). Sellards et al. (1932), Scott and Armstrong (1932), and Plummer and Hornberger (1935) were the first to actually attempt to correlate subsurface Strawn stratigraphy over any appreciable area.

Because of the extensive lithologic variation in the region there were many inherent correlation problems with middle Pennsylvanian rocks. Cheney (1940), proposed new time-stratigraphic boundaries for the Strawn in North Central Texas. These were quickly utilized and offered hope of easier and more consistent regional correlation. Unfortunately subsurface data were still limited by the restricted number of oil fields present in the area. Specific informal names usually developed in association with pay zones for individual fields. This further complicated correlation and left the responsibility of standardizing subsurface nomenclature to the local geological societies. As a result many log correlation charts have subsequently been published by the local societies (Abilene Geological Society, 1949a, 1949b, 1949c, 1950, 1953; Fort Worth Geological Society, 1940; and the North Texas Geological Society, 1954a, 1954b, 1954c).

The first regional compilation of Strawn lithofacies involved a 20 county area (Wilson, 1952). He used lithofacies, isopach, net sandstone isolith, net limestone isolith, sandstone vertical variability, limestone vertical variability and dip-oriented cross sections of the Gardner Sandstone in Taylor, Callahan, Runnels and Coleman Counties.

The next regional study was conducted over Jack, Wise, Palo Pinto and Parker Counties (Ohlen 1956a, 1956b). He divided the Strawn, Canyon and Cisco "Series" into 24 distinct intervals and made lithofacies maps for each interval. He also prepared four structure maps based upon key limestone markers, four isopach maps, two lithic percentage maps and five dip and strike lithologic cross sections.

Wermund, Jenkins and Ohlen (1962) used 2,800 well logs from 25 counties to regionally map the Desmoinesian, Missourian and Virgilian Series. They divided this 2,200 ft. of section into 22 equal intervals and prepared a computer generated lithofacies map for each. They also prepared three structure maps and two isopach maps. This study combined adequate subsurface control with sufficiently thin intervals to allow for the depositional framework of the Late Pennsylvanian to be reconstructed (Cleaves, 1975).

Depositional systems analysis using both surface and subsurface mapping of the Pennsylvanian of North-Central

Texas was done by L. F. Brown, Jr. and his students (Brown, 1969a, 1969b, 1969c, 1969d, 1973; Galloway and Brown, 1972, 1973; Exleben, 1973, 1974).

Cleaves (1975) conducted the most recent regional study. He used surface measured sections and 3,500 wells to delineate specific depositional systems within 24 counties in North-Central Texas. Cleaves was able to delineate both high constructive elongate and lobate delta systems and relate them to the structural evolution of the region.

CHAPTER III

STRATIGRAPHY

Introduction

The Middle and Late Pennsylvanian stratigraphy of the rock units on the Eastern Shelf of the Midland Basin is extremely complex. Because of the dominance of limestones on the southern part of the shelf the author was confronted with numerous difficulties in correlation. The problems in correlations were the direct result of difficulties in determining the lateral continuity of the individual rock units (Table I). Due to the inconsistency of the limestones in parts of the study area, sometimes units above or below the study interval had to be used to indicate the approximate area on the electric log in which the supposed unit should be located. Although the clastics were not quite as difficult to identify, their distal deltaic nature posed problems at times. All correlations were based upon the Composite Electric Log - Columnar Section of Subsurface Formations in Southeastern Coke County, Texas. This log was compiled by The Stratigraphic Committee of The Abilene Geological Society (Figure 2).

TABLE I

SURFACE AND SUBSURFACE STRATIGRAPHIC NOMENCLATURE, UPPER DESMOINESIAN AND LOWER MISSOURIAN (STRAWN GROUP), NORTH CENTRAL TEXAS

BROWN AND GOODSON (1972)

Pennsylvanian System	Canyon Group	Missourian Series	Palo Pinto Fm.	Wiles Ls. Posideon Sh. Wynn Ls.
	Strawn Group		Mineral Wells Fm.	Turkey Creek Ss. Ss. 2 Dog Bend Ls. Lake Pinto Ss
		Desmoinesian Series		Village Bend Ls. Ss. 1 Hog Mtn Ss.
			Brazos River Fm.	Ss. and Congl.
			Mingus Fm.	Thurber Coal. Goen Ls. Dobbs Valley Ss. Santo Ls.
			Grind stone Creek Fm.	Buck Crk. Ss. Brannon Bridge Ls.
			Lazy Bend Fm.	Meek Bend Ls. Hill Creek Beds
			Not Mapped On Abilene Sheet	

CHENEY (1940)

Pennsyvanian System	Canyon Series	Whitt Group	Palo Pinto Fm.	
			Keechi Creek Fm.	Turkey Crk.Ss.
			Salesville Fm.	Lake Pinto Ss.
	Strawn Series	Lone Camp Gp.	East Mtn. Fm.	Village Bend Ls. Hog Mtn. Ss.
			Garner Fm.	Brazos River Ss. Thurber Coal
		Millsap Lake Group	Grind stone Creek Fm.	Goen Ls. Santo Ls. Buck Crk. Ss.
			Lazy Bend Fm.	Brannon Bridge Ls. Dennis Bridge Ls.
			Dickerson Fm.	
	Lampasas Series	Smithwick Group	Parks Fm. Caddo Pool Fm. Eastland Lake Fm.	

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Pennsylvanian System	Canyon Series		Palo Pinto Ls. Cross Cut Ss.
	Strawn Series	U. Strawn Gp.	Capps Ls. Goen Ls. Bronte Ls. Gardner Ss. Gray Ss.
		L. Strawn Gp.	Odom Ls. Caddo Ls.
	Atoka Series	Bend Gp.	"Bend detrital"

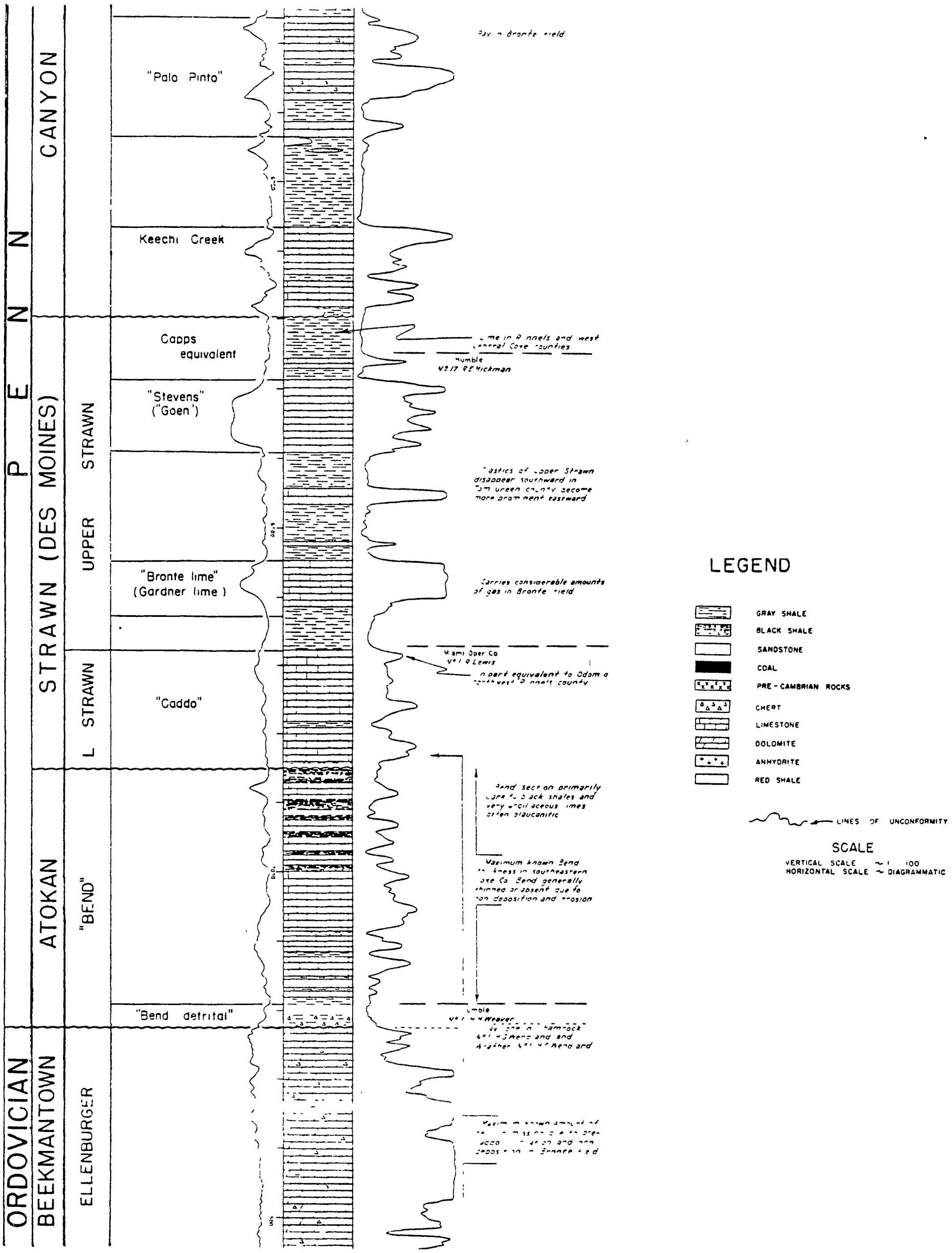

Figure 2. Composite Electric Log-Columnar Section of Subsurface Formations in Southeastern Coke County, Texas (From The Stratigraphic Committee of The Abilene Geological Society)

The following rock units were correlated over the two county study area whenever possible:

1. Canyon Series
    a. Palo Pinto Limestone
    b. Cross Cut Sandstone
2. Strawn Series
    a. Capps Limestone (includes both Upper and Lower Capps)
    b. Goen Limestone
    c. Gardner Limestone
    d. Gardner Sandstone
    e. Gray Sandstone
    f. Caddo Limestone (includes Odom Limestone when present)
3. Atokan Series
    a. Bend Limestone
4. Beekmantown Series
    a. Ellenburger Limestone

Beekmantown Series

Ellenburger Limestone

The Ellenburger Limestone is the only member of this series and is present over the entire two county area. The Ellenburger Limestone is a slightly cherty dolomitic limestone (Figure 2). It is located directly below the Caddo Limestone except when the Bend Limestone is present. It has a characteristic massive limestone signature on a spontaneous potential short-normal log (Figure 3).

Atokan Series

Bend Limestone

The Bend Limestone is the only member of this series present in the study area and is noted in very few areas in Coke and Runnels Counties. This absence is probably due to a period of erosion as evidenced by the inconsistent and sporadic locations of Bend Limestone in parts of the study area. The Bend Limestone is a very shaly limestone (Figure 2). It is directly below the Caddo Limestone and above the Ellenburger Limestone when present. It can easily be confused with the Caddo Limestone because of its shaly character (Figure 4a, 4b). The Bend Limestone may be distinguished by its higher shale content and less intense short normal response.

Strawn Series

The Upper Strawn was the principle stratigraphic interval of concern for this study. The Strawn is subdivided into an upper and lower stage. The upper limit of the Upper Strawn, in the Colorado River Valley, is the contact between the uppermost Capps Limestone and overlying basal Canyon shale (Shelton, 1953 and 1958). The lower boundary of the Upper Strawn is the base of the shale located beneath the "Bronte" limestone. The upper and lower limits of the Lower

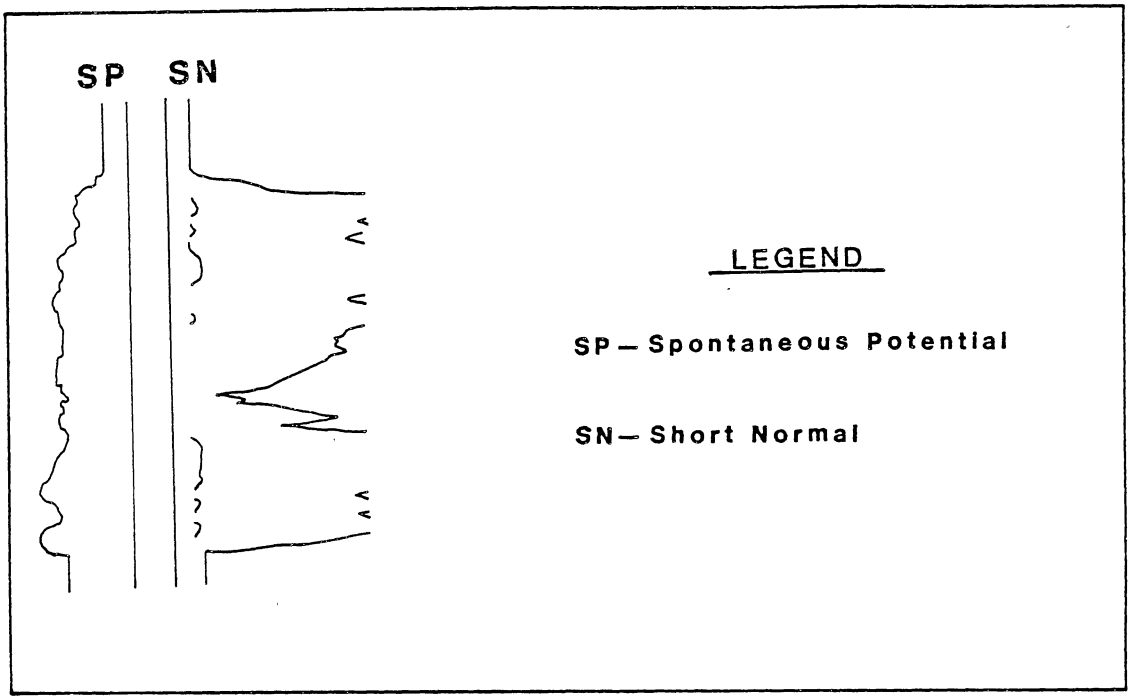

Figure 3. Typical Electric Log Signature for The Ellenburger Limestone-Western Runnels County

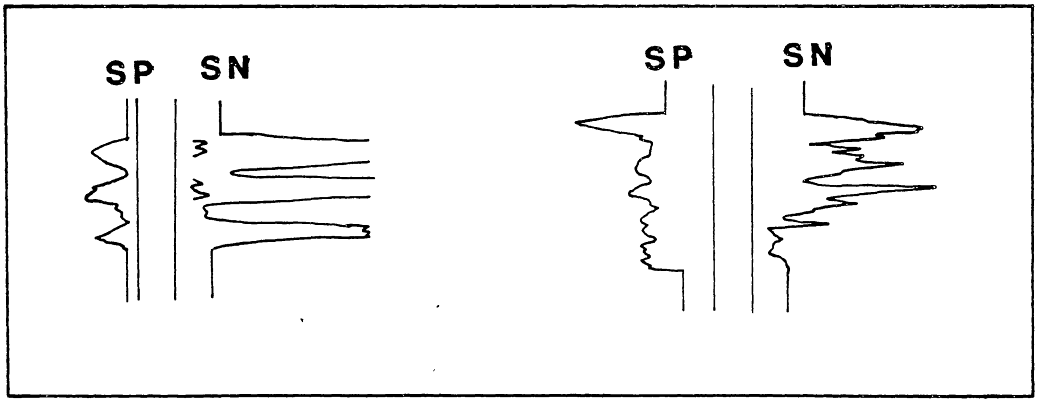

Figure 4. Typical Electric Log Signature for The Bend Limestone a) Typical Electric Log Signature for the Bend Limestone Showing Thin, Individual Limestone Fingers-Coke County b) Massive Character of The Bend Limestone With Characteristic High Shale Content-Coke County

Strawn are the upper and lower contacts of the Caddo Limestone respectively. Because of the dominance of limestone and difficulties associated with correlation, other units above and below the study interval were also used to solve problems of stratigraphic correlation.

Caddo Limestone

The Caddo is a slightly shaly limestone (Figure 2). It is located directly below the Gray Sandstone, when present. If the Gray Sandstone is not present it is located directly below the Gardner Limestone. The Caddo normally directly overlies the Ellenburger Limestone except in areas where the Bend Limestone is present, then the Bend is directly below the Caddo. The Caddo is recognized on electric logs by its thick limestone character, as reflected by electric log resistivity curves interspersed with numerous shale breaks (Figure 5).

Gray Sandstone

The Gray Sandstone is a fluvial-deltaic sandstone based upon electric log character (Figure 6a, 6b). It is located directly below the Gardner Sandstone (when present) and above the Caddo Limestone. The term "Gray" is a subsurface parastratigraphic unit that designates a pay zone. It is equivalent to the outcrop Buck Creek Sandstone of the Brazos River Valley (Cleaves, 1975).

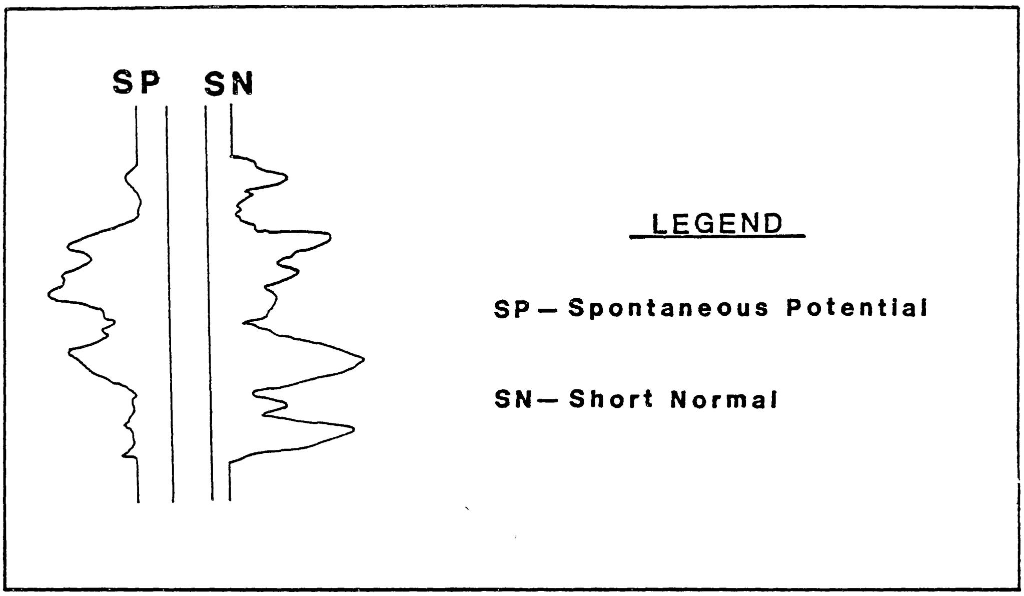

Figure 5. Typical Electric Log Signature for The Caddo Limestone-East Central Runnels County

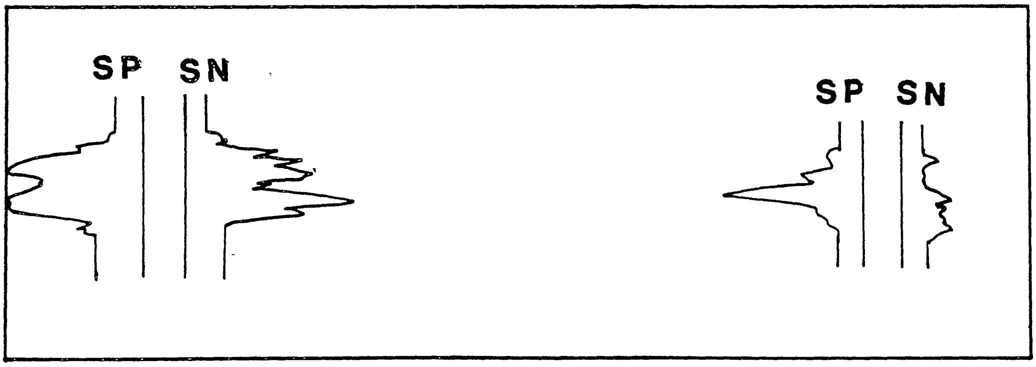

Figure 6. Typical Elecric Log Signature for The Gray Sandstone a) Fluvial Nature of The Gray Sandstone Northeastern Runnels County b) Deltaic Nature of The Gray Sandstone-Northeastern Runnels County

Gardner Sandstone

The Gardner Sandstone is a fluvial-deltaic sandstone based upon electric log character (Figures 7a and 7b). It is located directly below the Gardner Limestone and above the Gray Sandstone when present. The term Gardner is another parastratigraphic unit that has been utilized by the Abilene Geological Society to subdivide the Pennsylvanian subsurface section. Within the surface Strawn section of the Brazos River Valley, the Gardner is the same unit as the Dobbs Valley Sandstone.

Gardner Limestone

The Gardner Limestone is a dense slightly shaley limestone (Figure 2). It is located approximately 100 ft to 150 feet below the base of the Goen Limestone within the Strawn Series. The log characteristics of the Gardner Limestone vary greatly and causes extreme problems in correlation (Figures 8a and 8b). This was successfully dealt with by determining approximate position on the electric log based upon the overlying Goen Limestone and the underlying Gardner and Gray Clastics. The subsurface Gardner Limestone of the Abilene area correlates with the surface Goen Limestone of Palo Pinto County further to the north.

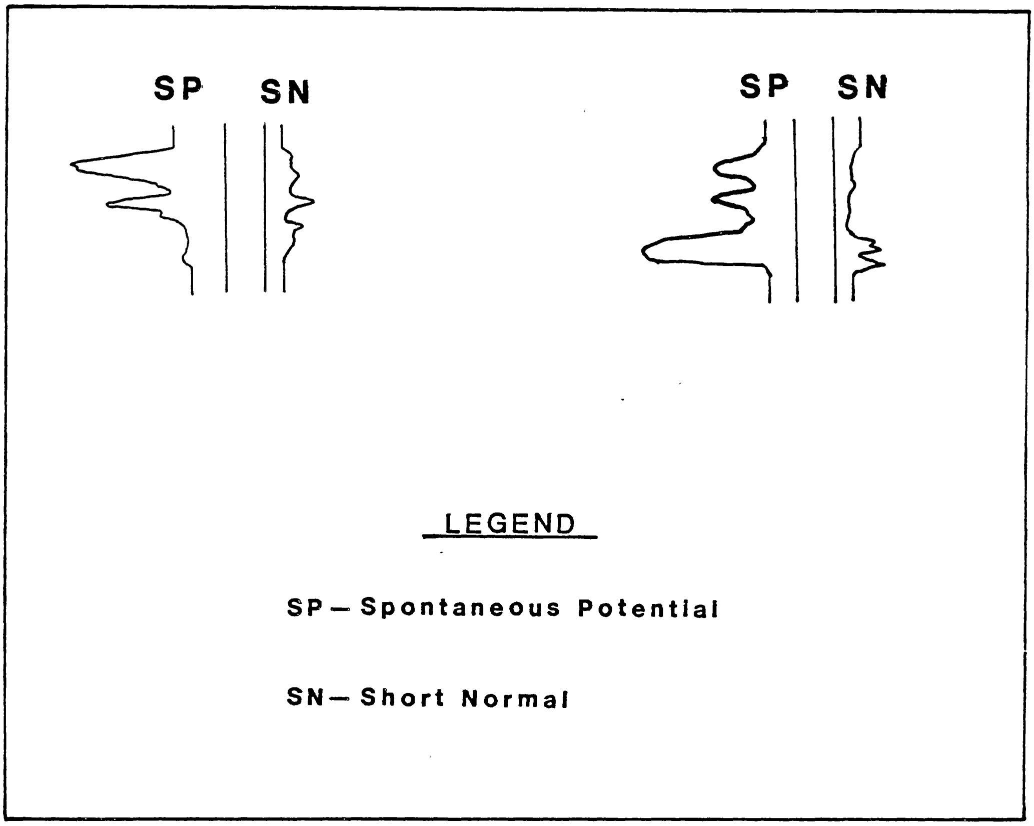

Figure 7. Typical Electric Log Signature for The Gardner Sandstone a) Deltaic Nature of The Gardner Sandstone-Western Central Runnels County b) Fluvial Nature of The Gardner Sandstone-Northeastern Runnels County

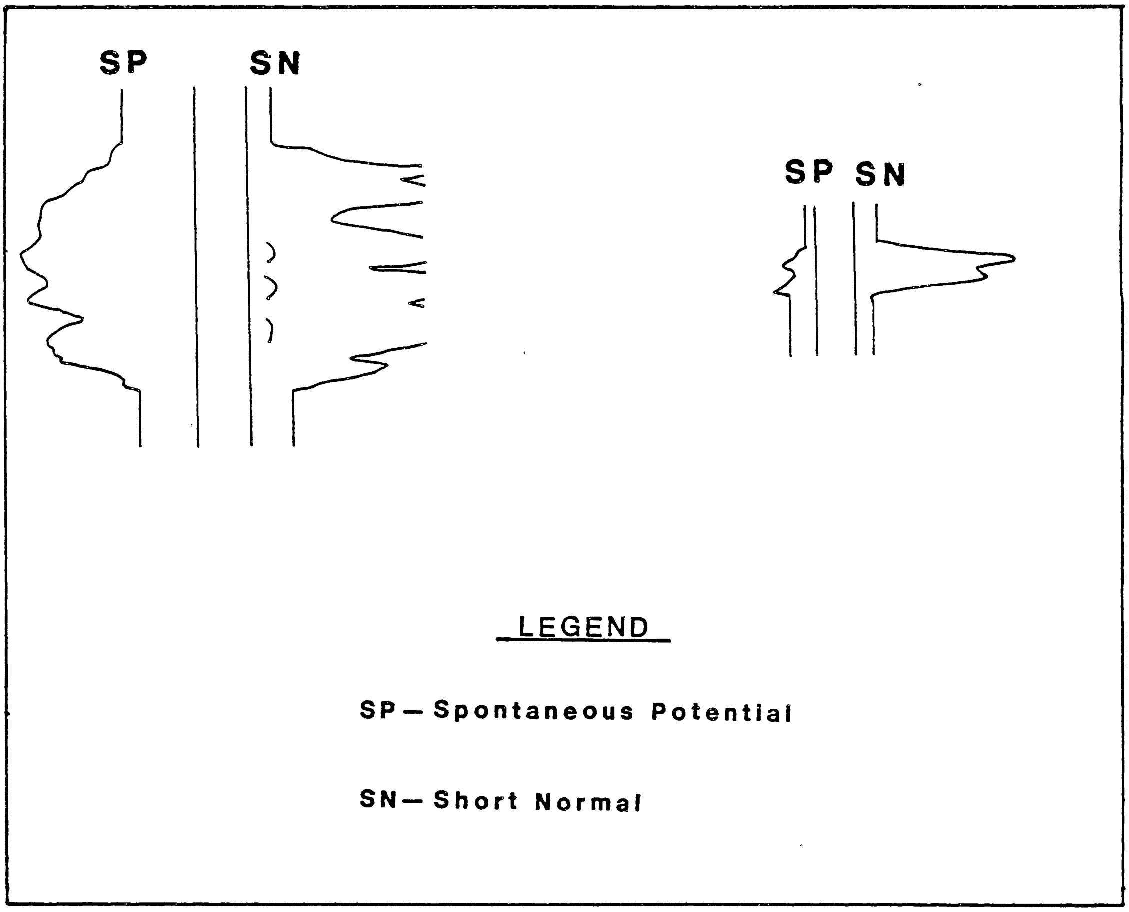

Figure 8. Typical Electric Log Signature for The Gardner Limestone a) Massive Character of The Gardner Limestone-Western Runnels County b) Thin Transgressive Character of The Gardner Limestone-Eastern Runnels County

Goen Limestone

The Goen Limestone is a dense slightly shaly limestone (Figure 2). It is located directly below the Capps Limestone within the Strawn Series. The Goen Limestone, when present, is usually easy to identify because of its characteristic square log signature (Figure 9a). The Goen thins drastically updip (Figure 9b) and becomes very difficult to identify. This subsurface Goen has no surface limestone equivalent in the Brazos River Valley of North-Central Texas and occurs higher in the stratigraphic section than the surface Goen Limestone.

Capps Limestone

The Capps Limestone is a sandy to chalky limestone (Figure 2). It is located at the top of the Strawn Series. It was recognized as the upper boundary of the Strawn Series using the last occurrence of diagnositc fusulinid index fossils (Shelton, 1953, 1958). The Capps Limestone characteristically displays a thick blocky limestone character on Spontaneous potential and short normal resistivity logs (Figure 10a). It can however, become quite thin and be difficult to identify (Figure 10b). This subsurface Capps unit is the subsurface extension of the surface Capps Limestone of Eastland and Brown Counties.

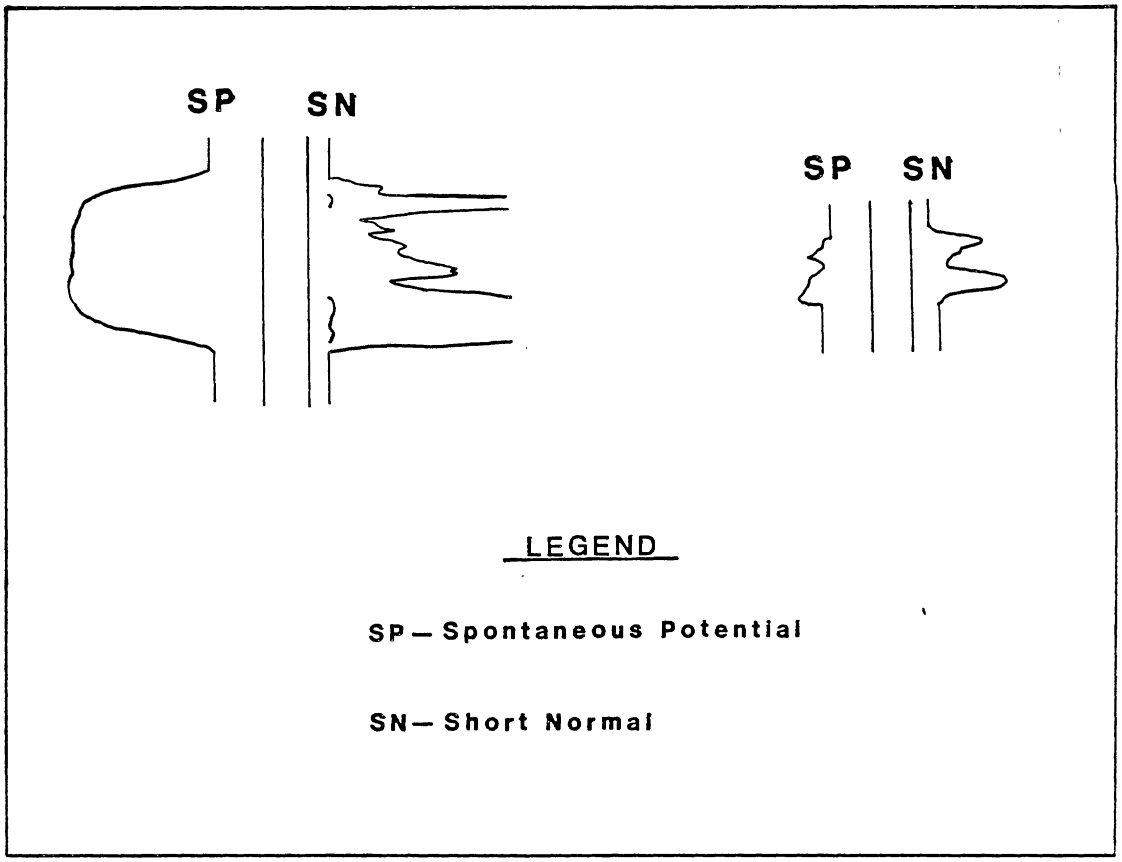

Figure 9. Typical Electric Log Character for The Goen Limestone a) Massive, Blocky Character of The Goen Limestone-Central Coke County b) Thin Transgressive Character of The Goen Limestone-Eastern Runnels County

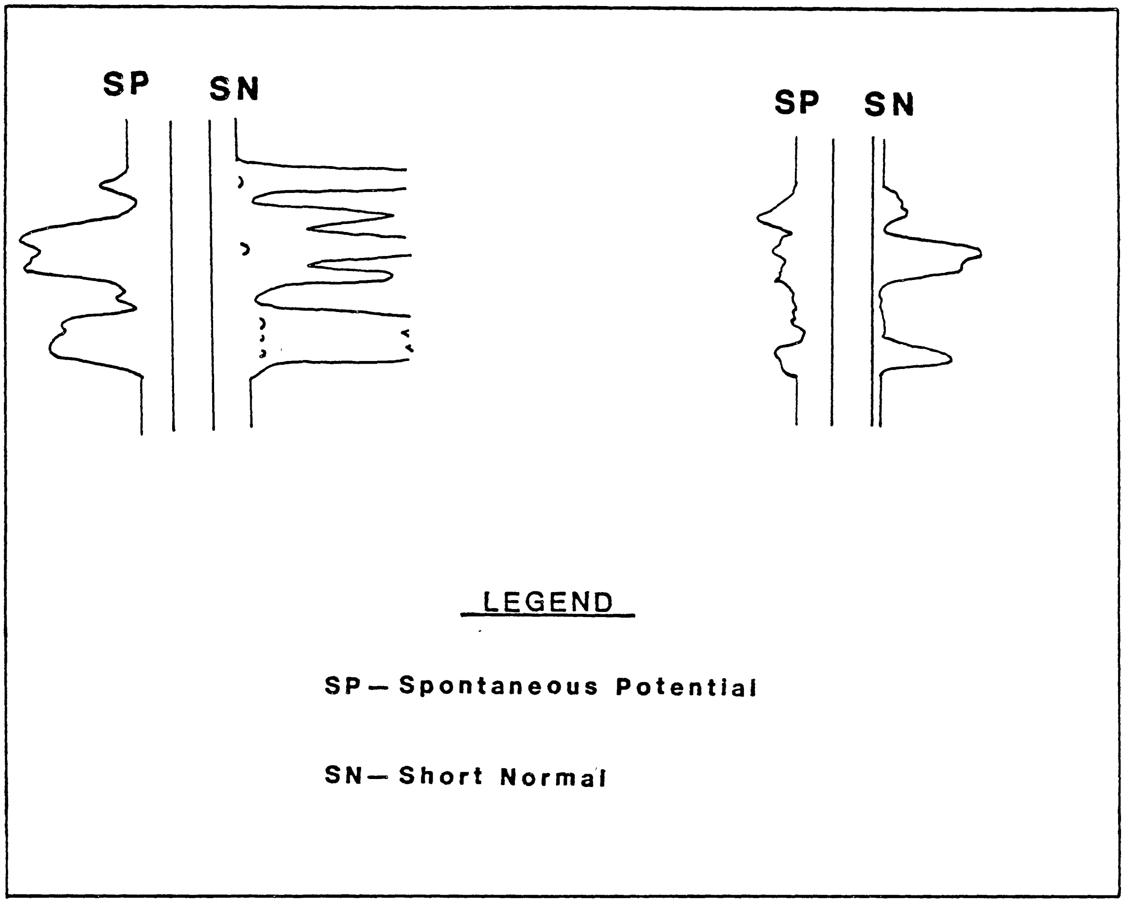

Figure 10. Typical Electric Log Signature for The Capps Limestone a) Massive Character of The Capps Limestone-Western Runnels County b) Thin Transgressive Character of The Capps Limestone-Eastern Runnels County

Canyon Series

Cross Cut Sandstone

The Cross Cut Sandstone is a fluvial-deltaic sandstone located below the Palo Pinto Limestone at the base of the Canyon Series (Figure 11). The Cross Cut is another subsurface parastratigraphic unit utilized by geologists in the Abilene area. This sandstone is laterally equivalent to the outcrop Turkey Creek of Palo Pinto County.

Palo Pinto Limestone

The Palo Pinto Limestone is a shaly to cherty dense limestone (Figure 2). It is located near the base of the Canyon Series. It has a characteristic dense limestone log character with a persistent double short normal inflection at the base (Figure 12). The Palo Pinto proved to be such a consistent marker across the study area it was often used as the datum for cross sections. As utilized in this study the term "Palo Pinto" includes the Wynn Limestone of the outcrop Palo Pinto Formation in the Brazos River Valley.

Conclusions

The stratigraphy of the Upper Strawn in Coke and Runnels County is complicated by the dominance of limestones within the interval. Correlation of limestones and clastics above and below the study interval must be used to correctly correlate the units of the Upper Strawn present in Coke and

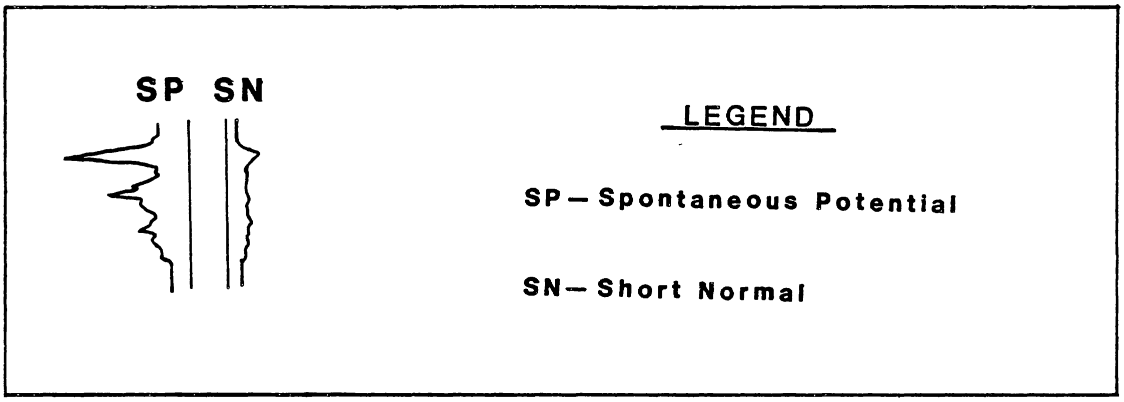

Figure 11. Deltaic Nature of The Cross Cut Sandstone-Northwestern Runnels County

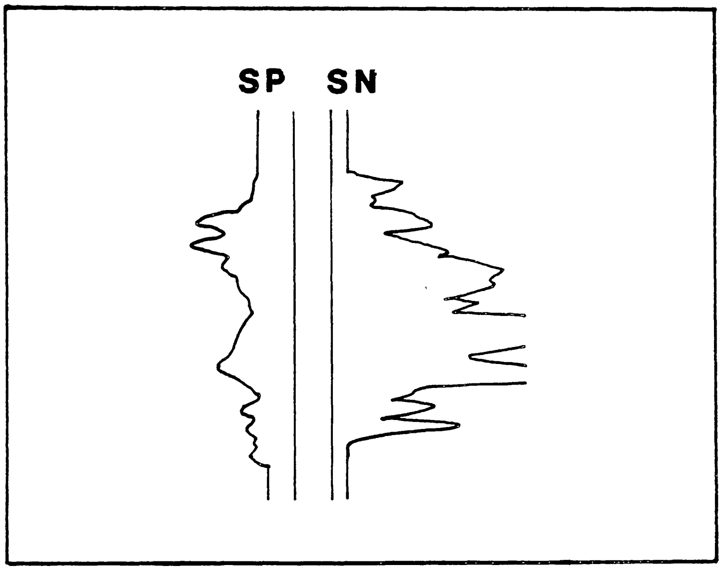

Figure 12. Massive Character of The Palo Pinto Limestone and Consistent Basal Double Inflection (Palo Pinto Dance)-Northwestern Runnels County

Runnels Counties. Surface stratigraphic nomenclature developed for the Strawn of the Brazos River Valley is inadequate to describe the distribution of the subsurface due to the aggregate thinning of the total interval onto the Eastern Shelf, as well as due to the westward and southward replacement of sandstone facies with carbonate rock units. The informal time stratigraphic nomenclature employed for subsurface rock units by the Abilene Geological Society best suits the needs of the present study.

CHAPTER IV

STRUCTURE AND TECTONICS

Introduction

Sedimentation on the Eastern Shelf of the Midland basin was influenced by major structural elements present in Central Texas. These structural elements include the Ouachita geosyncline, Fort Worth Basin, Midland Basin and Llano uplift and to a lesser extent the Fort Chadbourne Fault System. The evolution of these features not only determined the type but also the distribution of systems present within the Eastern shelf (Cleaves, 1975).

Major Structural Components

Ouachita Fold Belt

The Ouachita Fold Belt is a subsurface feature located along a northeast-southwest trend in North-Central Texas (Figure 13). Sedimentation within this geosyncline and its associated basin date from Cambrian to Middle Pennsylvanian. This 1,000 mile thrust faulted belt forms the eastern margin of the Fort Worth Basin. The Ouachita Geosyncline experienced multiple periods of compression and was finally uplifted during latest Early Pennsylvanian time to form a mountain range (Cleaves, 1975).

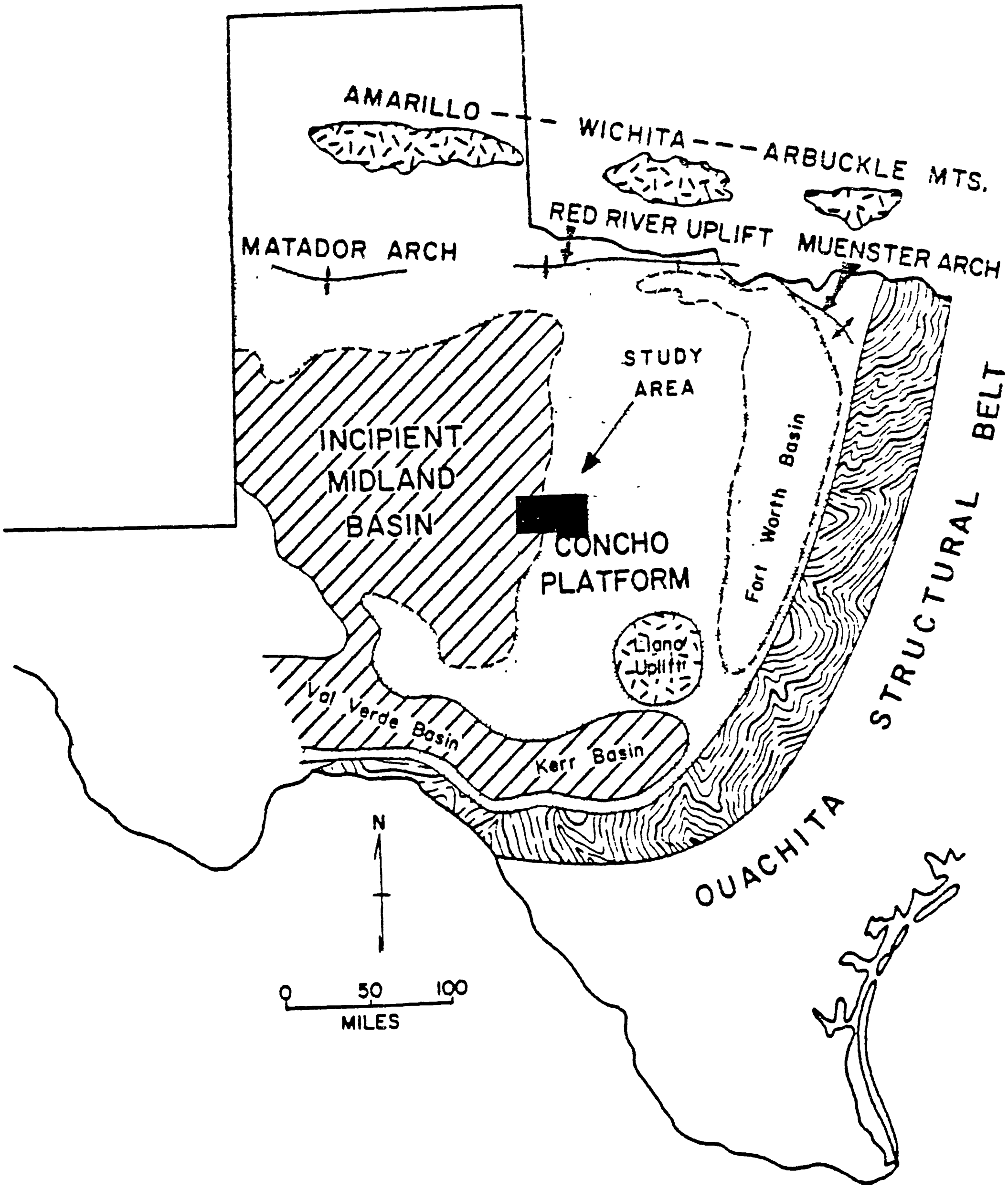

Figure 13. Tectonic Setting for North-Central Texas During The Desmoinesian Epoch (Modified From Wermund and Jenkins, 1969)

Fort Worth Basin

The Fort Worth Basin is an asymmetric syncline approximately 100 miles wide and 200 miles long (Figure 13). It was an early Pennsylvanian depocenter located just west of the Ouachita Fold Belt (Cleaves, 1975).

The basin became a significant structural depression in the late Mississippian. More than 5,000 feet of Atokan and 4,500 feet of Strawn terrigeneous clastics were deposited in the northern part of the basin (Turner, 1957). Subsidence was greatest during the Early and Middle Pennsylvanian. During Desmoinesian and Missourian time subsidence decreased substantially as the basin began to fill and became more stable. This was followed by the uplift of the eastern margin of the basin.

Bend Arch and Concho Platform

The Bend Arch extends from the Llano Uplift approximately 150 miles northward. It is a broad northward plunging flexure and is located adjacent to the eastern side of the previously formed Concho Platform. The Bend Arch did not form until the Fort Worth Basin had filled, stabilized and the Midland Basin began to subside (Cleaves, 1975).

Cheney (1929) proposed the term Bend Arch to indicate a hinge between the Forth Worth and Midland Basins. Due to rapid subsidence of the Fort Worth Basin during the Late Mississippian and Early Pennsylvanian an eastward-facing monocline was formed along the eastern margin of the Concho Platform (Figure 13). At the close of the Desmoinesian Epoch the eastern flank of the Fort Worth Basin began to rise. Because of this uplift, the entire Concho Platform began to tilt to the west forming a westward-dipping homocline. Reorientation of the Concho Platform caused relocation of the Fort Worth Basin depocenter. Because the dip of the Concho Platform was now westward as the Fort Worth Basin filled, Strawn fluvial-deltaic sediments prograded westward onto the Concho Homocline (Figure 14).

During Late Desmoinesian and Missourian time increased subsidence in West-Central Texas initiated development of the Midland Basin. This caused the western part of the Concho Platform to tilt westward and produce the closure that defines the Bend Arch (Cleaves, 1975).

Llano Uplift

The Llano Uplift is a dome composed of Precambian igneous and metamorphic rocks. It is located at the southern edge of a broad, north-south trending structure known as the Concho Platform (Cleaves, 1975) (Figure 13). Epeirogenic uplift during the Late Mississippian or Early Pennsylvanian associated with the Ouachita Orogeny, created the Llano. The upwarping that created the Llano was responsible for Paleozoic sediment removal in surrounding areas and exposure of the crystalline basement (Cleaves, 1975).

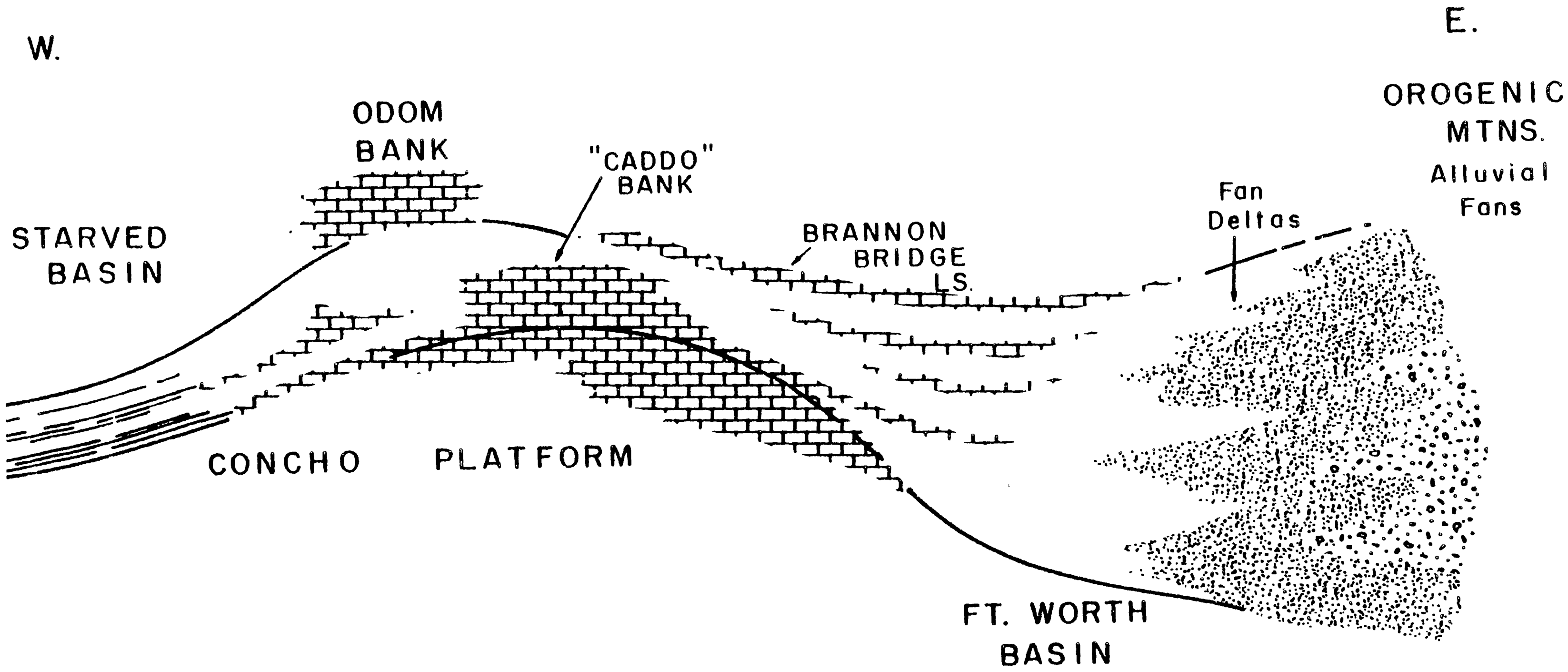

Figure 14. Lower Strawn Facies Tract

Fort Chadbourne Fault System

The Fort Chadbourne Fault System consists of a series of en echelon faults located along a north south trend throughout Coke County. Within this fault system a series of horsts and grabens have been formed.

The faults originated within basement rock coinciding with the western flank of the Concho Platform during the Late Ordovician to Pre-Devonian times. During the Late Mississippian - Early Pennsylvanian another major faulting episode occurred as the western flank of the Concho Platform was uplifted and rejuvenated. Activity decreased to intermittent movement throughout the remainder of the Pennsylvanian and Permian (Berumen, 1979).

Pre-Permian Tectonic History

During the Early and Middle Paleozoic, in North-Central Texas, sedimentation was characterized by carbonate platform deposition across the Concho Platform and a starved basin associated with the Ouachita Geosyncline to the east. In the Late Mississippian and Pennsylvanian a folded mountain belt replaced the Ouachita Geosyncline. This mountain belt served as the principal source of Pennsylvanian sediments throughout North-Central Texas (Cleaves, 1975) (Figure 14).

Formation of the Fort Worth Basin occurred simultaneously with the development of the Ouachita Fold Belt. These combined to deposit more than 10,000 feet of Morrow, Atoka and Lower Strawn terrigenous clastics (Figure 15). Meanwhile, along the western margin of the Fort Worth Basin and (eastern Concho Platform) shelf-edge carbonates of the Strawn Caddo were deposited (Cleaves, 1975) (Figure 14).

The intensity of uplift in the Ouachita Fold Belt and rate of subsidence in the Fort Worth Basin decreased during the Middle Pennsylvanian. This was followed by a westward shift of the Fort Worth Basin's axis of deposition. By the end of the Desmoinesian the Fort Worth Basin was largely full and fluvial-deltaic systems prograded westward across the Concho Platform (Cleaves, 1975).

Due to westward progradation of fluvial-deltaic systems during the middle Desmoinesian, Caddo Platform Limestone Facies were ultimately displaced westward more than 150 miles. An important control on the westward progradation of Strawn clastics was the deepening of water on the west flank of the Concho Platform. This westward movement caused reestablishment of carbonate bank deposition for the Caddo and Odom Limestones farther westward (Cleaves, 1975) (Figure 16).

During the Late Desmoinesian the eastern margin of the Fort Worth Basin continued to rise and the Midland Basin continued to subside. The Concho Platform slowly tilted westward. The flexure between the two basins is known as the Bend Arch. Continued uplift in the Fort Worth Basin served as a source of recycled Ouachita and Atokan sediments for Desmoinesian and younger Pennsylvanian, as well as Permian, river systems. As the Midland Basin continued to

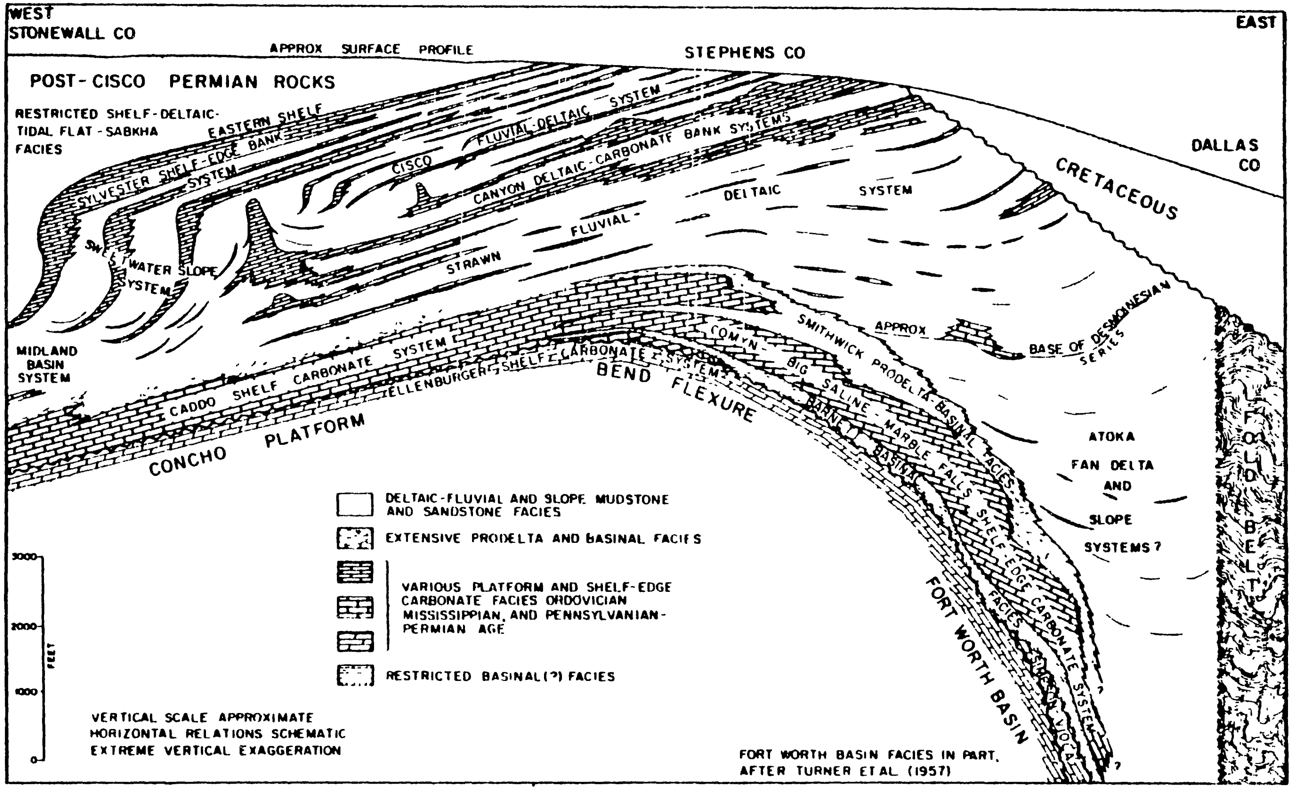

Figure 15. Evolution of Depositional Systems, North-Central Texas: Quachita Fold Belt, Fort Worth Basin, Bend Fluxure, and Concho Platform

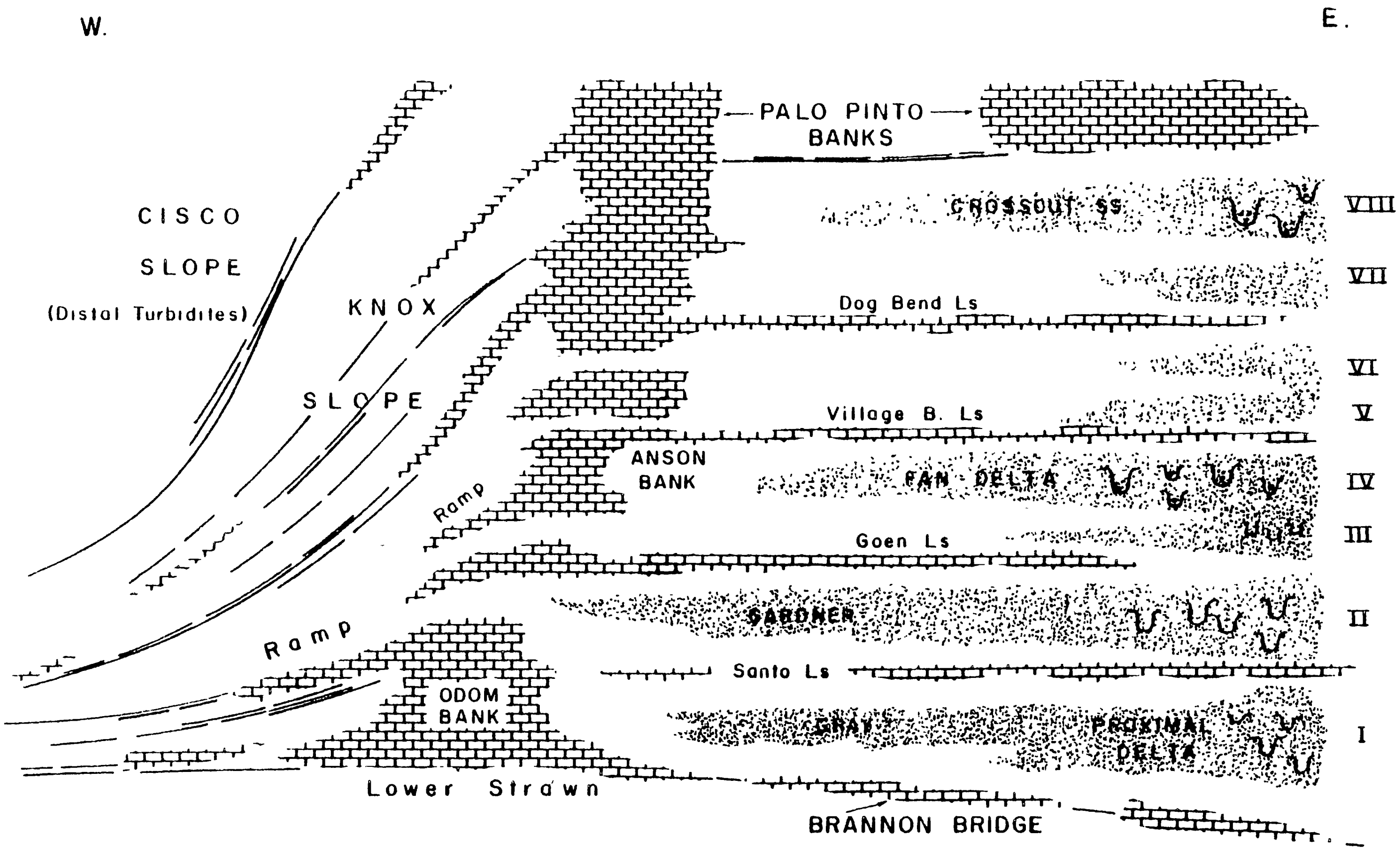

Figure 16. Upper Strawn Facies Tract

subside and the Concho Platform continued to tilt westward, Pennsylvanian and younger fluvial-deltaic systems were covered by the cyclic onlap of carbonate systems (Cleaves, 1975) (Figure 16).

CHAPTER V

REGIONAL ELECTRIC LOG STUDIES

Introduction

The regional electric log study consisted of five hundred and twenty-nine electric logs. Each log was examined for the presence or absence of three regional limestone markers. The three markers used for the study were:

1. The Bronte or Gardner Limestone.
2. The Goen Limestone with special attention no to include the Stephens Limestone.
3. The Capps Limestone (Upper and Lower Capps).

Structure maps were constructed for the two county area using the three regional limestone markers. The maps constructed were:

1. Structure on base of Gardner Limestone in Runnels County;
2. Structure on top of Goen Limestone in Runnels County;
3. Structure on top of Capps Limestone in Runnels County;
4. Structure on base of Gardner Limestone in Coke County;

5. Structure on top of Goen Limestone in Coke County;
6. Structure on top of Capps Limestone in Coke County.

Sandstone isolith maps were constructed in Runnels County using selected electric logs penetrating the desired interval. The isolith maps prepared were:

1. Gardner-Gray Sandstone Isolith;
2. Cross Cut Sandstone Isolith.

Stratigraphic cross sections were prepared using selected electric logs in the two county area. There were a total of seven cross sections prepared (Figure 17). The cross-sections prepared were:

1. Two dip oriented (east-west) cross sections in Runnels County;
2. Two strike oriented (north-south) cross sections in Runnels County;
3. Two dip oriented cross sections (east-west) in Coke County;
4. One strike oriented cross section (north-south) in Coke County.

The cross sections were principally based upon the correlation of the Gardner, Goen and Capps Limestones. Other units correlated, whenever possible, included the Ellenburger Limestone, Bend Limestone, Caddo Limestone, Gray Sandstone, Gardner Sandstone, Cross Cut Sandstone and Palo Pinto Limestone. Although several of these units are not contained within the study interval, they were considered a

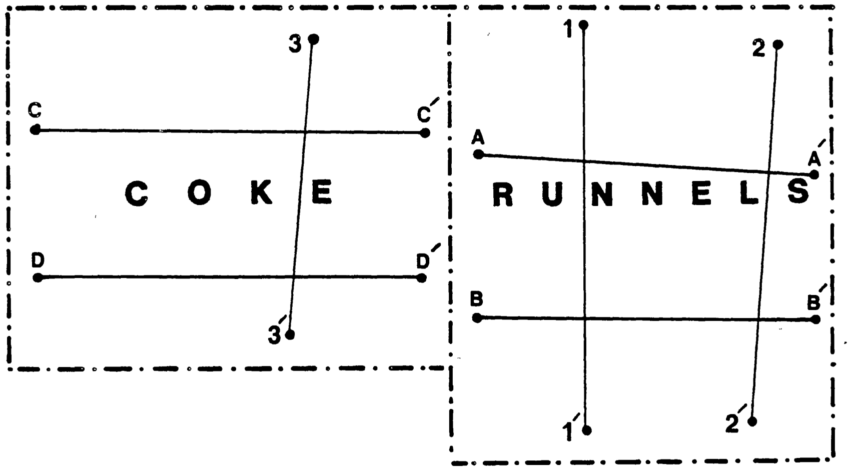

Figure 17. Generalized Index Map for Cross Sections Constructed in Coke and Runnels Counties, Texas

necessity for correlation when the three regional markers were either difficult to identify or not present.

Runnels County

All structure maps in Runnels County were contoured on a 50 foot interval. The scale used was one inch equals two miles. This scale and interval were chosen to show sufficient regional structure while yielding a map that could be easily worked with.

Gardner Structure

Structure on the base of the Gardner Limestone is characterized by fairly uniformly spaced contours (Figure 18). The regional dip is just slightly north of west. There are no apparent faults present within the Gardner Limestone. There are no significant highs or lows present that would substantiate closure. The Gardner appears as a relatively even plane with a slope of 52 ft/mile.

Goen Structure

Structure on top of the Goen Limestone is characterized by fairly uniformly spaced contours (Figure 19). The regional dip is just slightly north of west. There are no apparent faults present within the Goen Limestone. These are also no significant highs or lows present that would demonstrate closure. The Goen appears as a relatively even plane with a slope of 45 ft./mile.

RUNNELS COUNTY, TEXAS

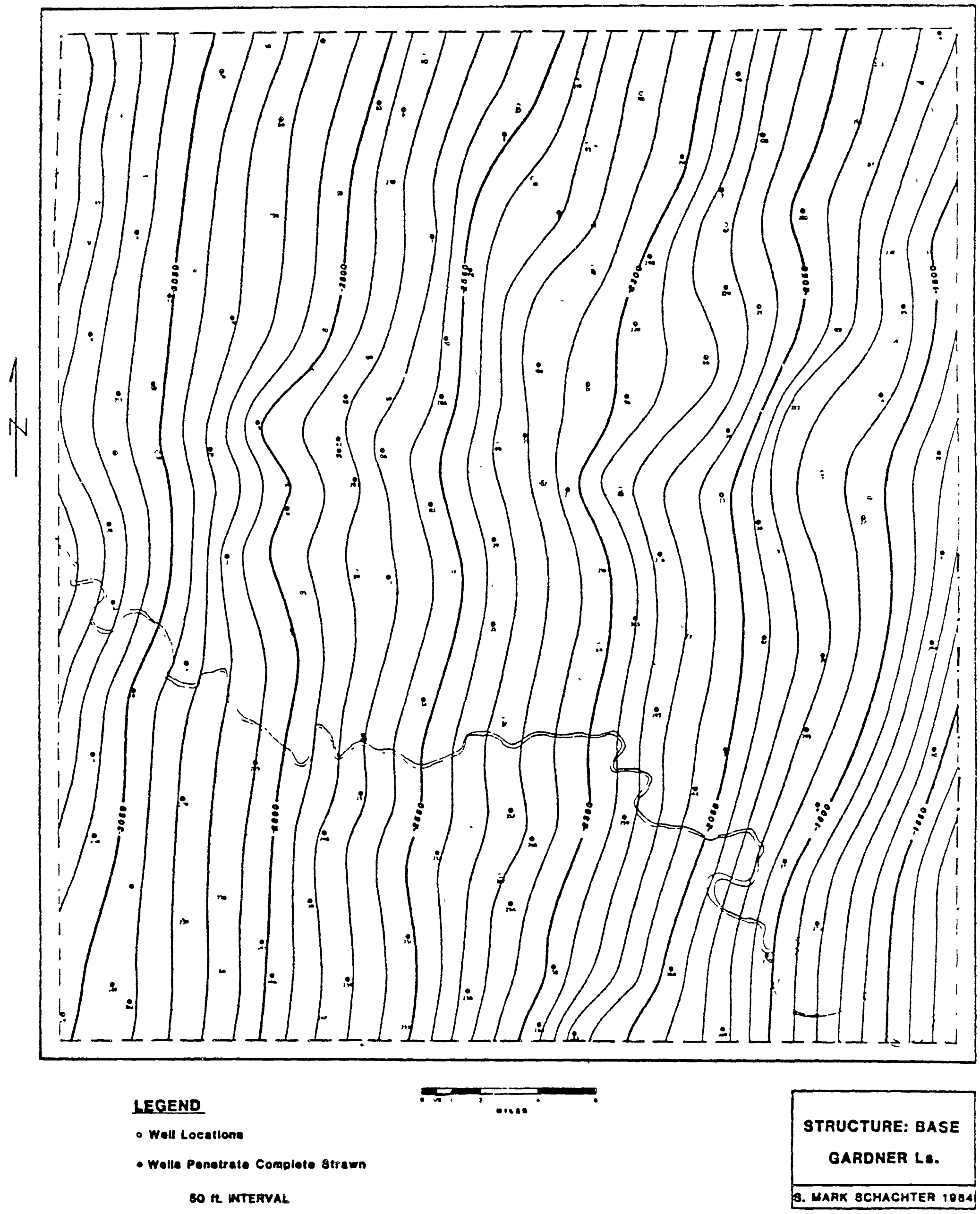

Figure 18. Structure Contour Map on Base of The Gardner Limestone-Runnels County, Texas

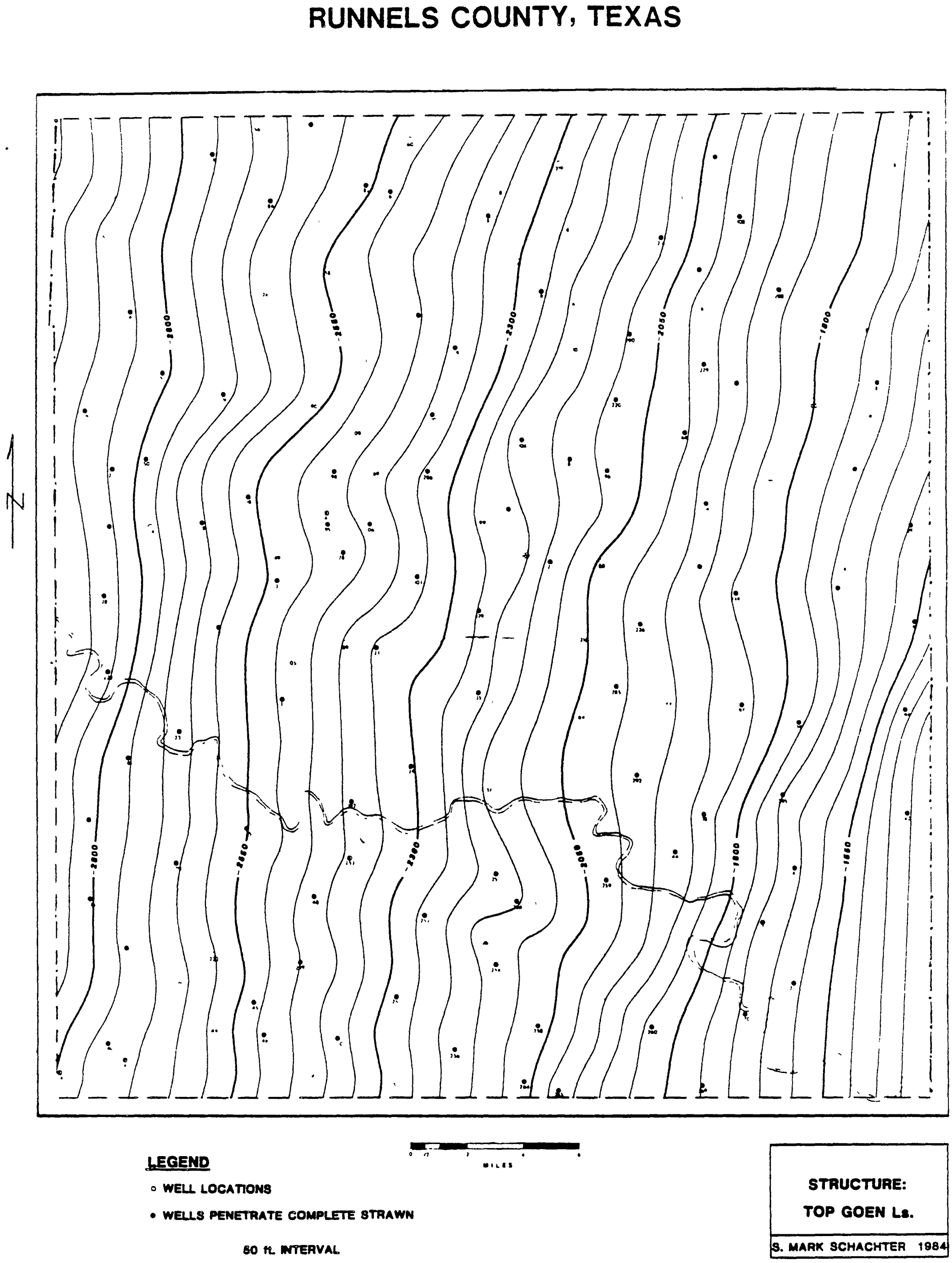

Figure 19. Structure Contour Map on Top of The Goen Limestone-Runnels County, Texas

Capps Structure

Structure on top of the Capps Limestone is characterized by uniformly spaced contours, similar to the situation seen with the two previously noted maps (Figure 20). The regional dip is just slightly north of west. There are no apparent faults depicted within the Capps Limestone. There also are no significant highs or lows present that would substantiate closure. The Capps appears as a relatively even plane with a slope of 43 ft./mile.

Gardner-Gray Isolith

A Gardner-Gray Sandstone Isolith map was constructed in Runnels County. It was constructed by combining the only significant clastics in the Upper Strawn Series, the Gardner and Gray Sandstones.

The isolith of the Garder-Gray Sandstone Interval reveals a distinct deltaic geometry (Figure 21). The map indicates three distinct lobes of a single deltaic complex. These three lobes extend almost due south, southwest and almost due west. The source area appears to be northeast of the map area. It appears that the Gardner-Gray Delta mapped in Runnels County is the distal expression of the Eastland Delta Complex as delineated by Cleaves (1975) (Figure 22). The major deltaic lobes coincide with large fields located within Runnels County that produce in part or wholly from the Gardner or Gray Sandstones.

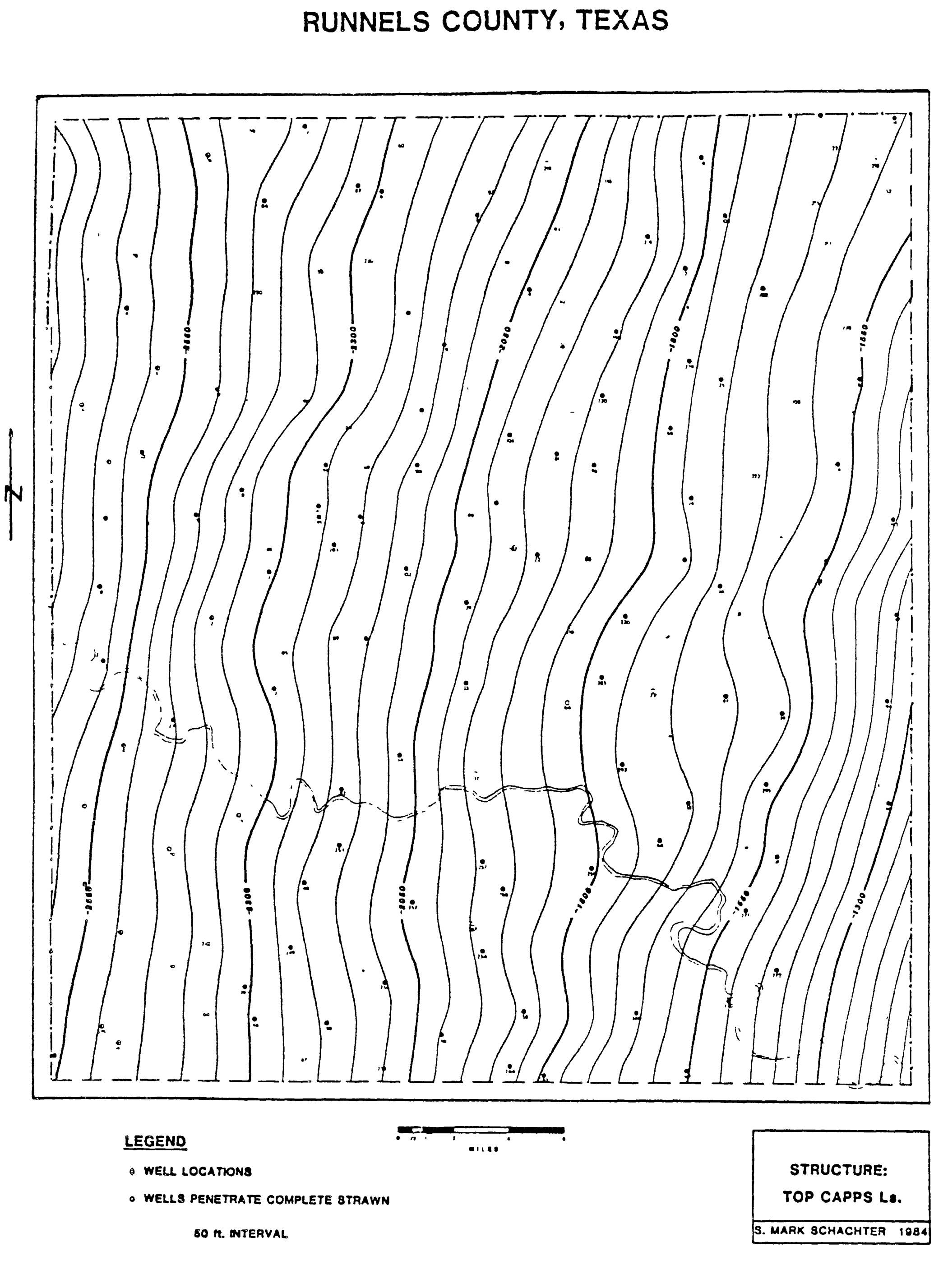

Figure 20. Structure Contour Map on Top of The Capps Limestone-Runnels County, Texas

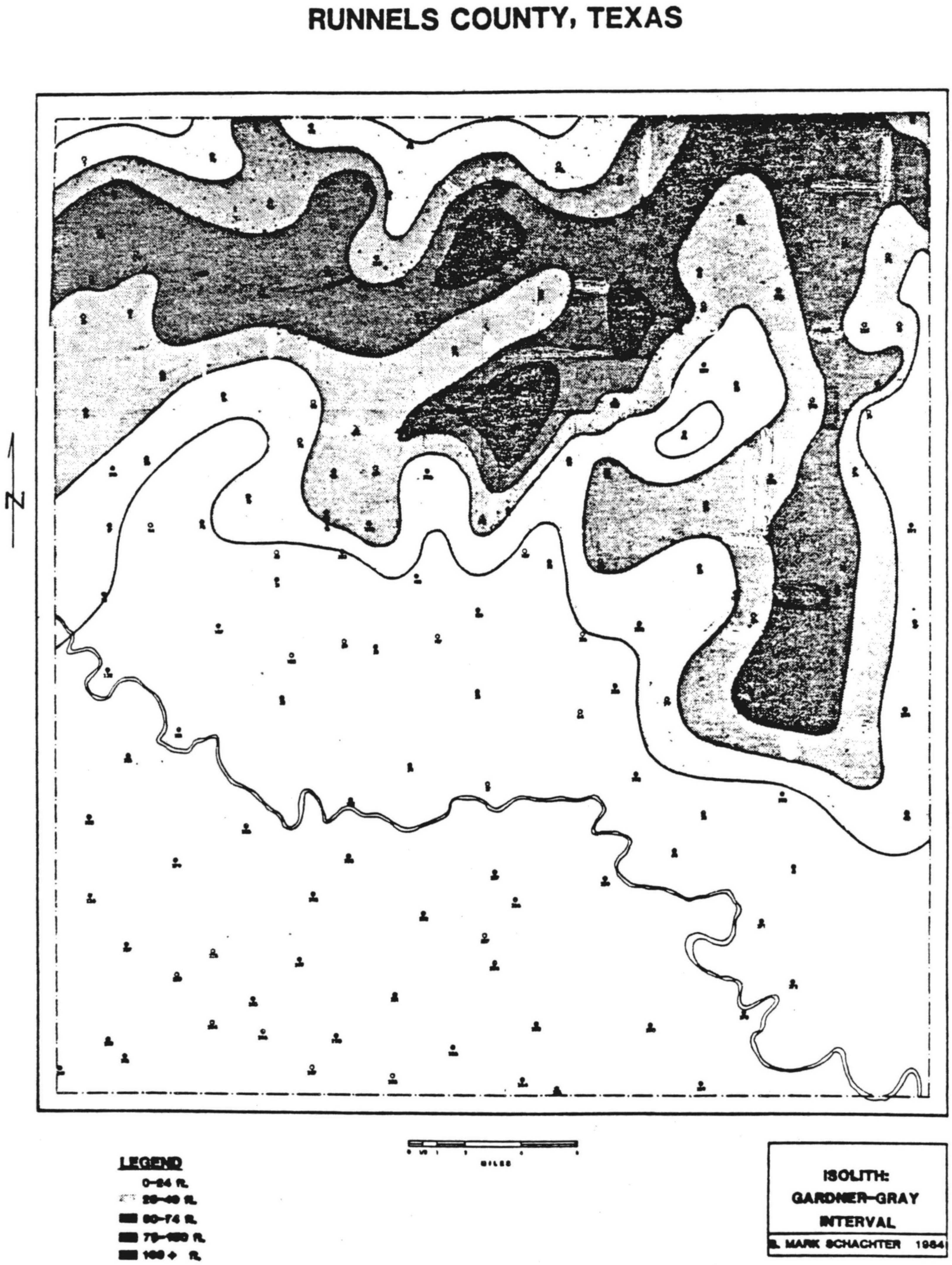

Figure 21. Sandstone Isolith Map for The Gardner-Gray Sandstone Interval-Runnels County, Texas

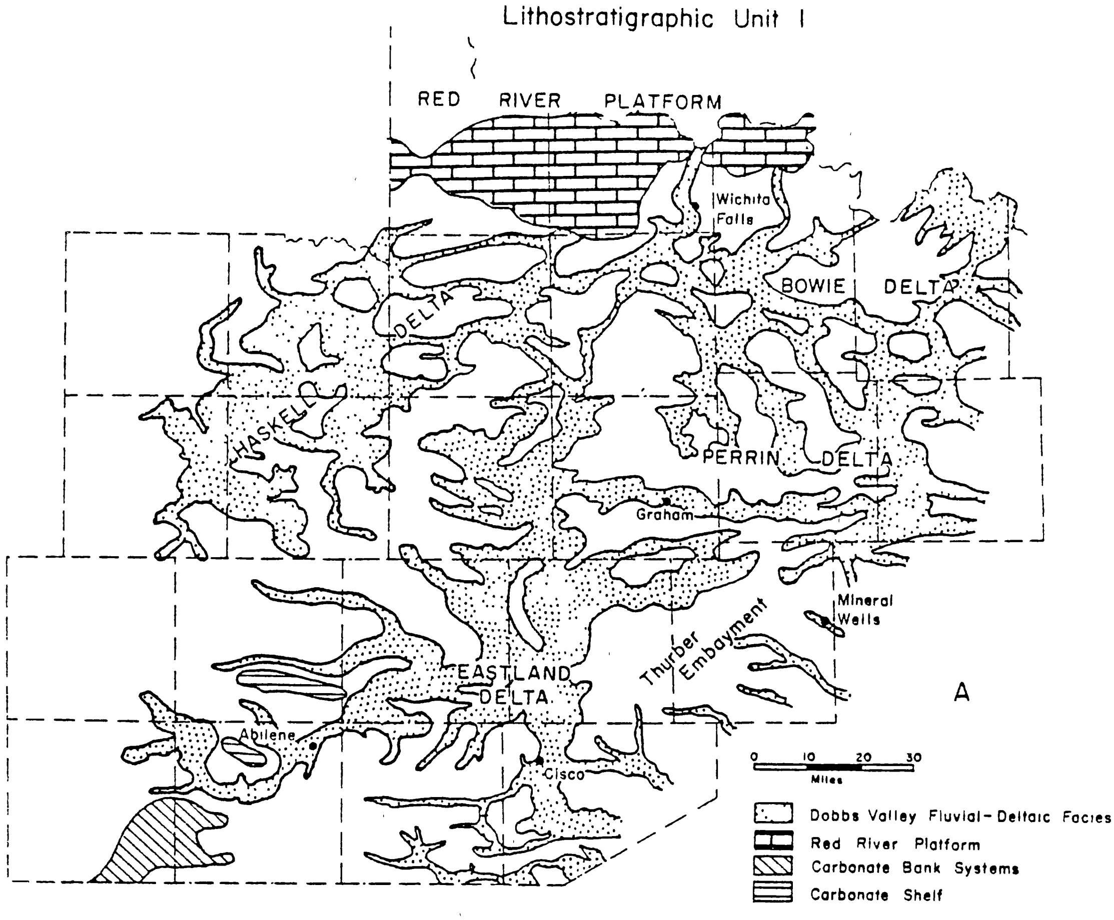

Figure 22. Cleaves' Eastland Delta Complex, North-Central Texas (from Cleaves, 1975)

Cross Cut Isolith

An isolith of the Cross Cut Sandstone was constructed in Runnels County. It reveals a distinct deltaic geometry (Figure 23). There is a major distributary channel trending west-southwest with a characteristic meandering form. In the central part of the county there are two distinct beaches in the channel probably indicative of two crevasse splays. Further westward the main channel appears to bifurcate with the main channel extending northwestward into Coke County. There is also what appears to be an abandoned delta lobe in the northeastern part of the county. The inferred source direction is to the east-northeast of the map area.

Northern Dip Cross Section

A dip oriented (east-west) cross section (A-A') was constructed in the northern half of Runnels County using nine electric logs (Figure 24). The Palo Pinto Limestone was chosen as the datum for this and the other three cross sections in Runnels County. The Palo Pinto was selected because it appeared to be the most regionally consistent limestone across the northern half of Runnels County. On the cross section the datum is denoted as the base of the Palo Pinto but in fact it is the top of the first limestone from the base of the Palo Pinto. This was suggested by Mr. William Guffey due to its more consistent nature. Mr. Guffey refers to this marker as "The Palo Pinto Dance" because of

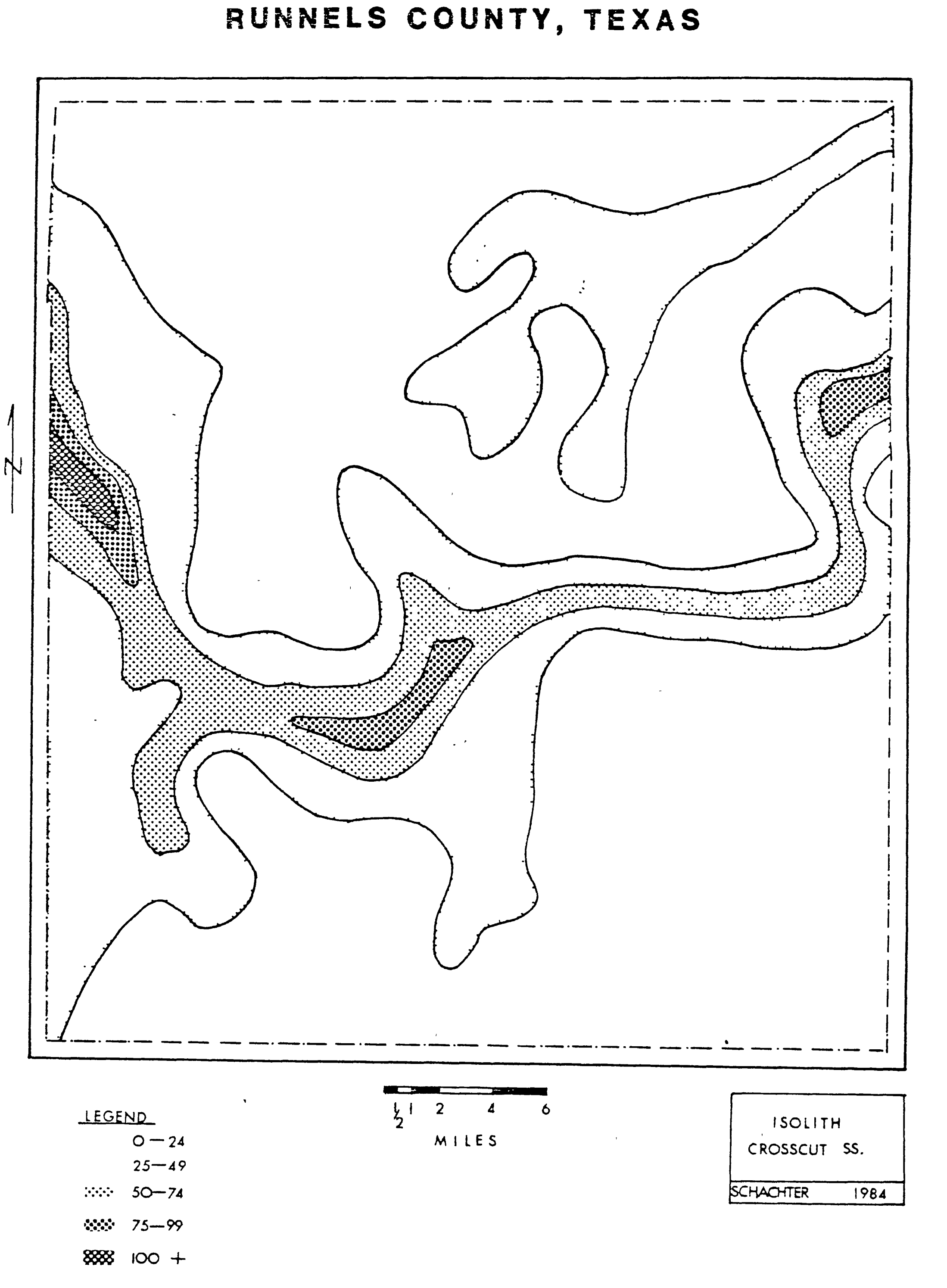

Figure 23. Sandstone Isolith Map for The Cross Cut Sand stone-Runnels County, Texas

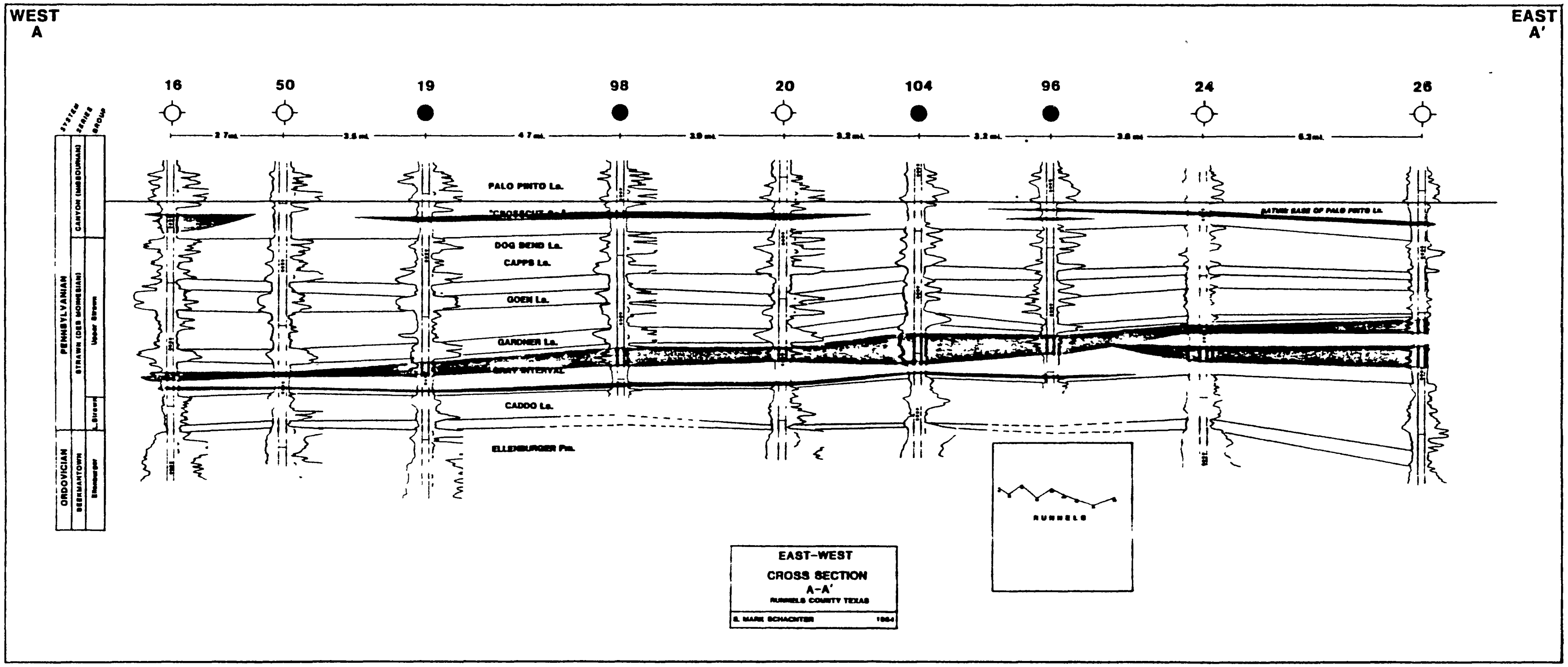

Figure 24. Northern Dip Cross Section A-A' Runnels County

it's "dancing" short normal deflection (Guffey, 1983, personal communication).

All limestones on the cross section are much thicker in the western two-thirds of the county. The Cross Cut Sandstone also thickens in the central and western half of the county. Conversely the Gardner-Gray Sandstone interval thins drastically to the western half of the county.

Southern Dip Cross Section

A second dip-oriented (east-west) cross section (B-B') was constructed in the southern half of Runnels County using eleven electric logs (Figure 25). All limestones on the cross section are much thicker in the western half of the county. Eventhough this coincides with the thickening to the west on the northern dip oriented cross section, the limestones almost approach a reefing character in the southern half of the county. The Cross Cut Sandstone thickens markedly to the central and western part of the county. The Gardner-Gray Sandstone interval is only present in the eastern one third of the county. Eventhough the Gardner-Gray Sandstone is present in the eastern one third of the county it is very thin and of limited extent.

Eastern Strike Cross Section

A strike-oriented (north-south) cross section (2-2') was constructed in the eastern half of Runnels County using eleven electric logs (Figure 26). All limestones on the

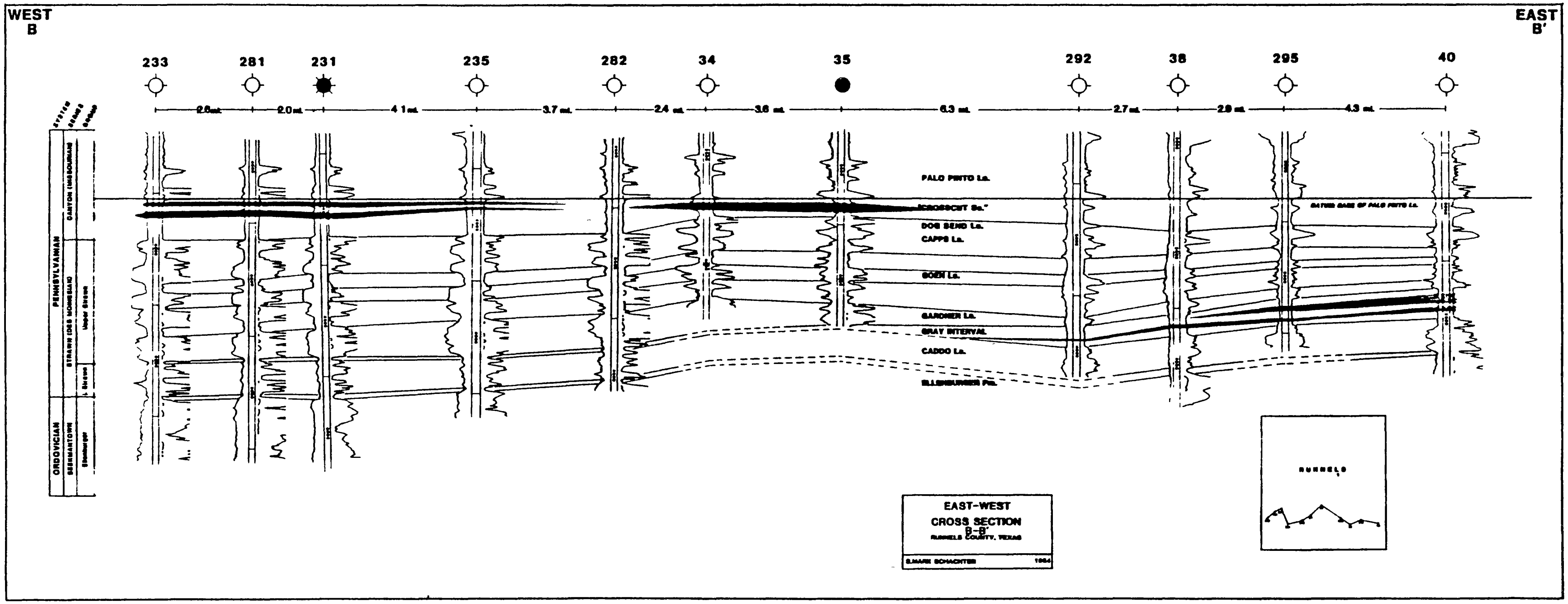

Figure 25. Southern Dip Cross Section B-B' Runnels County

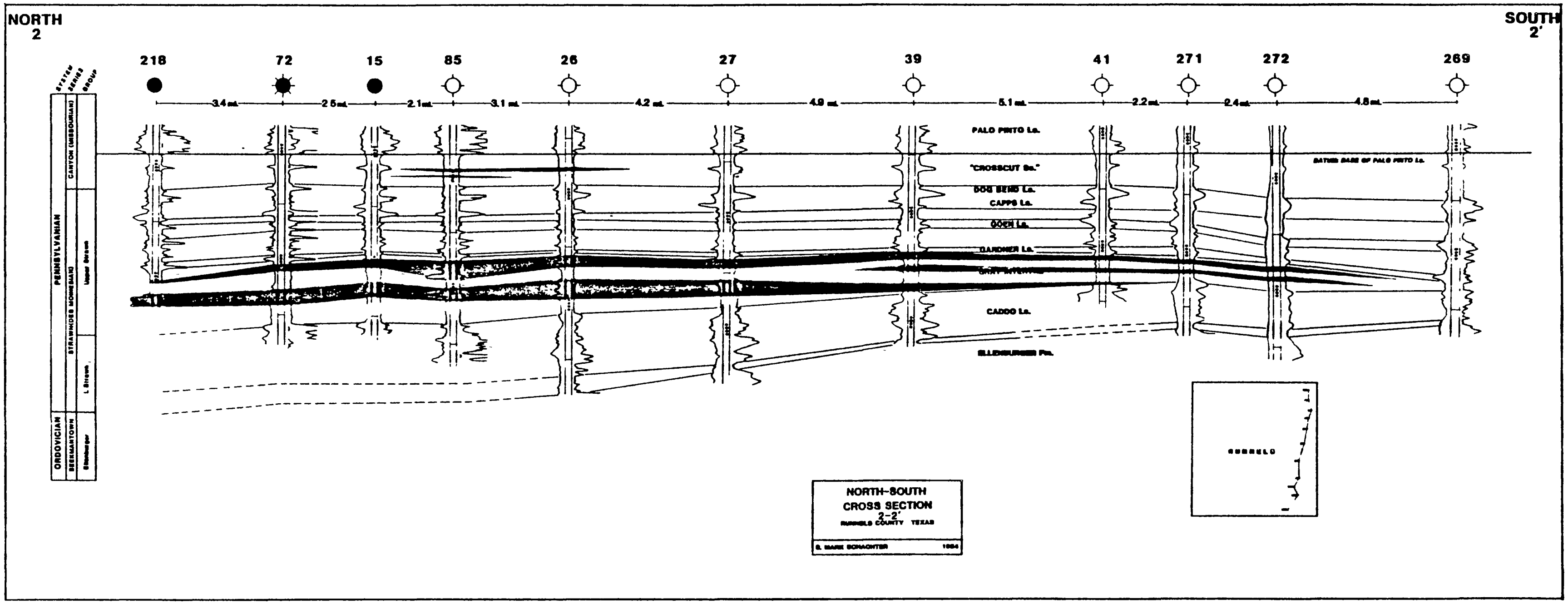

Figure 26. Eastern Strike Cross Section 2-2' Runnels County

cross section are poorly developed and very thin. Eventhough all the limestones are thin the limestones in the northern one third of the county are better defined than the southern part of the county (have a more definitive log character). The Cross Cut Sandstone is virtually absent in the eastern-most part of Runnels County. The Gardner-Gray Sandstone is quite thick (a maximum of ninety feet) and well developed to the east. It only thins toward the southernmost part of Runnels County.

Western Strike Cross Section

A second strike oriented (north-south) cross section (1-1') was constructed in the western half of Runnels County using twelve electric logs (Figure 27). All limestones were easily identified, although drastic thickening occurred in the southern half of the county. Some of the lower limestones, in particular the Gardner, approach a reefing character (thickness in excess of two hundred feet with poor vertical separation of individual units) in the southern half of the county. The Cross Cut Sandstone is no more than a stringer in the northern half of the county but thickens markedly to a maximum of ninety feet in the central and southern part of Runnels County. The Gardner-Gray Sandstone is quite thick (a maximum of ninety feet) in the northern half of the county, but thins quickly to the southern half of the county. The Gardner-Gray Sandstone undergoes a facies change

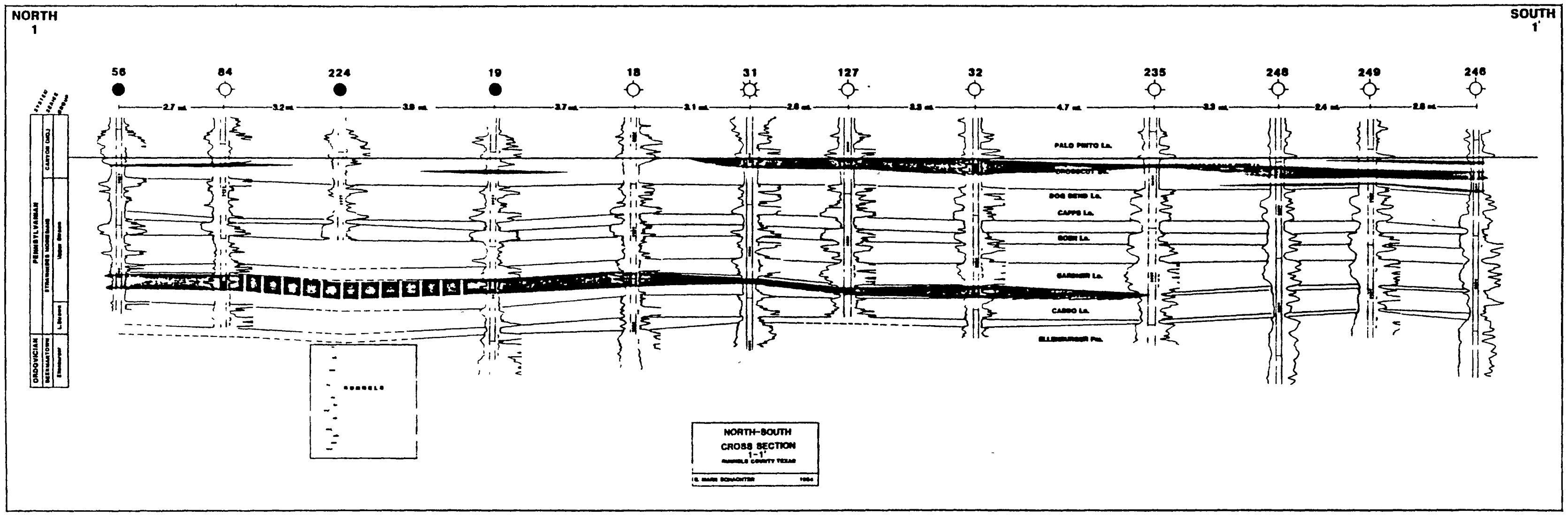

Figure 27. Western Strike Cross Section 1-1' Runnels County

from sandstone to limestone in the southern one-third of Runnels County (Figure 27).

As evidenced from the structure maps, isolith maps and cross sections the Desmoinesian of Runnels County appears to have been deposited as a relatively uniform plane with a slight westward dip. All limestones exhibit a distinct thickening to the western and southern part of the county. The Upper Desmoinesian experienced one substantial deltaic episode of sedimentation on the Concho Platform. This involved deposition of the Gardner-Gray Sandstones. These sandstones are thickest in the northern and eastern parts of the county. There is also one other significant episode of deltaic sedimentation depicted by the maps and cross sections in Runnels County. This is the Cross Cut Sandstone and, although it is of Canyon age, it deserves adequate recognition due to a longstanding controversy concerning the actual upper boundary of the Strawn. The Cross Cut Sandstone is most prominent in the southern half of Runnels County; it is absent in the northern half of Runnels County.

Coke County

All structure maps in Coke County were contoured on a 50 ft. interval. The scale used was one inch equals two miles. The scale and interval were chosen to show sufficient regional structure while yielding a map that could be easily worked with.

Gardner Structure

The structure map on the base of the Gardner Limestone consists of faulted areas, closed highs, closed lows, and areas of high relief bordered by areas of low sedimentation or non-deposition (Figure 28).

In the eastern one fifth of Coke County there is an area of significant faulting. These faults form an en echelon series of horsts and grabens (Berumen, 1979). There are several major oil fields located within the grabens of this fault system. These fields include the Bronte Field, Rawlings Field and the Fort Chadbourne Field. The last of these is actually a stratigraphic field but appears to have structurally enhanced production.

The Gardner Structure Map demonstrated two large areas that indicate closure and one smaller area. The largest is located adjacent to the Fort Chadbourne Fault System (Conselman, 1954) (Figure 28). This low could easily be interpreted as a rather large down-dropped block by the simple recognition of two minor faults extending from the major north-south fault. This is not recognized at this time however, and at the present time is merely conjecture. The second large low is somewhat smaller and located in the south central part of the county near what appears to be the edge of Gardner Limestone deposition (Figure 28). In this area Gardner deposition extends almost four-fifths the distance westward across Coke County. The westward margin of

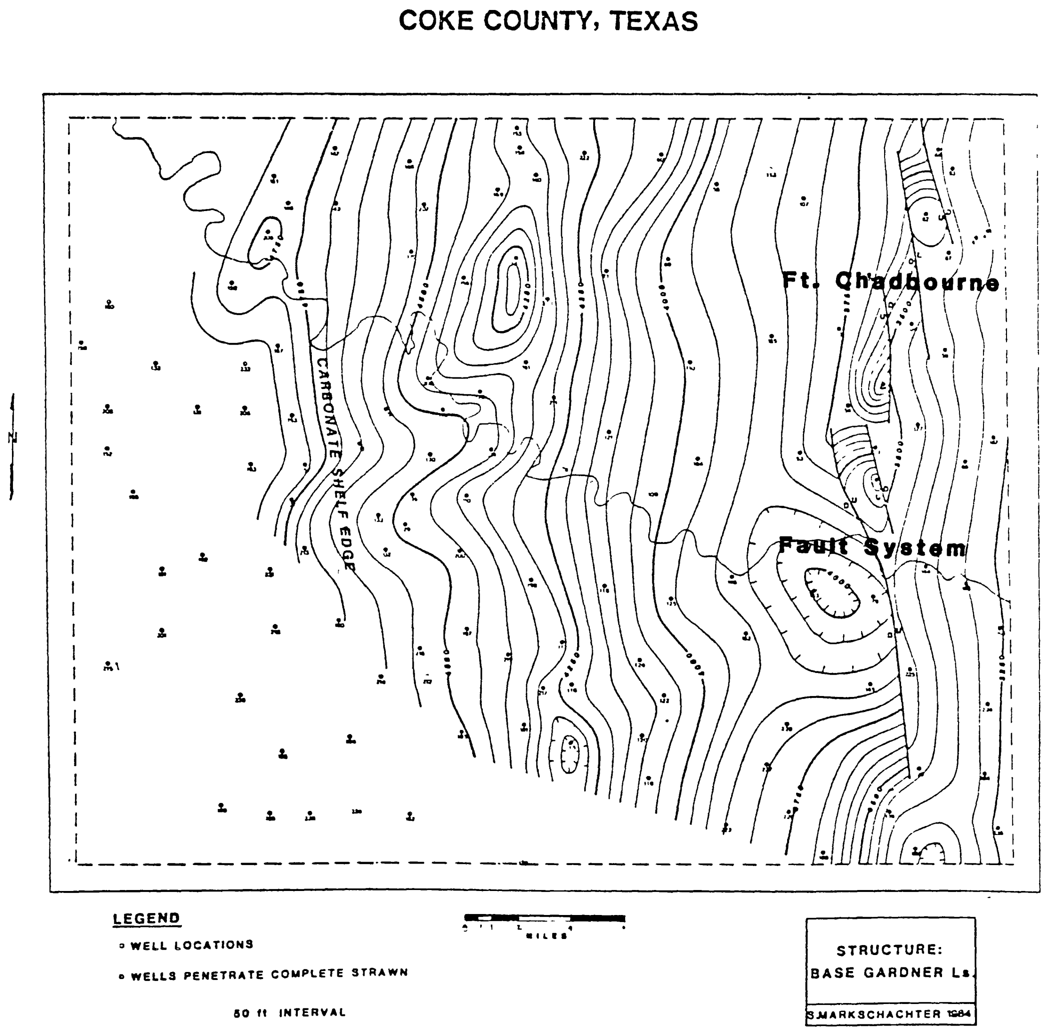

Figure 28. Structure Contour Map on Base of The Gardner Limestone-Coke County, Texas

this deposition appears to be the eastern carbonate shelf edge of the Midland Basin (Figure 28).

There are several highs located in Coke County not associated with the fault system. They are located in the northwestern one fourth of the county. These highs are considered to be organic reefs. There are several fields located in this area. They are the Millican, Frank Pearson, I.A.B. and Jameson Fields.

There is an elongate north-south carbonate reef trend running the entire length of the western central part of the county. To the west of this trend there is no Gardner deposition (Figure 28). This appears to be the delineation of the Gardner shelf edge.

Goen Structure

The structure map on the top of the Goen Limestone consists of faulted areas, closed highs, closed lows and areas of high relief followed by termination of Goen deposition, to the west of the shelf edge (Figure 29).

The structure is almost identical to the underlying Gardner Limestone. The same faults carry through the Goen in the area of the Fort Chadbourne Fault System. The two major lows present in the Gardner are present in the same location within the Goen. The organic reefs located in the northwest part of Coke County are also seen in the Goen Limestone. The only difference is the increased relief

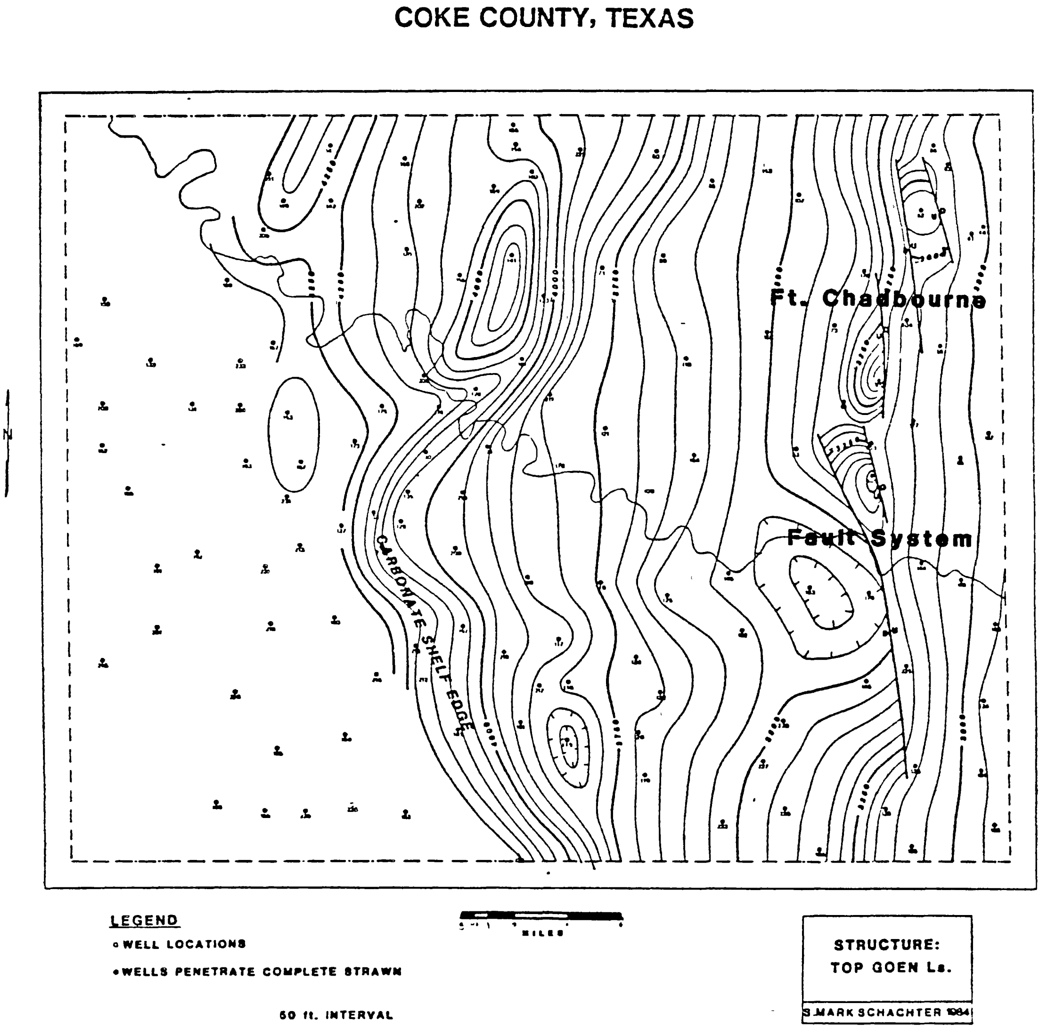

Figure 29. Structure Contour Map on Top of The Goen Limestone-Coke County, Texas

associated with the Goen Limestone shelf edge located along a north-south trend in the western central part of the county.

Capps Structure

The structure map on top of the Capps Limestone consists of faulted areas, closed highs, closed lows, and areas of high relief followed by termination of Capps deposition to the west of the shelf edge.

The structure is almost identical to the underlying Goen and Gardner Limetones. The same faults carry through the Capps in the area of the Fort Chadbourne Fault System. The two major lows present in the Gardner and Goen Limestones are present in the same location within the Capps. The organic reefs located in the northwest part of Coke County are also seen in the Capps Limestone in the same position. The addition of a back-reef area in the northwestern area of the county (Figure 30) is also recognized. A shelf edge is also present within the Capps and it shows a greater amount of relief than was present with the Goen and Gardner. This is perhaps indicative of vertical accretion of carbonate along a developing north-south hinge-line. This hinge-line formed between the Concho Platform and the Midland Basin.

COKE COUNTY, TEXAS

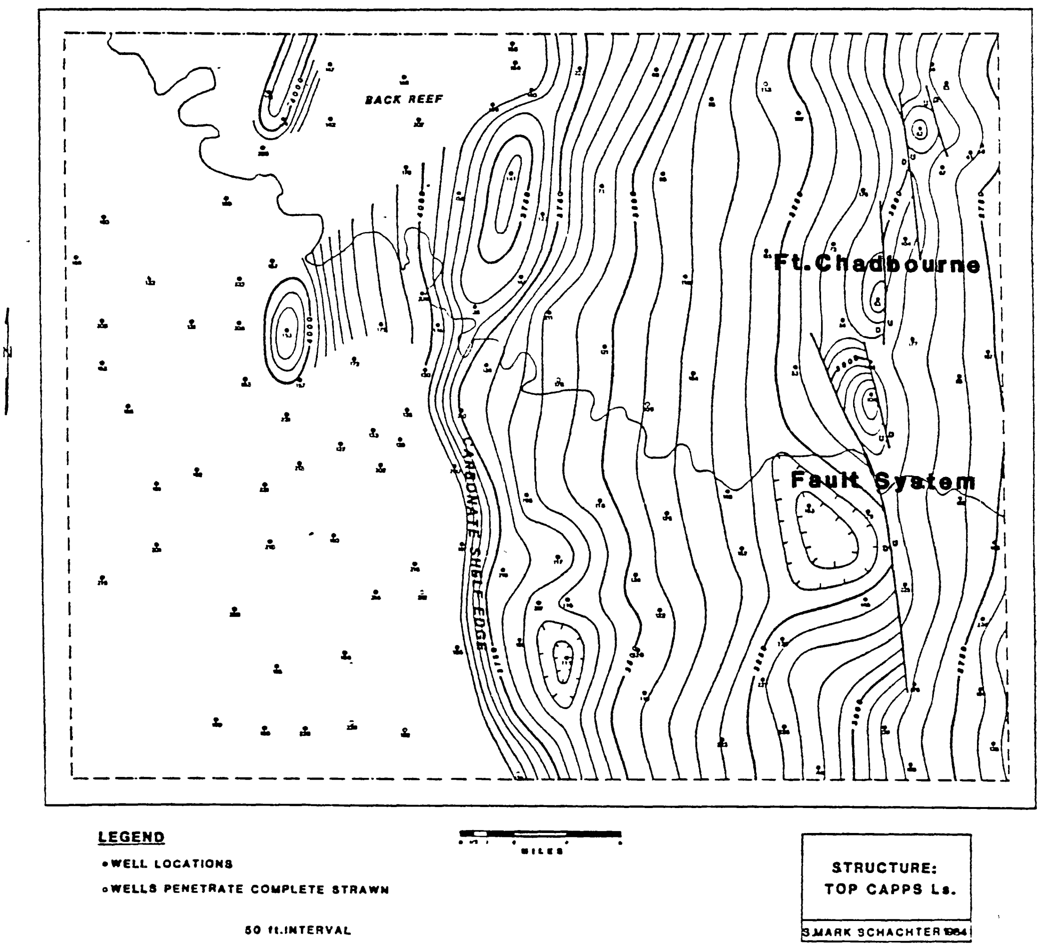

Figure 30. Structure Contour Map on Top of The Capps Limestone-Coke County, Texas

Palo Pinto Isolith

The Palo Pinto Limestone Isolith Map was modified from Wermund (1975) to indicate the continuation of a greater than eighty percent Palo Pinto Limestone Reef oriented along a north-south trend throughout central Coke County (Figure 31). This coincides with the two southernmost logs on strike oriented cross section 3-3' indicating an abrupt vertical accretion of limestone (reefing). This indicates a slight reorientation of this Palo Pinto Reef trend to the southeast in the southern one-half of Coke County. This is in close agreement with the structure maps showing a reorientation of the carbonate shelf edge to the southeast in southern Coke County.

Northern Dip Cross Section

A dip oriented (east-west) cross section (C-C') was constructed in the northern half of Coke County using ten electric logs (Figure 32). The top of the Goen Limestone was chosen as the datum for the cross section because it could be correlated throughout the county.

The limestones on this cross section remain relatively consistent as far as thickness and character are concerned over the eastern half of the County. At the center of the county they become thin and difficult to identify. Within the Capps interval the Capps Limestone actually pinches out and is replaced by shale. This is believed to be a back

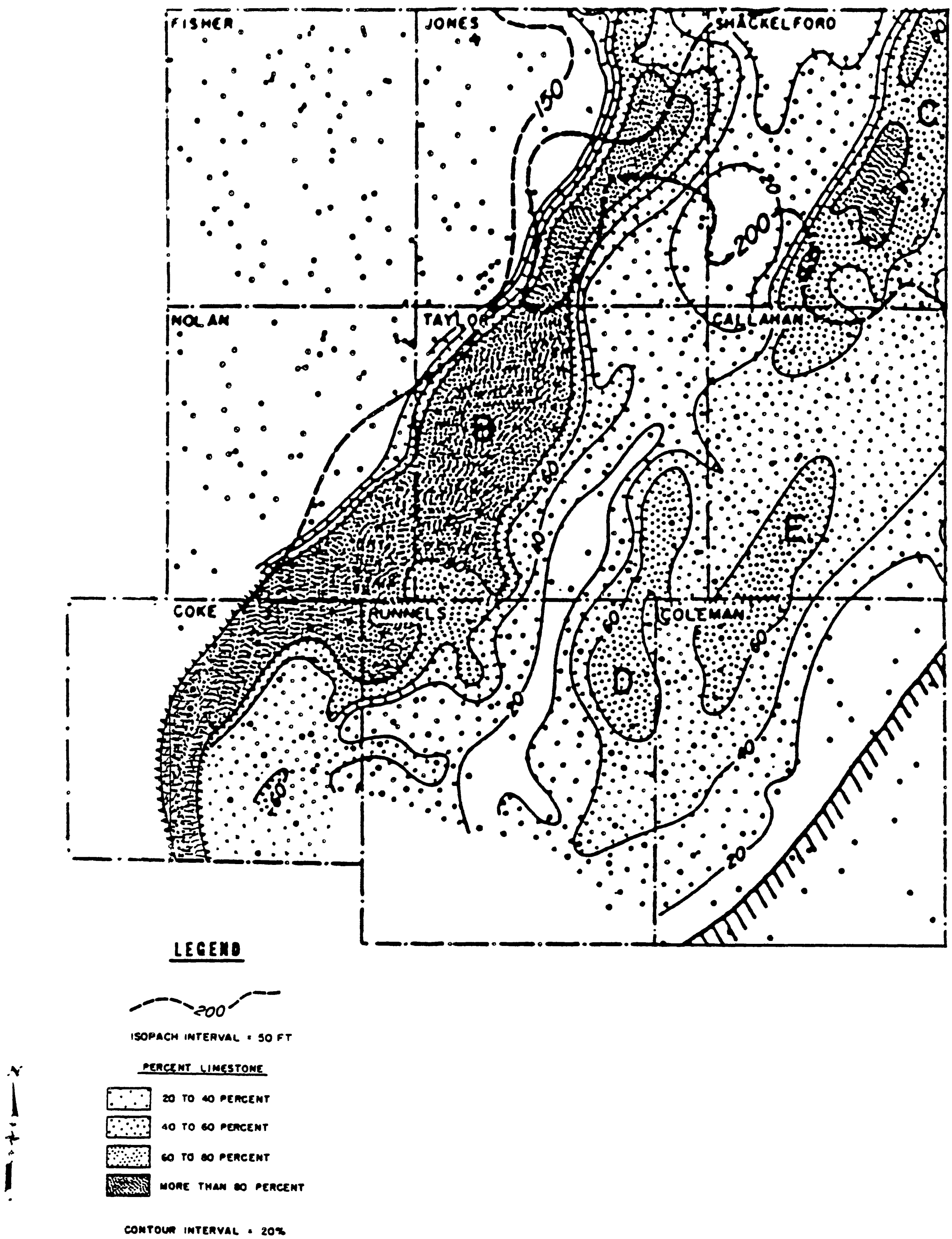

Figure 31. Palo Pinto Isolith North-Central Texas (Modified from Wermund, 1975)

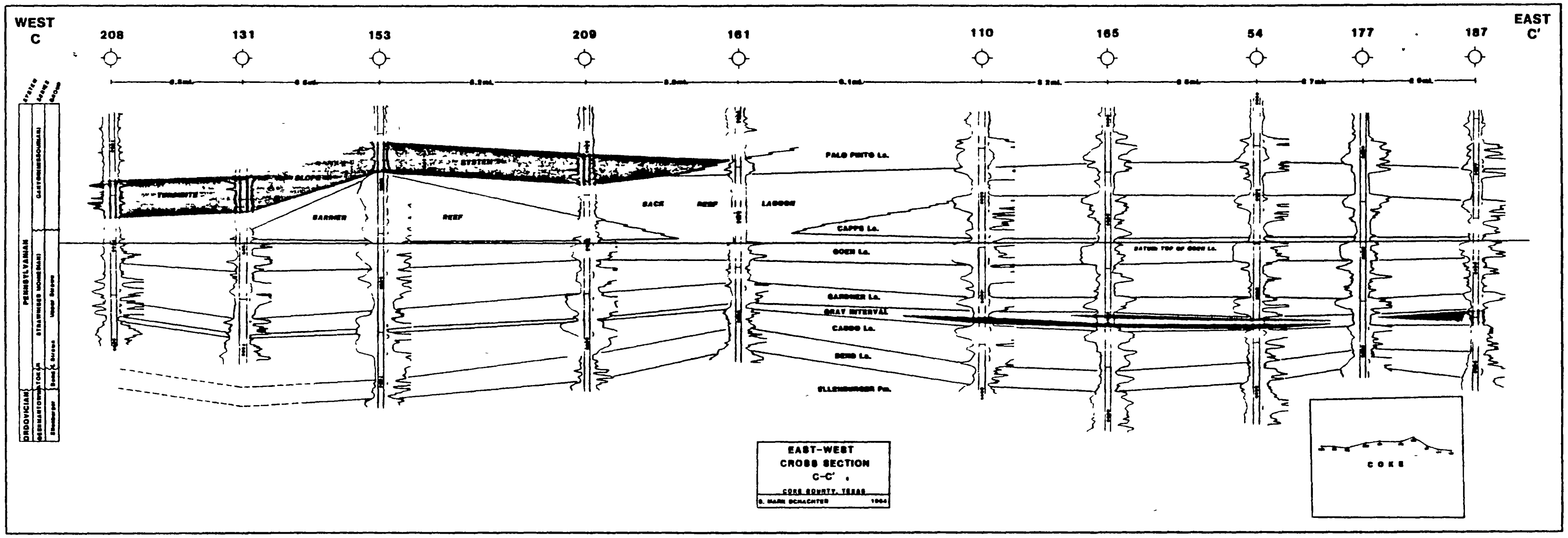

Figure 32. Northern Dip Cross Section C-C' Coke County

reef (lagoon) environment. Beyond the center of the county, proceeding westward, all limestones thicken and in some areas actually thicken drastically and form "reefal" limestones (Figure 32). Past these reefal limestones to the west the carbonates again become very thin and difficult to distinguish. Sandstones drape the carbonate reefs of the Capps. These sandstones appear to represent slope system turbidite sands. Whether these sands are equivalent to the Cross Cut Sandstone or possibly a Canyon or Cisco sandstone has not been determined. The Gardner-Gray Sandstone is present in the eastern one third of the county, but is extremely thin and poorly developed.

Southern Dip Cross Section

A second dip oriented (east-west) cross section (D-D') was constructed in the southern half of Coke County using ten electric logs (Figure 33). The Ellenburger Limestone was chosen as the datum for this cross section, because it was the only limestone present and identifiable over the entire county. This selection of datum raised some questions because the top of the Ellenburger is recognized as an unconformable surface. However, for the purposes of a stratigraphic cross section, and because there was no interest in total Ellenburger thickness, this datum poses no realistic difficulties.

All limestones on this cross section thicken toward the central part of the county. Further westward they form a

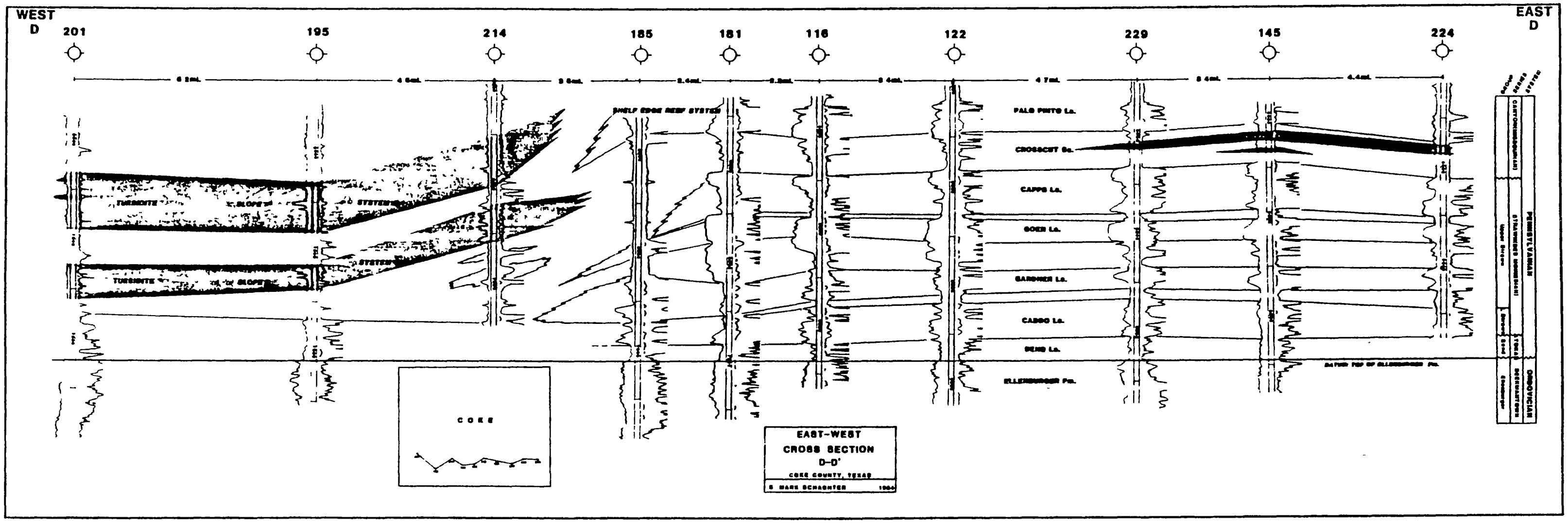

Figure 33. Southern Dip Cross Section D-D' Coke County

carbonate bank and then abruptly pinch out. This bank probably represents the fore-reef just east of the carbonate shelf edge. Again these carbonate banks are draped by turbiditic sandstones (Figure 33). These sandstone extend to the westernmost limit of the study area and appear to extend even further. Again it is necessary to emphasize the fact that the exact correlation of these sands is uncertain. There is no Gardner-Gray Sand present on this southern cross section (D-D').

Strike Cross Section

A strike oriented (north-south) cross section (3-3') was constructed in Eastern Central Coke County using eight electric logs (Figure 34). The datum for this cross section is the Goen Limestone, because it is easily correlated across the county.

All limestones are much thicker in the northern part of the county. In the southern part they become thinner and difficult to identify. There is no sand present on this cross section.

The Desmoinesian of Coke County appears to encompass several depositional systems. This conclusion is based upon structure maps and cross sections. The limestones of Coke County thicken to the west until they build into a fore-reef zone located just in back (east) of the shelf edge. Westward they pinch out except for three isolated build ups in the northern and central part of the county. Both the

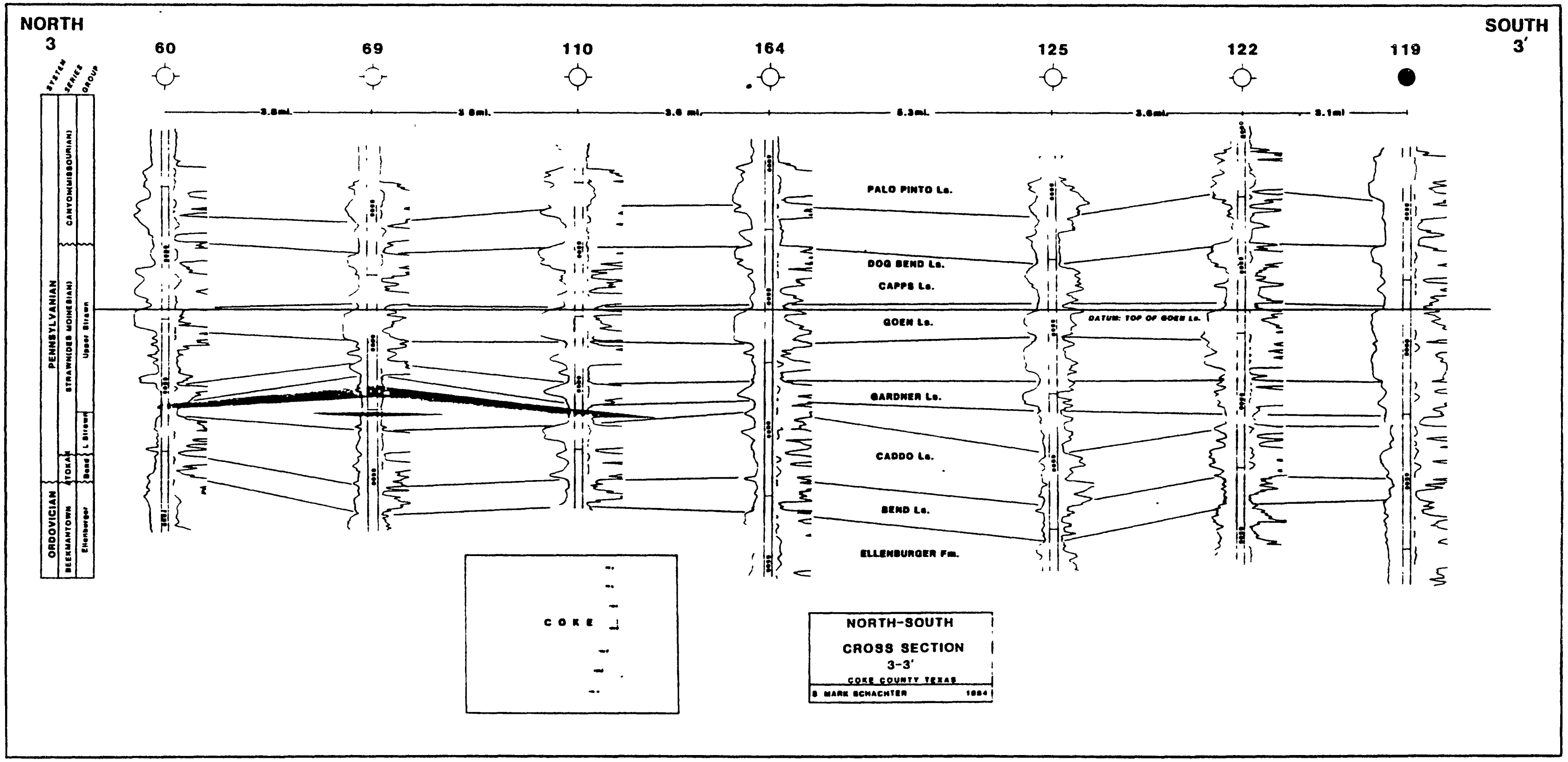

Figure 34. Strike Cross Section 3-3' Coke County

barrier reefs and fore reefs are draped by sands that appear to represent proximal turbidite facies as based on the location within the system and log character. This idea agrees with Galloway and Brown's slope-wedge sandstone facies reconstruction for the equivalent rock units to the north in Nolan County (Galloway and Brown, 1972). To the south, in Coke County, the Strawn sediments form thick build ups (in excess of five hundred feet) and then thin drastically. These limestones are then covered by turbidite sands in excess of one hundred-fifty feet. All available evidence suggests that West-central Coke County marks the location of the Eastern Shelf of the Midland Basin in the study area.

CHAPTER VI

DEPOSITIONAL ENVIRONMENTS

Introduction

The Upper Strawn open shelf depositional systems of Coke and Runnels Counties can be subdivided on the basis of geographic position into an inner and outer shelf (Cleaves, 1975). The inner shelf is a mixture of carbonate and clastic units. The clastic units within the inner shelf of the study area are the Gardner and Gray Sandstones. The major carbonate units within the inner shelf are the Gardner Limestone, Goen Limestone and Capps Limestone. The outer shelf is dominated by carbonates with very little clastic deposition. The dominant carbonate deposition is characterized by thick fore-reefs, barrier reefs and back reef areas. These units become very difficult to correlate vertically because all units above the Gardner-Gray Sandstone Interval merge and form massive limestone buildups extending well into the Canyon Group and exceed seven hundred feet in thickness.

Deltaic Models

Fisher (1969) classified deltas on the basis of constructional and destructional processes. He states that when constructional (progradational) processes are dominant over marine reworking (destructional) processes, these delta systems are classified as high-constructive deltas. When constructive and destructive processes are present simultaneously with the destructive marine influence being dominant in the formation of sandstone facies elements, the delta systems are classified as high-destructive deltas.

Brown (1972) noted that only high-constructive deltas have been recognized and documented within the Pennsylvanian of North-Central Texas. Because of this, only high-constructive delta models will be discussed further.

Fisher (1969) defined high-constructive deltas using the parameter of sand geometry. This allowed him to further subdivide high constructive deltas into elongate and lobate types.

High-Constructive Elongate Deltas

A modern example of a high-constructive elongate delta is the birdfoot lobe of the Mississippi Delta Complex (Figure 35). Elongate deltas in North-Central Texas exhibit similar geometry. They are characterized by extensive progradation, thick prodelta muds, and preservation of deltaic sands by compactional subsidence into the underlying muds (Brown, 1972).

Typical sedimentary structures associated with elongate deltas include laminated to contorted mud and silt within the prodelta facies. The distal channel mouth bar is

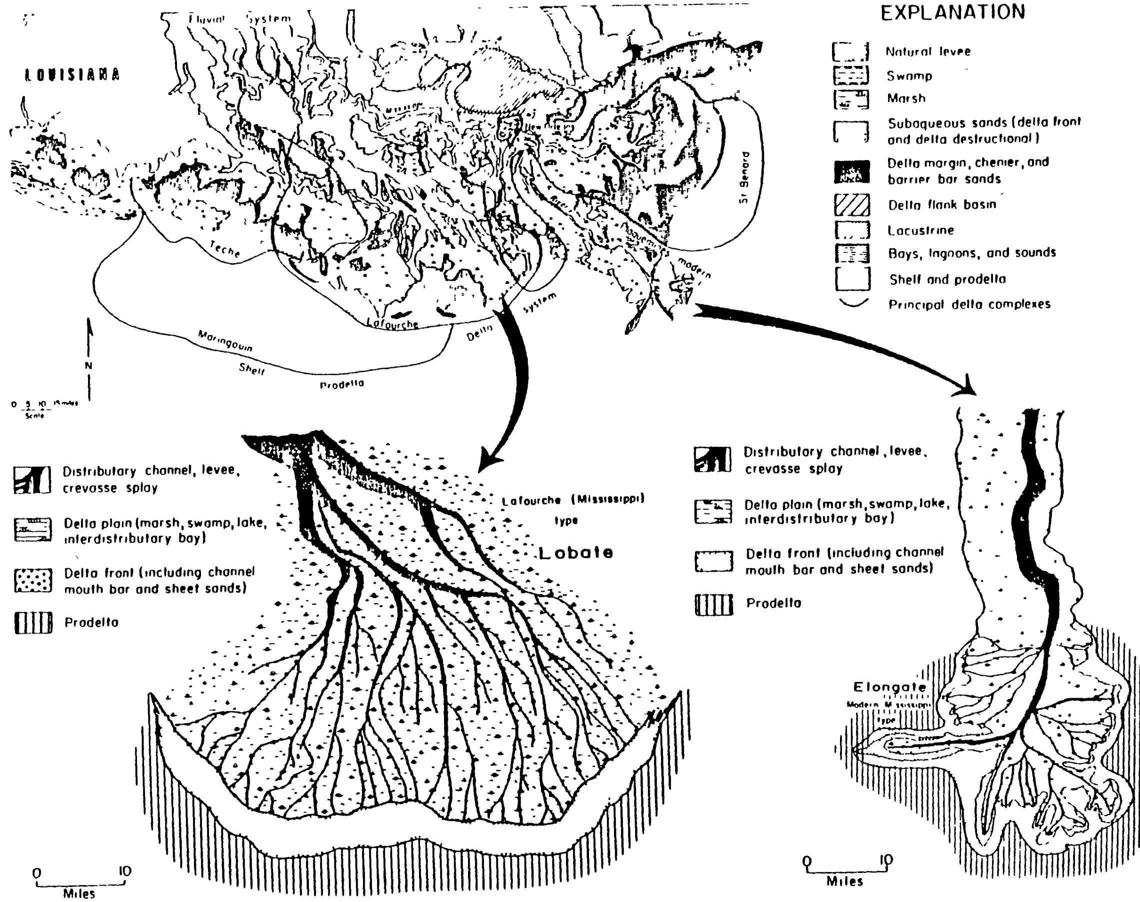

Figure 35. Plan View of Principal Depositional Environments, High Constructive Delta Lobes, Mississippi Delta (Fisher, 1969)

composed of highly contorted sands. The bar crest facies contains horizontal bedded sand with some trough cross beds. The delta plain is composed of mud, sand and coal, whereas the shelf is dominantly limestone. The elongate delta coarsens upward and may actually appear blocky within the channel mouth bar facies on a spontaneous potential log (Figure 36a).

High-Constructive Lobate Deltas

Modern examples of high-constructive lobate deltas are the modern Mississippi abandoned Lafourche (Figure 35), Teche and St. Bernard.

Typical sedimentary structures include laminated mud and silt within the prodelta facies. Within the delta front facies there may be contemporaneous slumping in some of the bedded sheets of the distal facies. Within the proximal delta facies there are rare troughs, horizontally bedded sand and some ripples. The delta plain is composed of mud, sand and coal, while the shelf is dominantly limestone. The lobate delta coarsens upwards gradually to a maximum coarseness within the proximal delta facies as seen on a spontaneous potential log (Figure 36b).

Cratonic Deltas

Cratonic deltas may assume either the elongate or lobate geometry. The cratonic delta however differs from the previous two systems in an absence of marine influences. A

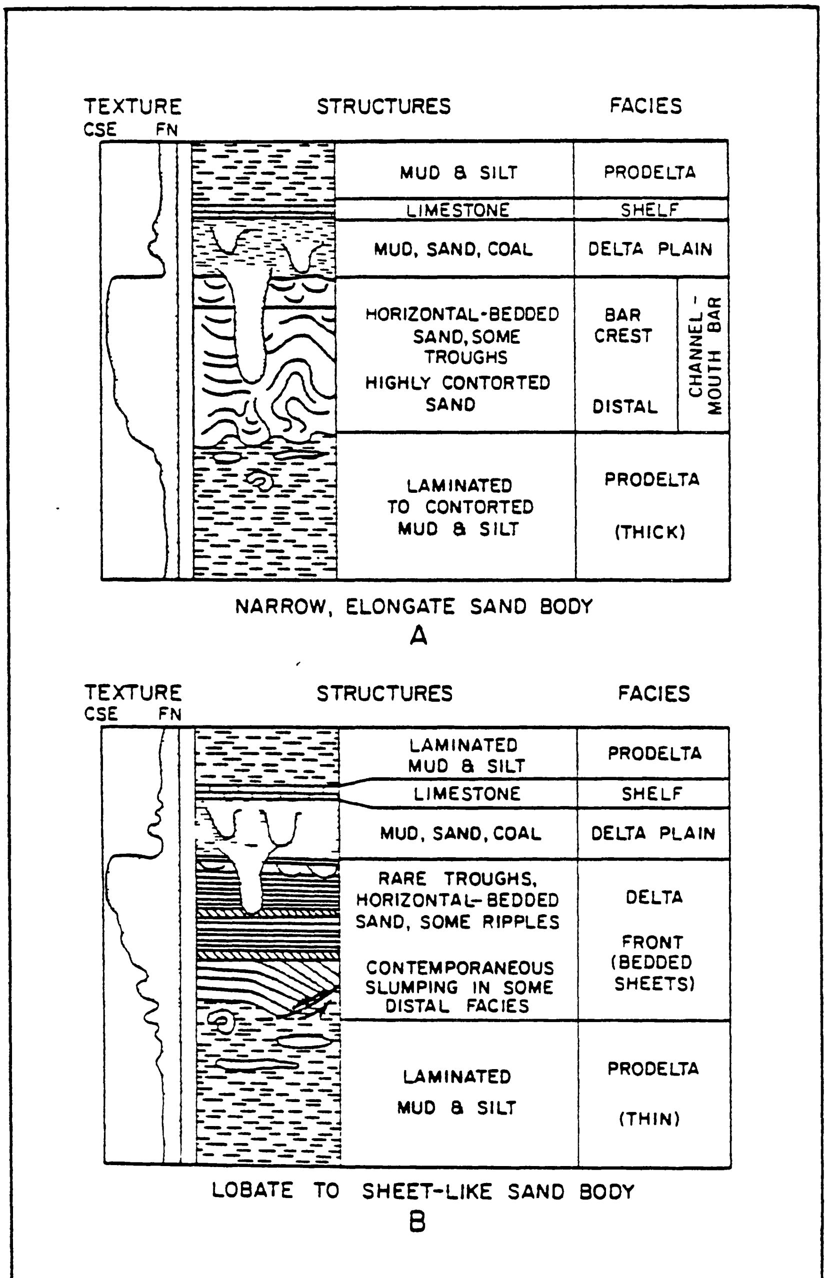

Figure 36. High Constructive Deltaic Vertical Sequences a) Elongate Delta b) Lobate Delta

cratonic delta builds across a stable platform and its distal most end terminates without being significantly influenced by marine processes. Also, the distributary channel erodes through the complete progradational sequence and is commonly the only coarse clastic facies element preserved in the sedimentary record.

Inner Shelf Systems

The two principal facies present within the inner shelf are terrigenous clastics and marine transgressive limestones (Cleaves, 1975). The inner shelf within the study area comprises all of Runnels County and part of eastern Coke County. The principal terrigenous clastic facies is the Gardner-Gray Fluvial Deltaic System which prograded across the inner shelf. The clastic facies is relatively thin and involves an elongate geometric form (Figure 21). Eventhough the classification of this system is made difficult due to its extreme distal nature, based upon the geometry displayed, and based on a similar high-constructive elongate delta system for the same interval in the West Tuscola Field of Taylor County (Shannon and Dahl, 1970) the Gardner-Gray Fluvial-Deltaic System would have to be considered the distal extremely of a high-constructive elongate cratonic delta.

Carbonate sedimentation within the inner shelf of Coke and Runnels Counties is characterized by thin transgressive limestones. The major transgressive limestones are the

Gardner, Goen, and Capps. These limestones become very thin in eastern most Runnels County as they interfinger with Strawn clastics. Further west, they thicken considerably as fluvial-deltaic processes are overcome by the increasing water depth on the western side of Concho Platform.

Outer Shelf Systems

Cleaves (1975) divided the limestone units within the outer shelf into three basic types:

1. Carbonate bank systems;
2. Carbonate Shelf-edge bank systems;
3. Pinnacle carbonate build-ups.

Within the outer shelf system of Coke County a distinct carbonate shelf-edge bank system is present. The recognition of a barrier reef-back reef lagoon system in addition to the carbonate shelf edge bank (reef) system noted by Cleaves in his study to the north will allow for a more accurate representation of the depositional systems present in Coke County along the Eastern Shelf of the Midland Basin during Late Desmoinesian Time.

Carbonate Shelf-Edge Reef Systems

The presence of a well defined carbonate shelf-edge reef system is illustrated in Figure 33). All major limestone units thicken westward toward the shelf edge, as indicated on the dip oriented cross section in southern Coke County (D-D'). Abruptly, at the delineated shelf edge the limestones thicken drastically and form carbonate reefs before pinching out. These build-ups have been referred to as "reefal" limestones for simplicity and consistency. Harrington and Hazelwood (1961) state

> As the word reef is tenaciously held in the vocabulary of the petroleum geologists it simply means a topographically expressed carbonate mass built in place with a rising sea-level (p. 358).

This shelf-edge reef system is present within Coke County along a north-south trend (Figure 30).

Barrier Reef-Back Reef Lagoon Systems

A barrier reef system has been delineated on the northern dip oriented cross section (D-D') in Coke County (Figure 32). It also appears on the three structure maps for Coke County (Figures 28, 29 and 30). This is merely the southerly continuation of a reef trend extending into Nolan County (Harrington and Hazlewood, 1961).

These carbonate build ups have been referred to as barrier reefs because of their separation from the contemporaneous shoreline (Strahler and Strahler, 1973) (Figure 37). These barrier reefs appear to have originated on a base of cherty limestone resting unconformably upon the Ellenburger Dolomite (Keplinger and Wanenmacher, 1950). They accrete vertically well into the Canyon Series where the crest of the reef is usually located (Figure 38).

The back-reef facies is not encountered until the Late Strawn (Capps Limestone) deposition at which time it appears

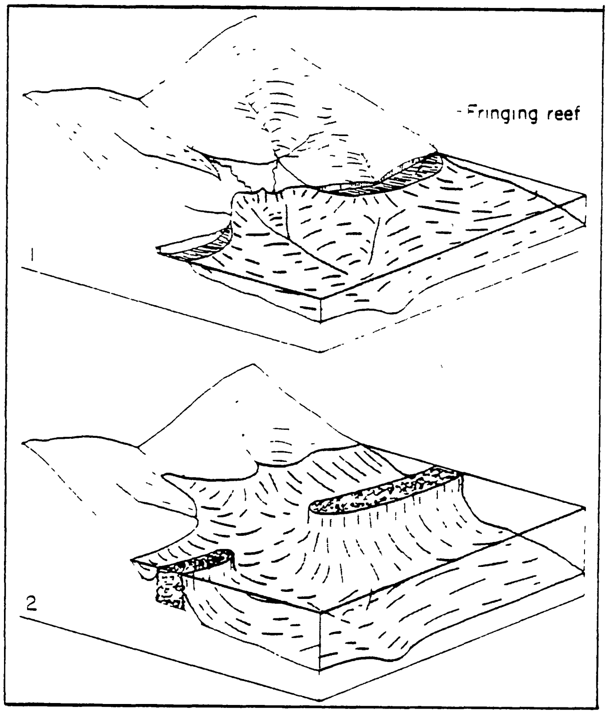

Figure 37. Linear Barrier Reef Formed by Submergence of a Landmass. 1) Fringing Reef Grows at Shoreline 2) Landmass is Submerged and Reef Grows Upward Thus Creating a Barrier Reef Separated From The Shoreline by an Elongate Lagoon (Strahler and Strahler, 1973)

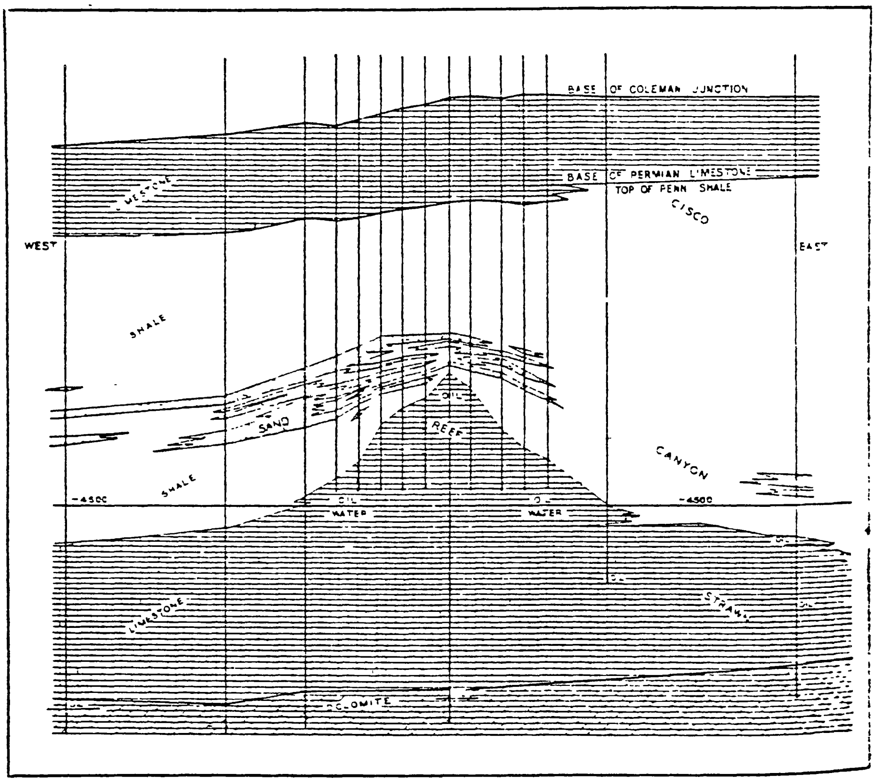

Figure 38. Section Through The North Snyder Pool in Scurry-Snyder Reef Area of Western Texas. The Trap is an Organic Reef of Canyon Age Built up From a Floor of Strawn Limestone (Keplinger and Wanenmacher, 1950)

behind the reef comprising part of the East Jameson Field and in front of the shelf-edge reef facies (Figure 30). The absence of the back-reef facies until Late Strawn Time is perhaps the result of the Eastern Shelf area being a carbonate ramp throughout most of Strawn time and not fully evolving into a shelf-edge until the end of the Desmoinesian.

Summary

Within the Upper Strawn of Coke and Runnels Counties there are five principal depositional systems which can be delineated using structure maps and stratigraphic cross sections. The systems present are:

1. Inner Shelf Systems
    a. A high-constructive elongate delta.
    b. Transgressive marine limestones.
2. Outer Shelf Systems
    a. Carbonate shelf-edge reefs.
    b. Carbonate barrier reefs.
    c. A back-reef lagoon.

These five depositional systems are the principal systems present within the Upper Strawn of Coke and Runnels Counties.

CHAPTER VII

REGIONAL SEISMIC STUDIES

Introduction

A regional seismic study was conducted in Coke County Texas. Runnels County was excluded from the seismic study due to a lack of available data. Thirteen seismic lines were originally obtained for evaluation in Coke County. After careful examination of structure maps and cross sections of Coke County the original number of thirteen lines was reduced to seven lines (Figure 39). Of the seven lines used, five were dip-oriented and two were strike oriented. The dip oriented lines were by far the most valuable because most significant depositional features are aligned parallel with strike. Because of this alignment a dip-oriented line tends to transect depositional features.

Velocity

Velocities were obtained from sonic logs in Coke County. This limited the number of studies performed due to the age of most wells in the county and due to the suite of logs run on each well. A well was selected approximately 1,000 feet from a seismic line that could be correlated with other

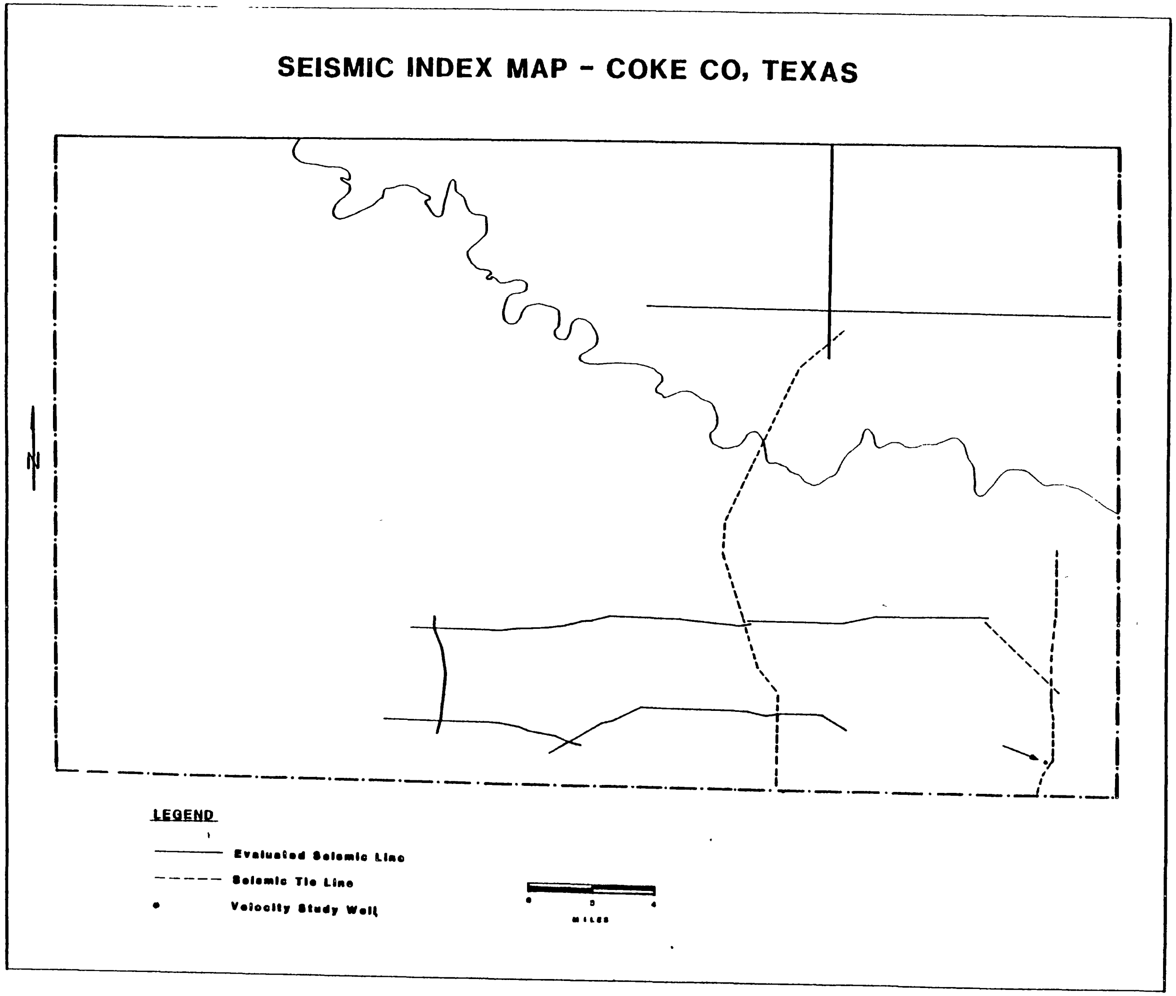

Figure 39. Seismic Index Map Coke County

lines of interest to the study (Figure 39). The close proximity of the selected well to the seismic line and the relatively flat datum present in most of the county posed little problem in terms of reflector identification on any of the correlated lines.

Principal Reflectors

Two principal reflectors were used to identify the study interval. Although neither reflector was located within the Upper Strawn, both were within an acceptable proximity to the interval of interest. The two reflectors used were the Palo Pinto Limestone and the Ellenburger Limestone (Figure 40). These two reflectors allowed for the effective bracketing of the Upper Strawn due to the Palo Pinto's position directly above the Upper Strawn and the Ellenburger's position just below the Caddo of the Lower Strawn.

A strong episode at .63 milliseconds was identified as the Palo Pinto Limestone. This was done using a nearby short-normal log and the synthetic seismogram seen in Figure 40. The second strong episode occurs at .75 milliseconds and was identified as the Ellenburger Limestone using the same process (Mr. Don Beck, personal communications, 1984).

It is assumed that the strength of these two reflectors is a direct result of their lithology and the lithology of the surrounding rock units. The Palo Pinto is usually separated from the Capps Limestone by a relatively thick shale section. Furthermore, the Palo Pinto is usually covered by

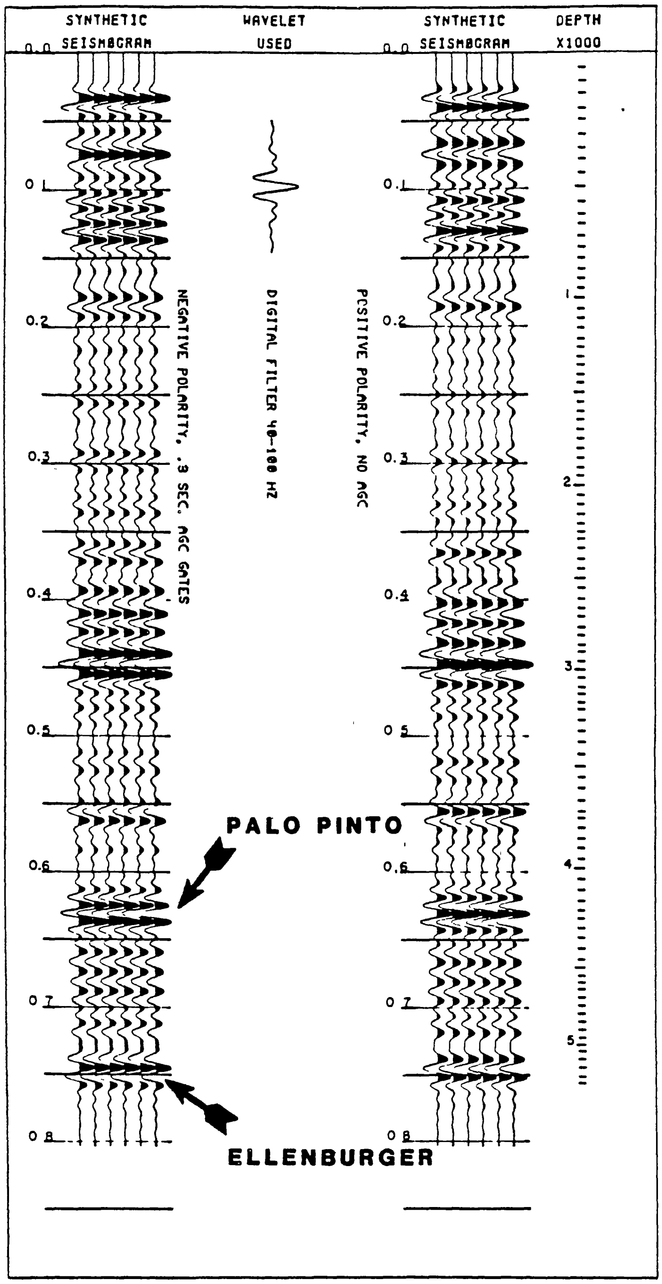

Figure 40. Synthetic Seismogram Showing Palo Pinto and Ellenburger Reflectors

a thick shale sequence. This creates the ideal situation for a strong reflection due to the difference in acoustic impedance between shale and limestone. The Ellenburger Limestone is a dolomitic limestone surrounded by very shaly limestone. Again this is a situation conducive to a strong reflector.

Structure and Stratigraphy

There is no apparrent structure discernable on any of the seismic lines. The line selected for the study that transversed the Fort Chadbourne Fault System showed no apparent faulting. This is probably due to the location of the line. It does cross mapped fault planes but unfortunately it crosses the planes in areas of minimal displacement. If the displacement was of greater magnitude the possibility of detection by seismic would surely increase markedly.

Stratigraphic features are present on two lines that are dip oriented and traverse the Upper Strawn shelf edge (Figures 41 and 42). The features recognized are:

1. A shelf-edge Palo Pinto reef;
2. A Strawn shelf edge;
3. A Canyon or younger sediment onlap onto the Strawn shelf.

These features were identified by first evaluating the seismic line on which they appeared. Then the line was compared with the southern, dip-oriented cross section (D-D') in Coke

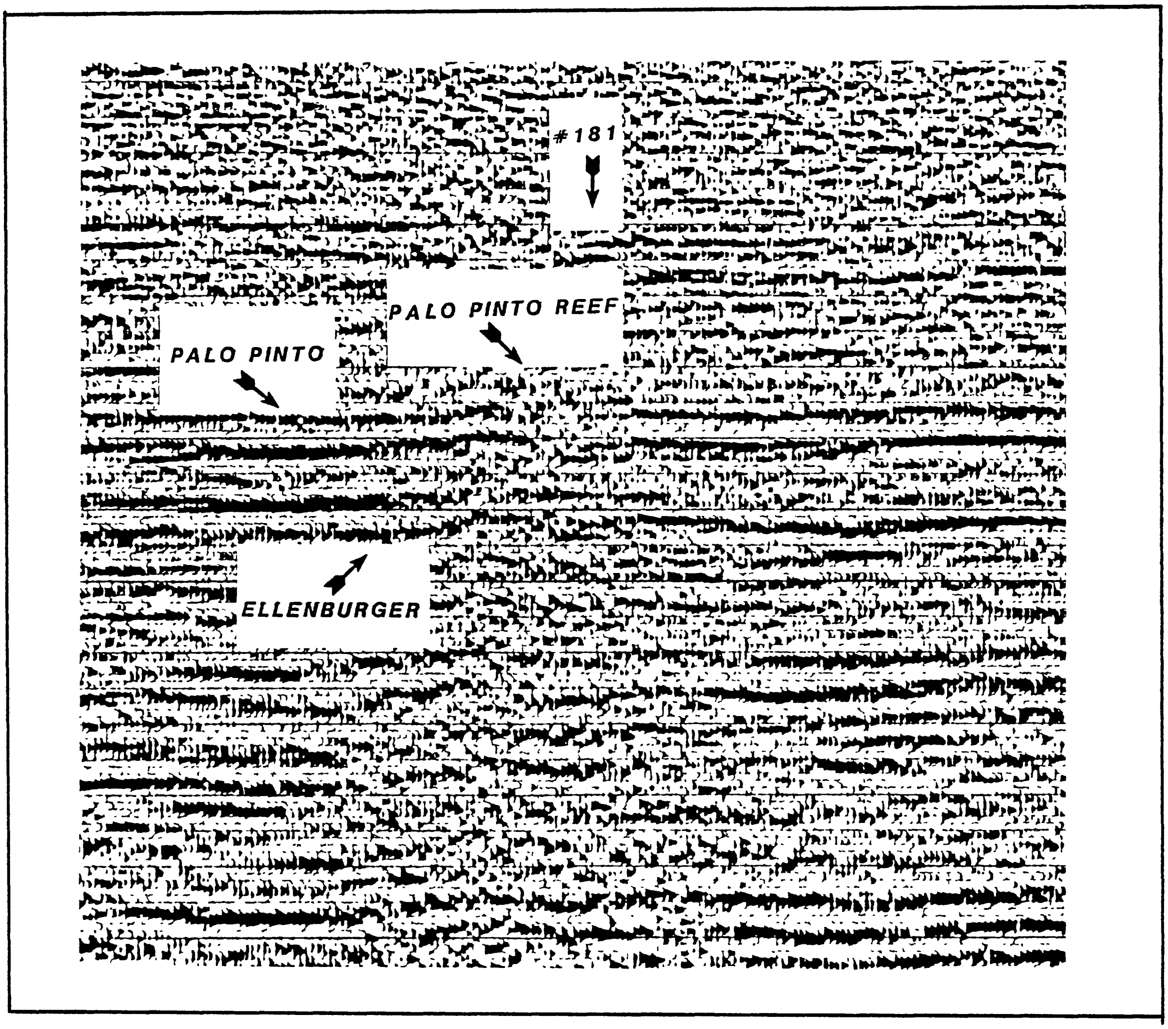

Figure 41. Selected Area of Seismic Line Showing Identified Palo Pinto Reef in Coke County

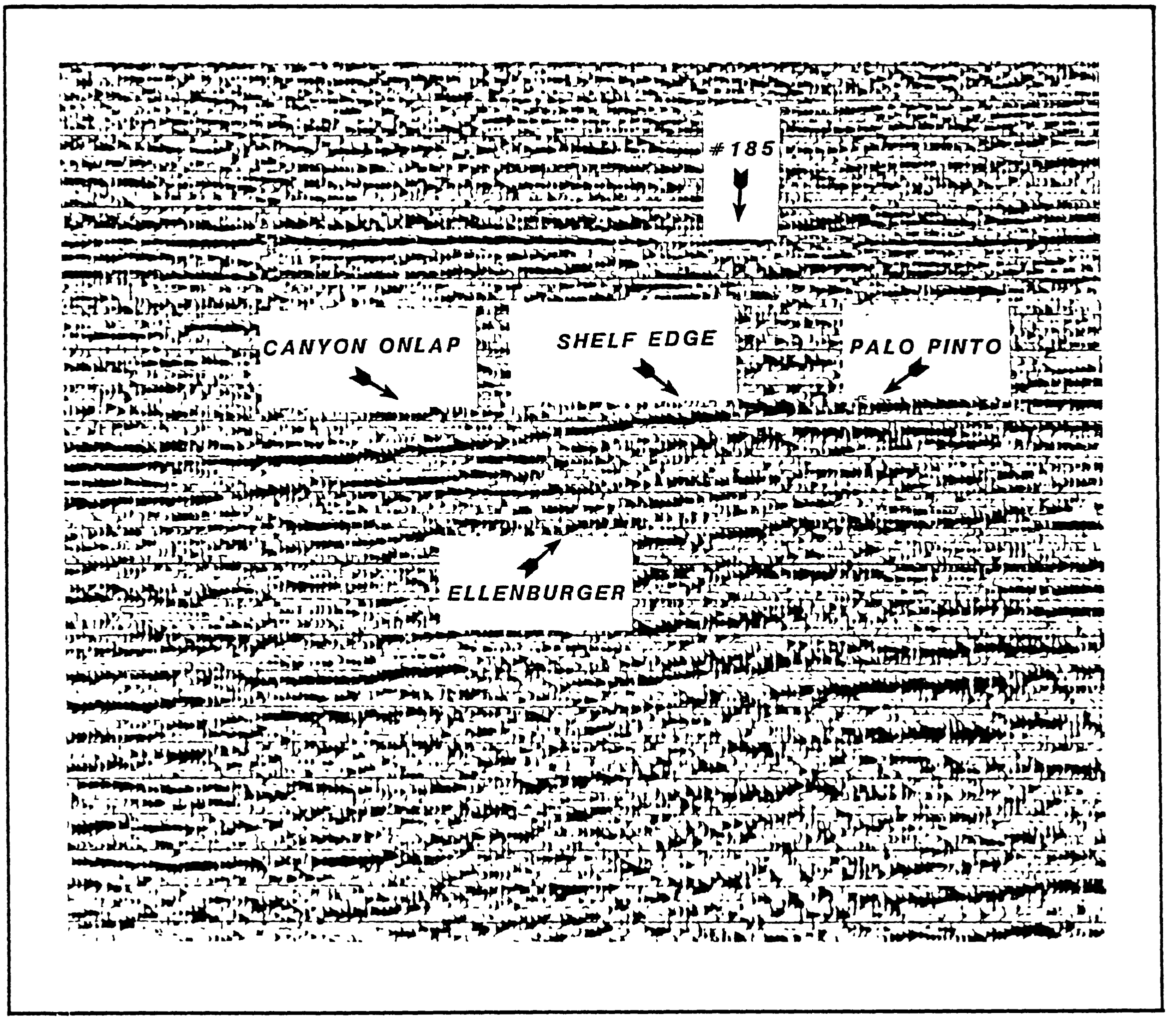

Figure 42. Selected Area of Seismic Line Showing Location of Strawn Shelf-Edge With Onlapping Canyon Sediments

County. The location of the features agreed well. The shelf-edge reef system is identified by recognizing the absence of the Palo Pinto Reflector. The scattered energy appears in the form of a hemispherical pattern (Figure 41). The diffraction of the data in the area of the reef is probably the result of the reefs steep sides. If the flanks of the reef were not as steep perhaps a broad structure would be decernable. The Strawn Shelf Edge is identified by the sudden and abrupt increase in dip to the west past the shelf-edge reef system (Figure 42). The last feature identified was the onlap and apparent pinch out of Lower Canyon sediments against the shelf edge (Figure 42). It should also be noted that the shelf edge reef system does not become well developed until the Latest Desmoinesian. The crest of the reef system also appears to carry well into the Canyon. These systems are accreting vertically with little or no progradation to the west. Careful examination of the shelf-edge area will reveal a carbonate ramp system until Middle Upper Strawn Time. The true shelf edge does not develop until Canyon time as evidenced by the Palo Pinto reflector.

Conclusion

Because of the good correlation between the dip-oriented seismic lines and the dip-oriented cross sections transversing the shelf-edge in Coke County the confirmation of an Upper Strawn Shelf-Edge and Shelf-Edge Reef System can be further substantiated.

CHAPTER VIII

PETROLEUM OCCURRENCE

Introduction

The fact that every major unit within the Upper Strawn of Coke and Runnels Counties produces hydrocarbons is indicative of the prolific production within this two county area. Production is from both limestone and sandstone. There is however, a marked increase in the occurrence of carbonate reservoir rock versus clastic rock westward across the study area. Most traps are predominantly stratigraphic in nature with minimal or no structural enhancement. There is only one significant area of structural entrapment. That area is along the north-south trending Fort Chadbourne Fault System. The distribution of fields and production statistics for Runnels and Coke Counties may be seen in figures 43 and 44 and Tables II and III.

Structural Traps

Anticlinal Structures

Anticlinal structures are the most common structural traps within Coke and Runnels Counties. Although these traps are the most common, they certainly are not the most

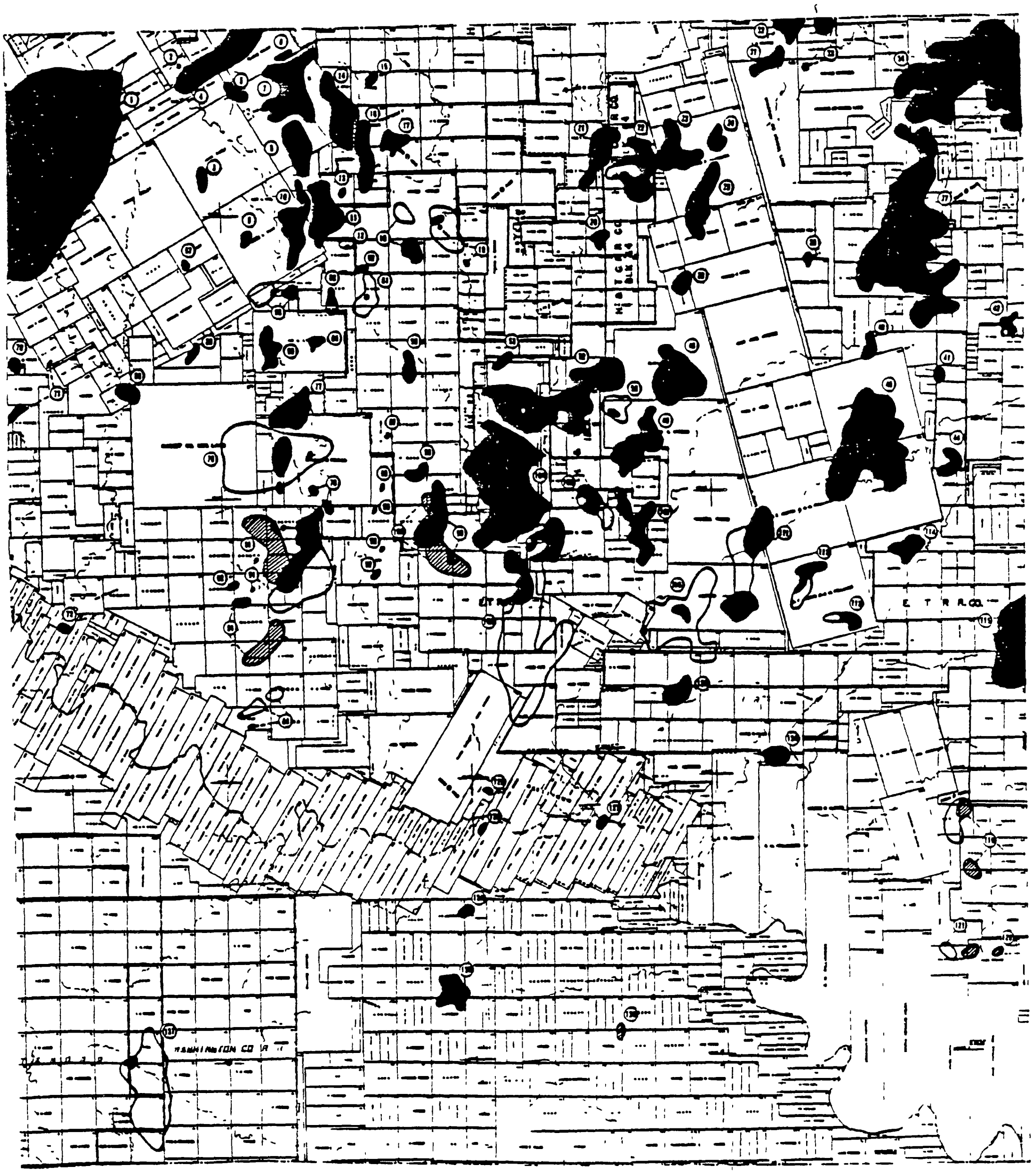

Figure 43. Location of Major Strawn Fields in Runnels County (Abilene Geological Society, 1979)

TABLE II

PRODUCTION STATISTICS FOR RUNNELS COUNTY FIELDS

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Formation	Lithology	# of Wells	Disc Date	Field Status
1	Fort Chadbounre	51,945	5,970	Odm	L	289	2-50	
2	Fort Chadbourne, N. E.	34		Odm	L	1	7-49	IN
3	Harkins	124		Grd	S	6	3-57	IN
4	Fort Chadbourne	303		UFry	S	4	9-56	IN
4	Fort CHadbourne	543	178	Gry	S	22	1-50	
5	Sanrob, West	54		Cp	L	6	4-62	
6	Sanford, North	91	126	UFry	S	2	6-62	
7	Sanford	2,261		UFry	S	79	9-54	IN
8	Pace	1,055		UFry	S	19	11-52	IN
9	Bays	335		UFry	S	9	6-52	IN
9	Bays	513		Gn	L	4	6-52	IN
10	Deike	122	282	UFry	S	8	12-75	
10	Deike	751	104	Gn	L	10	1-74	
11	Jim Adams	1,140		UFry	S	36	1-50	
11	Jim Adams	208		Gn	L	3	11-49	
12	Paul Thomas	94		Gn	L	1	5-72	
13	Big A	47		UFry	S	1	3-74	
14	Sueise	1,740		UFry	S	45	5-52	IN
14	Sueise	84		Grd	S	4	5-52	IN
15	Wingate	56		Grd	S	4	7-56	IN
16	Lloyd	699	1,141	UFry	S	18	3-50	IN
16	Lloyd	85		Grd	S	2	5-52	
17	Mitchell	348		UFry	S	11	11-52	IN

TABLE II (Continued)

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Formation	Lithology	# of Wells	Disc Date	Field Status
18	Winters, North	399		Gn	L	3	1-54	IN
18	Winters, North	308		Grd	L	3	5-54	IN
18	Winters, North	123					1-54	
19	Winters, North	38		Grd	S	2	2-63	IN
20	Kendrick	96		Grd	S	4	4-55	
21	Kuper	43		Grd	L	6	5-65	
21	Kuper	324	624	Grd	S	13	7-64	
22	Briley	299	247	Grd	S	22	256	
23	Red Flat	535	538	Grd	S	11	5-57	
24	Red Flat, Northeast	146	472	Grd	S	5	3-64	
25	Briley, Southeast	402	1,463	Grd	S	18	12-65	
26	Cold Duck	67	483	Grd	S	2	1-69	
31	Nevins, Southwest	357	673	Grd	S	7	3-61	IN
32	Nevins	1,338	1,392	Grd	S	20	1-57	
33	Nevins, East	175	183	Gry	S	5	9-61	
34	Goldsboro	(See Coleman County)						
37	Cree - Sykes	17,041	680	Grd	S	214	7-50	
39	Cree - Sykes, West	75		Grd	S	3	3-60	IN
40	Vanderlaan - Freedman	43		Grd	S	5	2-51	IN
41	Henson	51		Jen	S	3	8-55	IN
42	Wilmalee	69	535	Gry	S	6	1-62	
44	Crews, South	59		Jen	S	4	1-53	IN
45	Crews, South	1,303		LFry	S	30	2-52	IN

TABLE II (Continued)

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Forma-tion	Lithol-ogy	# of Wells	Disc Date	Field Status
45	Crews, South	2,180		Grd	S	58	3-52	IN
48	Nora	40		Gn	L	2	11-54	
48	Nora	1,729	125	Grd	S	36	10-50	IN
49	Jim Burt	77		Gn	L	?	8-53	
49	Jim Burt	113		Grd	S	2	9-49	
49	Jim Burt	337		Cad	L	16	9-52	IN
50	Messenger	45		Grd	S	2	5-52	
52	Winters	618				?	3-50	
52	Winters	717		Jen	S	12	11-50	
52	Winters	131		Gn	L	6	8-54	
52	Winters	583	743	Grd	L	?	3-53	
52	Winters	557	275	Cad	L	30	1-52	
53	Winters, Northwest	121	118	Jen	S	3	3-66	
58	Howerton	398		Gn	L	4	6-67	
61	Fennell	157		Gn	L	2	5-56	IN
62	J. P. D.	115		Gn	L	4	7-75	
63	Poe	492		Gn	L	2	3-52	
64	Dorman	485		Gn	L	6	6-61	
65	Dorman, West	131		Gn	L	3	3-76	
65	Dorman, West	72		Jen	S	2	2-76	
66	Wilmeth, Southeast & NAM	76		UFry	S	5	1-61	
67	Overman	88		Grd	S	2	6-60	IN
68	Ash	13	11	Grd	S	2	3-77	
69	Kirkham	64		Grd Grd	L S	3 1	4-62 4-62	

TABLE II (Continued)

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Forma-tion	Lithol-ogy	# of Wells	Disc Date	Field Status
70	Pearl Valley	25		Grd	S	3	7-59	
71	Pearl Valley	37		Jen	S	6	7-59	IN
72	Lee - Humphrey	84		Cad	L	2	9-52	IN
76	Norton, West	662		LFry	S	15	3-54	
76	Norton, West	61		Gn	L	3	7-56	
76	Norton, West	39		Cad	L	2	1-60	IN
77	Norton, North	94		Cp	L	5	2-60	IN
77	Norton, North	365		LFry	S	6	10-54	IN
77	Norton, North	179		Gn	L	3	4-56	
77	Norton, North	218		Jen	S	6	2-56	
77	Norton, North	641		Grd	L	17	7-55	
77	Norton, North	158		Gry	S	3	9-56	
78	Norton, East	249		Gn	L	5	5-56	IN
78	Norton, East	191	107	Grd	S	3	2-56	
81	Motley, North		8,433	Odm	L	13	9-59	
82	Motley, West		1,102	Odm	L	1	3-61	IN
84	Motley	19		Odm	L	2	6-60	IN
84	Motley	44		Cad	L	7	1-55	IN
91	Motley, North	630		Gn	L	8	8-59	
91	Motley, North	45	223	Cad	L	11	10-59	
92	Oakes	87		Gn	L	2	10-67	
93	Tyree	82		Gn	L	1	3-51	IN
95	Hollekirk (Capps)	47		Cp	L	1	4-57	IN
96	Hollekirk (Goen)	78		Gn	L	1	5-57	IN
97	J. A. D.	57		Gn	L	1	10-68	IN

TABLE II (Continued)

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Forma-tion	Lithol-ogy	# of Wells	Disc Date	Field Status
98	Chayo	77		Cp	L	4	1-63	
98	Chayo	3		Gry	S	1	2-77	
99	Winters, Southwest	3		Gn	L	1	12-77	
99	Winters, S. W. & Ballinger	162	103	Grd	L	14	5-57	
100	Winters, Southwest	50	18,134	Gry	S	11	7-60	
102	Ballinger	400		Grd	L		2-56	
102	Ballinger	115		Grd	S		6-55	IN
104	Dick Richardson; Ballin-ger, N. W.; & H. R. O.	518	382	Cp	L	22	6-57	
104	Dick Richardson	1,217	1,596	Grd	L	65	10-62	
104	Dick Richardson	269	317	Grd	S	12	10-62	
105	Andergram	76		UFry	S	3	9-58	
105	Andergram	94		Jen	S	4	6-58	
105	Andergram	105		Grd	S	4	6-58	
107	Elm Creek	57	535	Jen	S	2	8-58	
107	Elm Creek	426	351	Grd	S	22	2-50	
110	Beddo;Beddo,N.;&Florance	1,377[1]		Gn	L	50[1]	1940	
110	Beddo;Beddo,N.;&Florance			Grd	S			
111	Lindemann	107		Gn	L	7	6-54	
111	Lindemann			Jen	L			
111	Lindemann	235		Grd	S	10	7-52	
112	Ashton	70		Grd	S	9	10-51	
113	Loco Rico	41	169	Grd	S	4	7-75	
114	Wico	27		Jen	S	2	5-66	
114	Wico	97		Grd	S	5	9-65	

TABLE II (Continued)

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Formation	Lithology	# of Wells	Disk Date	Field Status
115	Burt - Ogden - Mabee	(See Coleman County)						
119	Hollow Creek	7	928	Grd	S	3	8-70	
120	Midstates		205	Gn	L	1[1]	4-76	
121	Love		133	Fry	S	3	1-76	
124	Cindy Kay	61		Grd	S	8	3-61	IN
125	Hall	159		Grd	S	6	7-53	IN
127	Ballinger, South		243	Cp	L	1	5-59	IN
129	Ballinger	52		Grd	L	2	11-47	IN
132	Big Ed	35		Grd	L	2	3-73	IN
134	Rowena, North	36		Grd	L	3	9-62	
135	Rowena	3,504	649	UCp	L	14	2-55	
135	Rowena	227		LCp	L	4	4-57	
135	Rowena	142		Jen	L	3	3-59	IN
135	Rowena		238	Grd	L	1	1-68	IN
136	T. J. C.		196	Cp	L	2	3-77	
137	Urban, West	41		Grd	L	2	11-62	

1 Production from Cisco, Canyon, & Strawn undifferentiated - 1,377,000 P. O. & 40 Wells Total

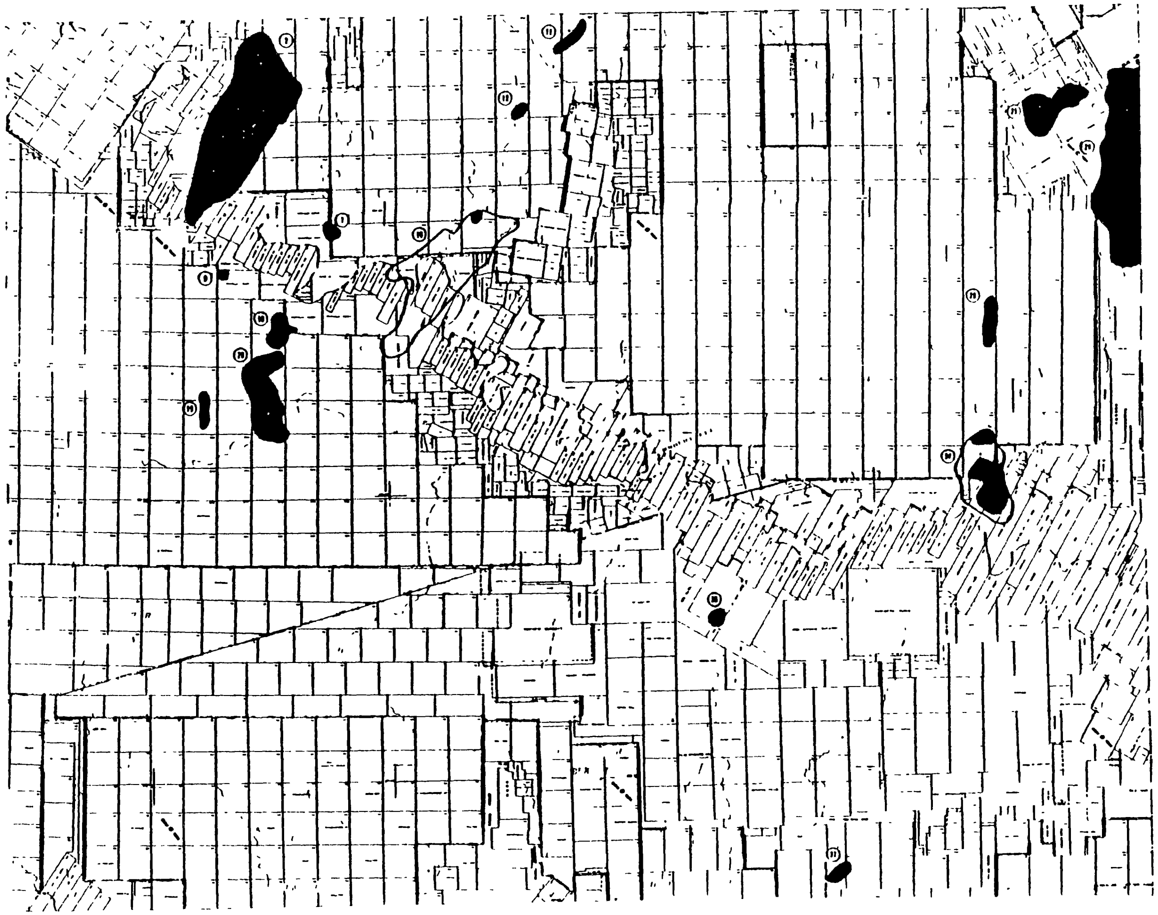

Figure 44. Location of Major Strawn Fields in Coke County (Abilene Geological Society, 1979)

TABLE III

PRODUCTION STATISTICS FOR COKE COUNTY FIELDS

No.	Field	Thousand Barrels Oil	Million Cu. Ft. Gas	Formation	Lithology	# of Wells	Disc Date	Field Status
2	Jameson Reef[1]	41,367		Reef	L	152	12-46	
7	Lygay, East	1			L	2	6-58	IN
9	Lygay, South	83		Odm	L	1	8-48	IN
11	Arledge	167		Odm	L	8	1-48	
12	San Beneto	42		Odm	L	2	6-48	
16	IAB Menielle Reef	7		Odm	L	2	6-57	
18	Frank Pearson	464	4,133	Reef	L	10	2-70	
19	Millican, West	99			L	4	12-67	
20	Millican Reef	6,571	11,983+	Reef	L	37	11-48	IN
25	Fort Chadbourne, West	237		Gn	L	2	4-51	
25	Fort Chadbourne, West	144		Grd	L	3	3-57	
25	Fort Chadbourne, West	1,827		Grd	S	18	9-49	
26	Fort Chadbourne	379	659	Grd	L		3-54	
26	Fort Chadbourne, North	212	591	Gry	S		7-63	
26	Fort Chadbourne	(See Runnels County)		Odm	L			
28	Rawlings	6,308		Gn	L	5	2-53	IN
28	Rawlings	357		Jen	L	3	4-58	
28	Rawlings	695		Grd	L	6	6-52	IN
34	Bronte	1,693		Cp	L	13	8-52	
34	Bronte	6,209	18,761+	Gn	L	34	2-52	IN
				Grd	S	4	6-52	
36	Weaver Ranch	70		Cad	L	1	4-56	
37	Schuch	27		Cad	L	2	9-70	

1 Production from Canyon & Strawn - undifferentiated - 41,367 Bbls. Oil Total

effective. Very few of the anticlinal traps are commercially productive unless combined with stratigraphic or other structural trapping mechanisms. The Jim Adams Field, eight miles northwest of Runnels County is a typical example.

> The Field is a small reef situated on the eastern flank of a low anticlinal fold. Although the Field is situated on a positive structural feature development depends on the presence and character of the pay zone rather than structural elevation (Simons, 1952, p. 45) (Figure 45).

Faults and Faulted Anticlines

Faults and faulted anticlines are significant traps in the study area. In the north-south trending Fort Chadbourne Fault system there are faulted anticlinal structures which are productive. An example is the Rawlings Field located four miles north and one mile west of Bronte, Texas in north eastern Coke County. The anticlinal structure is a north-south asymmetrical anticlinal ridge that is faulted on its eastern flank (Ayers, 1945) (Figure 46). The eastern bounding fault is considered the principal trapping mechanism within the Rawlings Field, with the positive structure being of secondary importance.

Stratigraphic Traps

Producing stratigraphic traps within the Strawn of Coke and Runnels Counties are numerous. This is due in part to their prominance and the large size of some of these traps. The stratigraphic traps within the study area can be

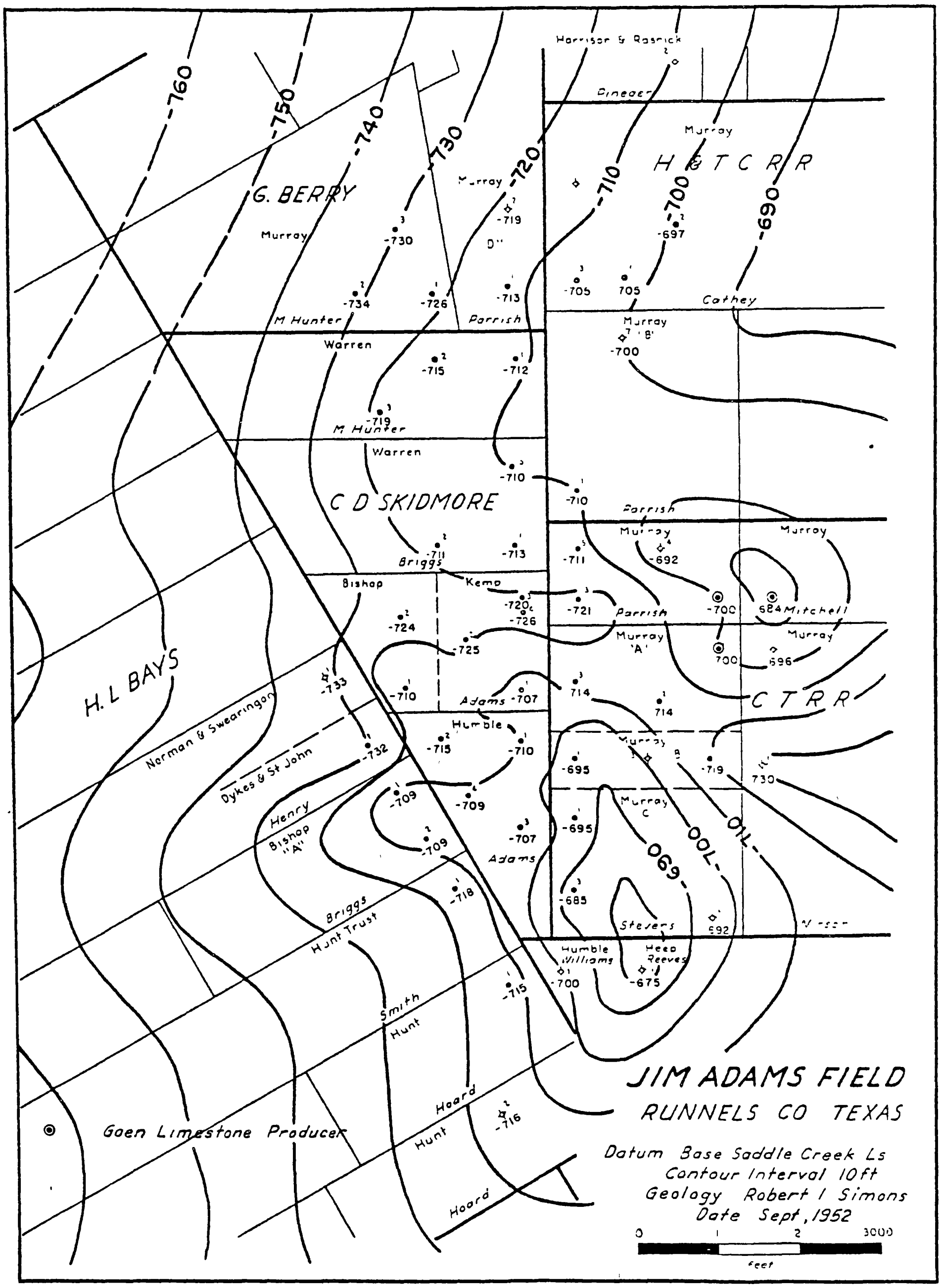

Figure 45. Jim Adams Field Runnels County Showing Secondary Importance of Positive Structure and Primary Importance of Pay Zone Thickness

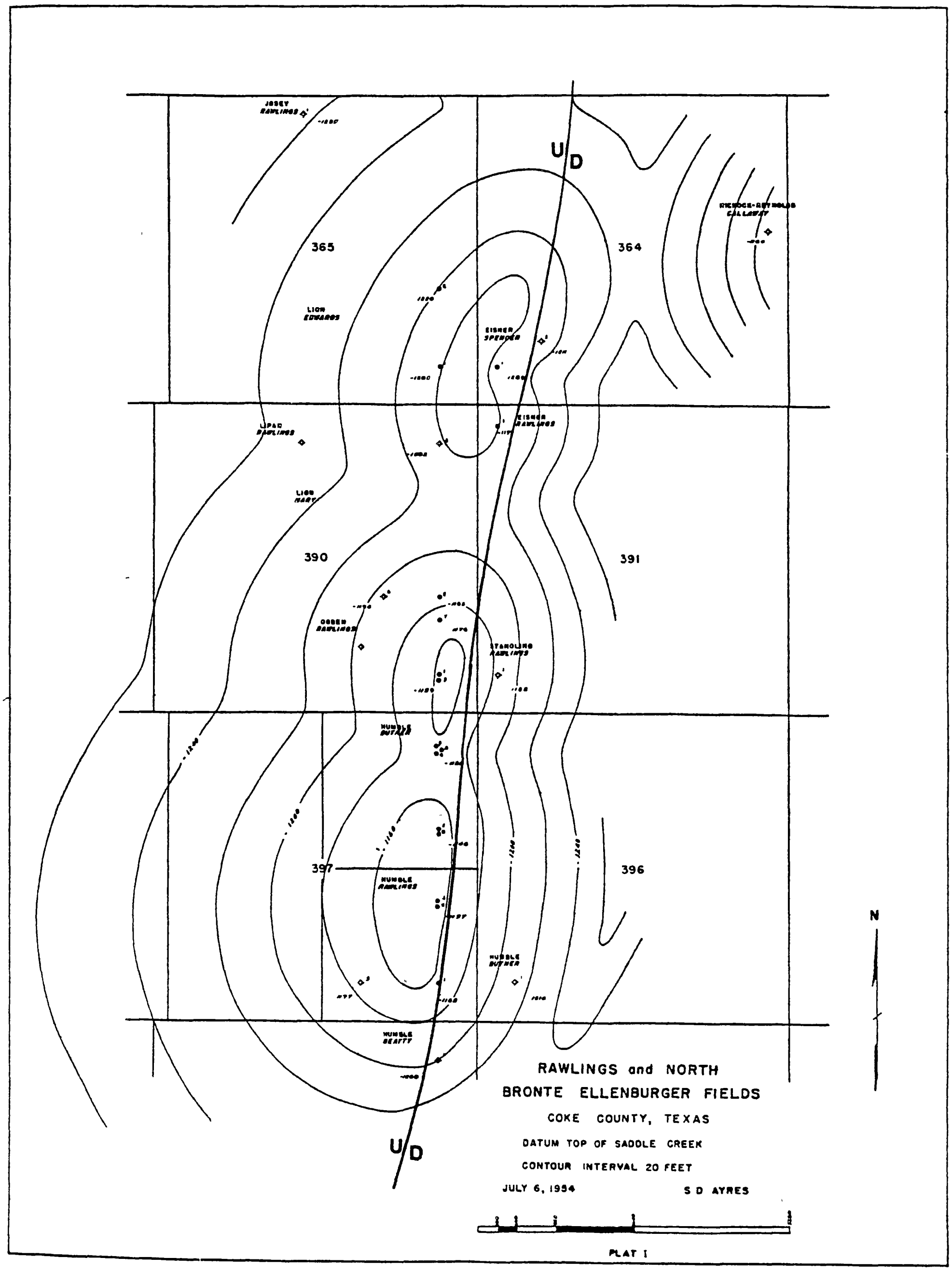

Figure 46. Structure Map of Rawlings Field and Approximate Location of Fault Controlling Production

classified according to Cleaves' earlier work on the basis of:

1. Abrupt facies changes or sandstone pinchout;
2. Porosity/permeability pinchouts within sandstone facies;
3. Structural closure in reservoir facies as caused by differential compaction;
4. Primary or diagenetic porosity and permeability in carbonate facies.

Abrupt Facies Change or Sandstone Pinchout

The stratigraphic trap which results due to a sandstone pinchout is probably the direct result of a lateral or vertical facies change. An example of a lateral change would be the transition from a permeable delta sandstone to an impermeable prodelta mudstone (Cleaves, 1975). An example of a lateral and vertical change would be the transition from an impermeable delta front sandstone to a delta plain mudstone (Cleaves, 1975). The Morris-Sykes Field in Runnels County is just such a stratigraphic trap.

> Oil accumulation appears to be bounded on the west, at least to some degree, by down-dip pinch-out of sands. Accumulation is terminated on the south and southwest by a shaling-out of reservoir rock. The up-dip or east end of the Field, also bounded by a sand pinchout, contains a gas cap (Haskins, 1952, p. 51).

Although such traps are subtle, their significance can not be overlooked. The possibility of locating a thin fluvial or deltaic sand unit must be considered at all times.

The possibility is greatly reduced however, without knowledge of fluvial and deltaic depositional processes and facies distribution.

Permeability/Porosity Pinchouts

This type trapping mechanism involves a modification of the original porosity, permeability or both. This is usually the result of a diagenetic process. An example would be the cementation at the top of a deltaic channel-mouth bar or distributary channel deposit by calcite. This would effectively act as a seal against the migration of hydrocarbons by reducing porosity and or permeability (Cleaves, 1975). The South Crews Field seems to have such a permeability barrier.

> There is strong evidence of a permeability barrier across the north end of the most easterly sandstone lense because even though the sandstone is present, the tests drilled there recovered gas and some water. Structurally, the sandstone is above the oil-water contact, established in the wells to the south, and below the gas-oil contact. However, production tests on these wells affect the reservoir pressure of those wells producing from the lense to the south, the assumption being that the barrier is impermeable to oil, yet permeable to gas and water (Lawless and Webber, 1956, p. 50).

Compactional Structural Closure

This type stratigraphic trap is the result of differential compaction of sediment over less compactible facies (Cleaves, 1975). This situation is encountered in a sandstone unit seven hundred and fifty feet above the Strawn

Limestone reef composing the Millican Field in Coke County (Figures 47 and 48).

> There seems to be little evidence to indicate that the structure found above the reef is other than the result of differential compaction and settling of sediments deposited subsequent to the formation of the reef (Bonifield, 1950, p. 35).

Porosity/Permeability Variations in Carbonate Facies

This type stratigraphic trap results in or around carbonate facies (Cleaves, 1975). Carbonate depositional systems that often display these porosity and permeability variations are interior carbonate reefs, shelf edge reefs, pinnacle reefs and barrier reefs (Cleaves, 1975).

Cleaves (1975) noted the significance of these carbonate build ups as stratigraphic traps because they are virtually surrounded by less permeable mudstone and shale in many cases. The Millican Field in west-central Coke County is a carbonate buildup surrounded by less permeable mudstone that acts as a seal for hydrocarbons (Figure 32).

Exploration Prospects

Because oil and gas exploration has been ongoing for well over one half century in this area, the exploration geologist must assume a more careful stratigraphic approach. It is safe to say there are no large structural or stratigraphic reservoirs left to discover in Coke and Runnels Counties. Obviously this is why the largest oil companies

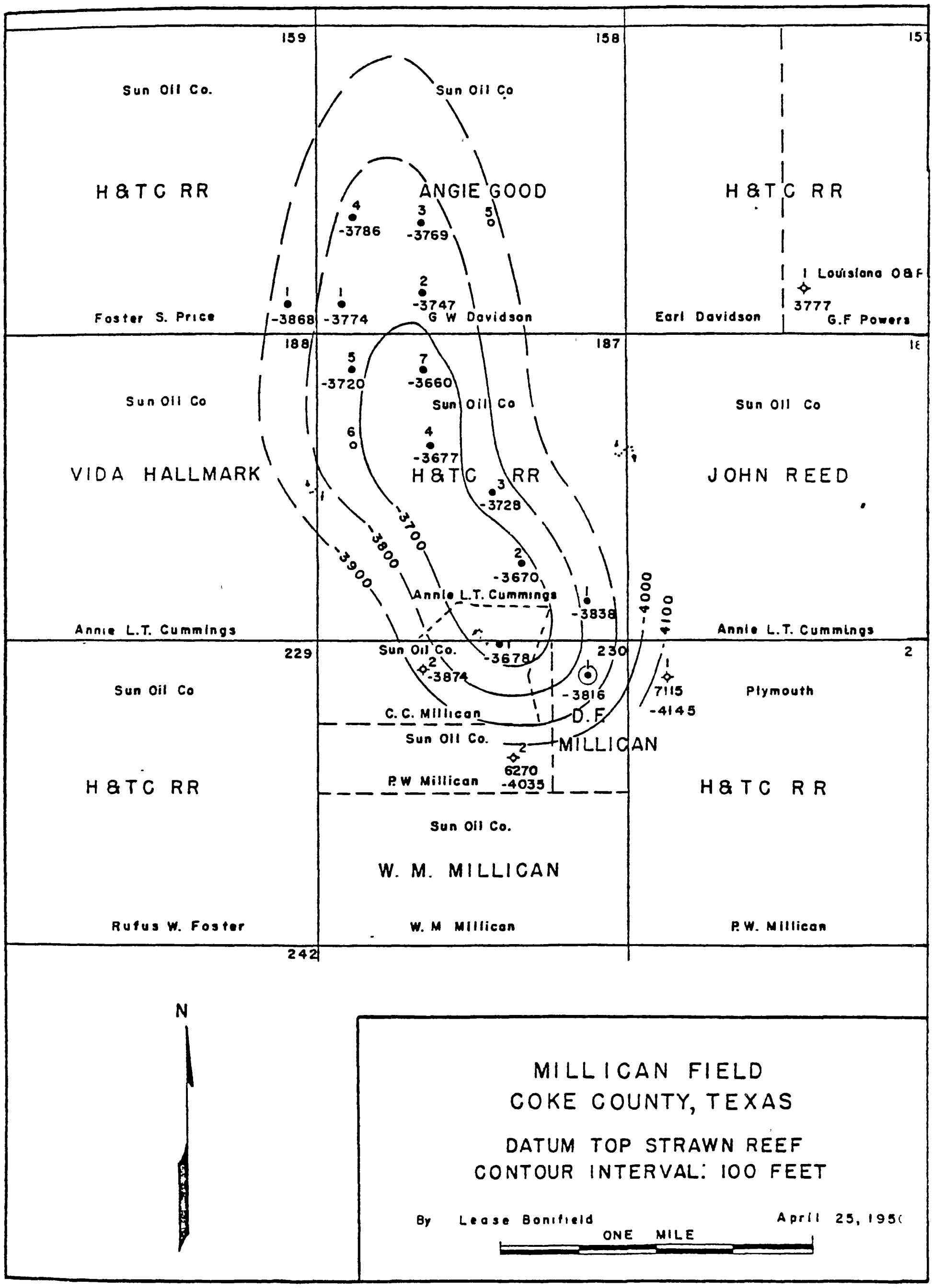

Figure 47. Structure on Top of Strawn Reef Millican Field, Coke County (from Bonifield, 1950)

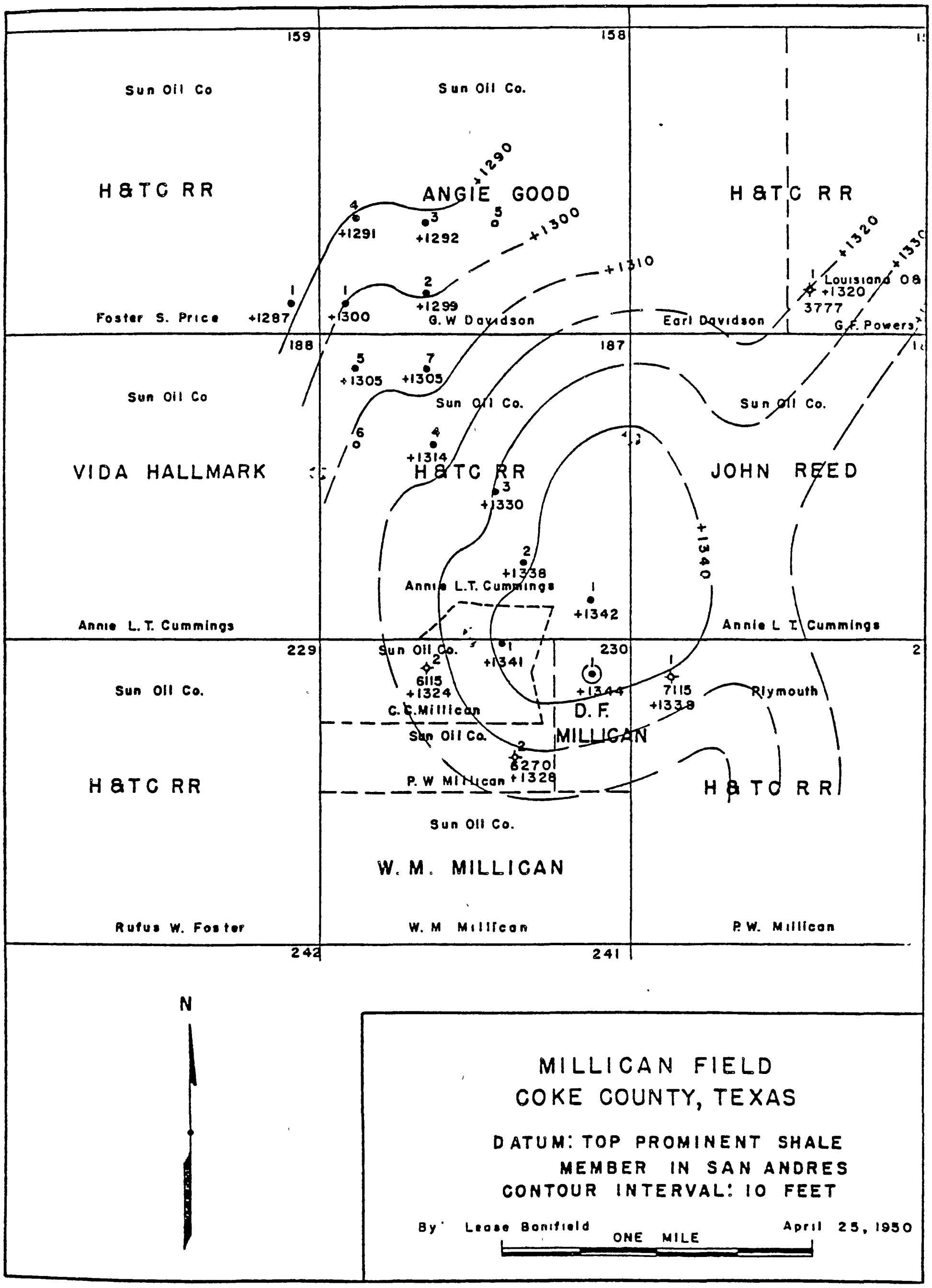

Figure 48. Structure on Top of Shale Member Showing Differential Compaction of Sediments Millican Field, Coke County

are not actively engaged in exploration in this area. Instead they are well into tertiary recovery from their early "easy finds". Despite the extensive exploration history for this area there is still the potential for modest discoveries, attractive to all but the largest independents.

An ambitious geolgist would do well to carefully evaluate the Upper Strawn fluvial-deltaic sands of Coke and Runnels Counties for the subtle up-dip pinchouts often overlooked in the haste of locating larger fields. There is still much acreage where wells are absent or the wells present have not penetrated the Strawn. This information combined with the valuable knowledge of Strawn depositional systems in this two county area easily holds the potential for modest future discoveries.

CHAPTER IX

CONCLUSIONS

Based upon the evidence contained within this study certain conclusions may be arrived at concerning the depositional systems present within the Upper Strawn (Pennsylvanian) units in Coke and Runnels Counties Texas. The conclusions are:

1. The distal most edge of a high-constructive elongate delta is located within the inner shelf of Coke and Runnels Counties. The system is present within the Gardner and Gray Sandstone Interval of the Lower, Upper Strawn.
2. Transgressive marine limestones are present within the inner shelf of Coke and Runnels Counties. These limestones are present throughout the Upper Strawn and are the Gardner Limestone, Goen Limestone and Capps Limestone.
3. A carbonate shelf-edge reef system is present within the outer shelf of Coke County. The shelf-edge reef system slowly builds from the base of the Strawn upward until a well developed system appears at the top of the Upper Strawn.

4. A carbonate barrier reef system is present within the outer shelf of Coke County. The barrier reef system originated on a base of cherty limestone resting unconformably upon the Ellenburger Dolomite. The crest of these reefs extend upward into the Canyon.
5. A back-reef lagoon system is present within the outer shelf of Coke County. The back-reef lagoon system was not present until the latest Desmoinesian. It does not appear until the shelf edge and barrier reefs become well established within the outer shelf.

The previous five depositional systems have been delineated within the inner and outer shelves of Coke and Runnels Counties, Texas. The systems were delineated using electric log structure maps, electric log cross-section and selected seismic data.

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APPENDIX A

ELECTRIC LOGS RUNNELS COUNTY

ELECTRIC LOGS RUNNELS COUNTY

Project Number	Well Name	Company
1	Newton #1	Murray Pet.
2	C. Cave #1	Humble Oil
3	Sallie Odom #B27	Humble Oil
4	Stubblefield #4	G. W. Strake
5	Cathey #1	G. W. Strake
6	Will Pumphrey #1	G. W. Strake
7	Ernst #1	Humphrey
8	Gardner #1	Warren Oil
9	Hinas #1	Warren oil
10	Nitch #	Delaware Inc.
11	Norton #1	Humble Oil
12	Crockett #1	Mitchell
13	Willis #3	Andrews
14	Willis #1	Pan American
15	Stephens #1	Texas Trading
16	Black #1	Deep Rock Oil
17	Gentry #1	Humble Oil
18	Heirs #1	Standard oil
19	Ash #1	Continental Oil
20	Chapmond #1	Puckett Inc.

Project Number	Well Name	Company
21	Smith #1	D. R. Co.
22	Michaelis #1	King
23	Dietz #13	American Trading
24	Taylor #1	Welch
25	Davenport #1	G. W. Strake
26	McCord #1	United North
27	Clayton #1	Delaware Inc.
28	Levy Lee #1	Spartan
29	Grindstaff #1	Snowden
30	Poynor #1	Eagle Prod.
31	Yarnell #1	Tunstill
32	Herring #1	King
33	Busher #1	Rowan Oil
34	Allen #3	Southern Corp.
35	Byler #1	Youngblood
36	Stokes #1	Miami Oper.
37	Dickinson #1	Day
38	Spreen #1-62	American Trading
39	Clayton #1	McMahon Oil
40	Smith #1	Harvey Co.
41	Spreen #1	Blackwell Oil
42	Barr #1	Waitlenmaier
43	Barnhill #1	Continental Oil
44	McShan #1	American Trading

Project Number	Well Name	Company
45	Odom #D-1	Humble Oil
46	Puckett #1	Gulf Oil
47	Jameson #1	Mabee Co.
48	David #1	Johnston
49	Niehues #1	Youngblood
50	Stubblefield #1	Sells Petro.
51	Richards #1	Hiawatha Oil
52	Aldridge #1	Fulwiler
53	Heirs #1	Standard
54	Taylor #1	Welch
55	Cave #1	Humble Oil
56	Hensley #1	Lone Star
57	Broadstreet #1	Delaware
58	Adams #1	Kemp
59	Allcorn #1	Gilchrist
60	Alexanber #1	Gulf oil
61	Allcorn #1	King
62	Armstrond #1	Gilchrist Co.
63	Ashton #1	Investors Prod.
64	Ashton #1	LA Gloria Corp.
65	Bailey #1	Moore Drilling
66	Benson #1	Rhodes Drilling
67	Bishop #1	King
68	Bishop #1	Page

Project Number	Well Name	Company
69	Bishop #1	Youngblood
70	Breadley #1	Texas Union Oil
71	Bredemeyer #1	Anderson
72	Bright #1	Snowden
73	Brookshier #1	Big D Oil
74	Brookshier #1-A	Smith
75	Bryan #2	Account
76	Brian #3	G. W. Strake
77	Bryers #1	Barmellow
78	Carter #1	King
79	Chapman #1	Cheyenne Oil
80	Clayton #2	Warner
81	Dale #1	Woods Drilling
82	Davidson #1	Gulfshore Oil
83	Davis #1	Vincent & Welch
84	Bessie Dean #1	Brannon
85	King #1	United
86	Diek #1	Robinson
87	Doset #1	King
88	Early #1	Killam
89	Earnshaw #1	Cherry Bros.
90	Eubanks	Texkan Oil
91	Fennell #1	West
92	Freeman #1	Twin Oil

Project Number	Well Name	Company
93	Gardner #1	Murphy Drilling
94	Gerhart #1	Herring Drilling
95	Gerhart #1	Landa Oil
96	Goetz #1	Woods Drilling
97	Green #1	Humphrey
98	Hale #1	Wylie
99	Harris #1	Killam
100	Harris #1-A	Ransome
101	Harper #1	Earl Wells
102	Harter #1	Bridwell Oil
103	Harber #1	Humble Oil
104	Herndon #1	Humble Oil
105	Herring #1	AB-TEX
106	Holle #1	Ambassador Oil
107	Holliday #1	Hoxsey Oil
108	Howell #1	Subsurface
109	Huback #1	Wylie
110	Jordan #1	Cheyenne Oil
111	Kirkham #1	King
112	Landers #1=A	A. W. Cherry
113	Sallie Odom	Humble Oil
114	Ford #1	Humphrey
115	Sanger #1	King
116	Nevins #1	American Trading

Project Number	Well Name	Company
117	Holliday #1	Anderson
118	Sallie Odom #7	Humble Oil
119	Sallie Odom #54	Humble Oil
120	Sallie Odom #53	Humble Oil
121	Sallie Odom #67	Humble Oil
122	Sallie Odom #66	Humble Oil
123	Sallie Odom #16	Humble Oil
124	Smith #3-A	Gulf
125	Sallie Odom #29	Humble Oil
126	Lee #2	Humphrey
127	Moore A-1	Hoblitzelle
128	Lee #1	Humphrey
129	Gottschalk #1	Geochemical Suv.
130	Sallie Odom #13	Humble Oil
131	Lange #1	Hickok
132	Wyllie #13	Humble Oil
133	Michalaelis #9	G. W. Strake
134	Ashton #1	Hickok
135	Sallie Odom #B-57	Humble Oil
136	Sallie Odom #B-58	Humble Oil
13e7	Sallie Odom #B-60	Humble Oil
138	Sallie Odom #B-62	Humble Oil
139	Sallie Odom #B-65	Humble Oil
140	Sallie Odom #D-15	Humble Oil

Project Number	Well Name	Company
141	Sallie Odom #D=1	Humble Oil
142	Sallie Odom #D-2	Humble Oil
143	Sallie Odom #B-71	Humble Oil
144	Sallie Odom #B-70	Humble Oil
145	Salli eOdom #C-10	Humble Oil
146	Sallie Odom #C-12	Humble Oil
147	Sallie Odom #C=13	Humble Oil
148	Sallie Odom #C-6	Humble Oil
149	Sallie Odom #C-8	Humble Oil
150	Tad Richards #1	Standard Oil
151	Sallie Odom#D-12	Humble Oil
152	Sallie Odom #D-8	Humble Oil
153	Salli eOdom #D-6	Humble Oil
154	Sallie Odom #B-69	Humble Oil
155	Sallie Odom #B-68	Humble Oil
156	Sallie Odom #B-78	Humble Oil
157	Sallie Odom #B-77	Humble Oil
158	Sallie Odom #B-76	Humble Oil
159	Sallie Odom #B-75	Humble Oil
160	Sallie Odom #B-74	Humble Oil
161	Sallie Odom #B-73	Humble Oil
162	Sallie Odom #B-73	Humble Oil
163	Sallie Odom #B-85	Humble Oil
164	Sallie Odom #B-72	Humble Oil

Project Number	Well Name	Company
165	Sallie Odom #B-81	Humble Oil
166	Sallie Odom #C-4	Humble Oil
167	Sallie Odom #B-82	Humble Oil
168	Sallie Odom #C-5	Humble Oil
169	Sallie Odom #B-83	Humble Oil
170	Nelson #1	G. W. Strake
171	Stubblefield #3	G. W. Strake
172	Sallie Odom #B-5	Humble Oil
173	Sallie Odom #A-5	Humble Oil
174	Stubblefield #3	G. W. Strake
175	Sallie Odom #B-85	Humble Oil
176	Sallie Odom #B-73	Humble Oil
177	Sallie Odom #B-78	Humble Oil
178	Sallie Odom #B-77	Humble Oil
179	Sallie Odom #B-76	Humble Oil
180	Sallie Odom #B-75	Humble Oil
181	Sallie Odom #B-74	Humble Oil
182	Sallie Odom #B-86	Humble Oil
183	Sallie Odom #B-81	Humble Oil
184	Sallie Odom #B-72	Humble Oil
185	Sallie Odom #C-5	Humble Oil
186	Sallie Odom #B-83	Humble Oil
187	Sallie Odom #B-82	Humble Oil
188	Sallie Odom #C-4	Humble Oil

Project Number	Well Name	Company
189	Nelson #1	G. W. Strake
190	Sallie Odom #B-68	Humble Oil
191	Sallie Odom #B-69	Humble Oil
192	Sallie Odom #B-62	Humble Oil
193	Sallie Odom #B-60	Humble Oil
194	Sallie Odom #B-57	Humble Oil
195	Sallie Odom #B-58	Humble Oil
196	Sallie Odom #B-65	Humble Oil
197	Sallie Odom #D-15	Humble Oil
198	Sallie Odom #D-2	Humble Oil
199	Sallie Odom #D-1	Humble Oil
200	Sallie Odom #B-71	Humble Oil
201	Sallie Odom #B-70	Humble Oil
202	Sallie Odom #C-10	Humble Oil
203	Sallie Odom #C-12	Humble Oil
204	Sallie Odom #C-6	Humble Oil
205	Sallie Odom #C-13	Humble Oil
206	Richards #1-A	Humble Oil
207	Sallie Odom #C-8	Humble Oil
208	Sallie Odom #D-8	Humble Oil
209	Sallie Odom #D-12	Humble Oil
210	Sallie Odom #D-6	Humble Oil
211	Sallie Odom #32	Humble Oil
212	Sallie Odom #D-4	Humble Oil

Project Number	Well Name	Company
213	Black #1	Lee Bros.
214	McWilliams #1	Fletcher
215	Barker #B-3	Trans-Tex
216	Bagwell #1-A	Lone Star
217	Miller #5	Union Oil
218	R. B. Smith #7	Texas Pacific
219	Johnson #1	Puckett
220	Carlisle #1	G. W. Strake
221	Spann #1	Humphrey
222	Harris #Y-5	Geochemical
223	lafoon #1=A	Texas Pacific
224	Beryman #1	American Trading
225	Pace #13	G. W. Strake
226	King 34	American Tading
227	mitchell #3	G. W. Strake
228	Presley #1	Saxon
229	Davenport #2	G. W. Strake
230	Colburn #1	G. W. Strake
231	Smith #1	Humble Oil
232	Grindstaff #1	Snowden
233	Herring	Fletcher
234	Wilbanks #1	Hood
235	Dudley #1	Hoblitzelle
236	Kellermeier #1	Fuller

Project Number	Well Name	Company
237	Curry #1	W. Texas Drilling
238	Lang #1	Moore Drilling
239	Straach #1	Burt Drilling
240	Lacy #1	Fletcher Oil
241	Schoenfield #1	Corrance
242	City of Miles	Miles Production
243	Kasberg #1	Armstrong
244	A. F. Book #1	Crouch
245	Kasberg #1	Matrix
246	Macitotka #1	Howse Drilling
247	Matejowski #1	Burt Drilling
248	Schertz #1	Cont. Oil
249	Schumann #1	Cherry
250	Glass #1	Vincent & Welch
251	Kvasnicka #1	Vencent & Welch
252	Mabee #1	Slick
253	Edmondson	American Trading
254	Glass #1	Hudson
265	TEGEL #1	De Soto
257	Hoffman #1	Sadler
258	Halfman #1	Duncan
259	Kresta #1	Saxon
260	Bigby #1	Saxon
261*		

Project Number	Well Name	Company
262*		
263*		
264	Lingnav #1	Woodley
265	Russell #1	Childress Drilling
266	Gulley #1	Slick Oil
267	Gulley #1	Fox
268*		
269	Wilbanks #1	Hood
270	Kreitz #1	Brooks & Turner
271	BArr #1	Humphrey
272	Barr #1	Wahlenmaier
273*		
274*		
275*		
276*		
277*		
278*		
279	Gross #1	Western Drilling
280*		
281	Treadway #1	Texas-New Mexico
282	Herring #1	W. Central Drilling
283	McWilliams	Hack Drilling
284*		
285	Hall #2	Humphrey

Project Number	Well Name	Company
286	M. Sparkman #1	Ambassador
287*		
288	White #A-1	G. W. Strake
289*		
290	Harris #1	Warren Oil
291*		
292	Hudman #1	McLean
293	McCord #1	Transcontinental
294	Deakins #1	Southern Miss.
295	Clayton #1	Gilchrist

* Log on file at Petroleum Information Library in Dallas, Texas. Omitted from study.

APPENDIX B

ELECTRIC LOGS COKE COUNTY

ELECTRIC LOGS COKE COUNTY

Project Number	Well Name	Company
1	E. H. Schuch #1	Humble Oil
2	Waldrop #1 Lion Oil	Lion Oil
3	Jack Frost #1	Union Oil
4	Wendland #1	Shamrock Okl
5	S. E. Adams #1	Sun Oil
6	J. L. Reed	Laan-Tex Oil
7	J. A. Waldrop #1	Fuller Okil
8	Emma C. Nicholas	Stanolind Oil
9	Charles Copeland	Maxey Oil
10	Hendry #1	Edgar Davis Co.
11	Sallie Odom #10	Humble Oil
12	Salie Odom #2	Humble Oil
13	Edna Wylie #22	Stanolind Oil
14	S. Gray #1	J. K. Wadley
15	Butner #1	Humble Oil
16	Mackey #1	Fulerton Oil
17	Russel #1	C. H. Mruphy
18	Marvin Simpson #1	Seaboard Oil
19	Oscar Kresta #1	J. J. Lynn Co.
20	McCutchen #1	Union Oil

Project Number	Well Name	Company
21	Warren #1	Chicago Corp.
22	Luttrell #1	M & M Prod. Co.
23	Brunson #1	Humble Oil
24	R. Lewis #1	Miami Operating Co.
25	Bell #1	Union Oil
26	Hill #1	Saxon Expl. Co.
27	R. C. Rawlings #1	Hickok & Reynolds
28	Jameson #1	Sun Oil
29	Arledge #2	Sun Oil
30	Billy Hanks #1	Sun Oil
31	Jameson #2	Sun Oil
32	Tubb #1	Sun Oil
33	Greenland #1	S. Minerals Co.
34	Davidson #11	Sun Oil
35	Davids #1	Johnsons Co.
36	Burns 1-A	Stanolind Oil
37	Millican #1	Plymouth Oil
38	Price 1-1761	Superior Oil
29	Weaver #2	Humble Oil
40	Nora Gee #1	Mar-Tex Corp.
41	Cummings #1	Sun Oil
42	Adams #1	Providence Oil
43	Gartman #1	Sharp
44	Odom #2	Humble Oil

Project Number	Well Name	Company
45	Sallie Odom #77	Humble Oil
46	Sallie Odom #74	Humble Oil
47	Sallie Odom #73	Humble Oil
48	Sallie Odom #69	Humble Oil
49	Sallie Odom #59	Humble Oil
50	Sallie Odom #93	Humble Oil
51	Brunson #8-5	Humble Oil
52	Sallie Odom #78	Humble Oil
53	Eubanks #1	Harper
54	Simpson #1	Midwest Oil
55	Sallie May	Tucker
56	Kind #1	Randle
57	Sallie Odom #79	Humble Oil
58	Cumbie #1	Duffy
59	Sallie Odom #85	Humble
60	Whiteside #1	Union Oil
61	Sallie Odom #83	Humble Oil
62	Sallie Odom #87	Humble Oil
63	Rawlings #2	Humble Oil
64	Davlong #1	Graham
65	Boecking #1	Hoblitzell
66	Pruit #1	Humble Oil
67	Wylie #1	Humble Oil
68	Hines #1	Schroeck

Project Number	Well Name	Company
69	Wink #1	Lipan Oil
70	Devoll #1	Standard Oil
71	Austin #1	Tucker
72	Denman #1	Hurray
73	Rawlings	Wiley
74	Sallie Odom #39	Humble Oil
75	Sallie Odom #38	Humble Oil
76	Sallie Odom #37	Humble Oil
77	Sallie Odom #32	Humble Oil
78	Sallie Odom #31	Humble Oil
79	Sallie Odom #30	Humble Oil
80	Sallie Odom #53	Humble Oil
81	Sallie Odom #67	Humble Oil
82	Sallie Odom #9	Humble Oil
83	Sallie Odom #3	Humble Oil
84	Sallie Odom E-92	Humble Oil
85	Sallie Odom E-88	Humble Oil
86	Sallie Odom E-86	Humble Oil
87	Harris #2	Texas Co.
88	Odom #67	Humble Oil
89	Odom #53	Humble Oil
90	Odom #39	Humble Oil
91	Odom #38	Humble Oil
92	Odom #30	Humble Oil

Project Number	Well Name	Company
93	Odom #31	Humble Oil
94	Odom #53	Humble Oil
95	Harris #2	Texas Co.
96	Odom #9	Humble Oil
97	Odom #3	Humble Oil
98	Odom #37	Humble Oil
99	Odom E-86	Humble Oil
100	Harris #2	Texas Co.
101	Odom E-88	Humble Oil
102	Odom E-92	Humble Oil
103	Roger #1	Hickok
104	Callaway #1	Hickok
105	Keeney #3	Humble Oil
106	Steffey #1	Elm Oil
107	Shamblin #1	Champlin
108	Whiteside #1	Payne
109	Robert Lee #1	Union Oil
110	Davidson #1	Union Oil
111	Devoll #1	Tucker
112	Wojtek #1	Union Oil
113	Carter #1	Stanolind
114	Simpson #1	Midwest Oil
115	Stone #1	Pan American
116	Blackburn #1	Tucker Drlg.

Project Number	Well Name	Company
117	Tucker #1-B	Davis
118	Powell #1	Empire Drlg.
119	Weaver #1	Humble Oil
120	Weaver #1	Wilson
121	Wojtek	Page
122	Weaver #1	Tucker Drlg.
123	Gartman #1	Stanolind
124	Weaver #4	Humble Oil
125	Cowley #1	Deep Rock Oil
126	Conger #1	Gore Drilling
127	Schooler #1	U.S. Smelting
128	Roe #3	Pet. Drlg.
129	J. Fields #1	Wadley & Conley
130	Thompson #1	Tucker
131	Price	Cobb
132	W. R. Davis #1	Johnson
133	Burns 1-A	Stanolind
134	Roe #1	Seaboard
135	Burns #1	Wadley
136	Herring #1	S. Minerals
137	Reed #3	S. Minerals
138	M. Ranch #1	Pan Am
139	Webb #1	Honolula Oil
140	Leeper #1	Tucker

Project Number	Well Name	Company
141	Menielle #5	Sun Oil
142	Jacobs #1	Sun Oil
143	Neill 1-A	Tucker
144	Stephenson #1	Rice
145	Arrot #1	Norewood
146	Weadland #1	Lone Star
147	Walker #1	Sun Oil
148	Perice #1	Tucker
149	Walker	Sun Oil
150	Walker #2	Sun Oil
151	Jameson #3	Sun Oil
152	Bynum #1	Pan Am
153	Davidson #1	Sun Oil
154	Carrole #1	Sun Oil
155	Arledge	Sun Oil
156	Bird #1	Humble Oil
157	Millican	Plymouth
158	Gee #4	Smowden
159	Johnson #9	Humble Oil
160	Johnson #1	Fuller
161	Russell #1	Murphy
162	Wendland #1	Shamrock
163	Hill #1	Saxon
164	McCutchen #1	Union

Project Number	Well Name	Company
165	Waldrop #1	Lion Oil
166	Runkles #1	McCormick
167	Harris #1	Sun Oil
168	Johnson #15	Humble Oil
169	Lassiter #2	Guiberson
170	Malone #1	Dugger
171	Russell #1	Seaboard
172	Phelan #1	Adams
173	Featherstone	Diamond
174	Roe #1	Murray
175	Smith 1-A	Norsworthy
176	Nicholas #1	Stanolind
177	Gray #1	Wadley
178	Kresta #1	Lynn
179	Lewis #1	Miami
180	Wendland #2	Shamrock
181	M. Ranch #2	Amerada
182	R. Wilson #1	Forest Oil
183	Rawlings #2	Katx
184	Saynor 1-A	Miami
185	M. Ranck #1	Amerada
186	Bridges #1	Hilliard
187	Mackey #1	Fullerton
188	Brown #1	Craig

Project Number	Well Name	Company
189	Sayner	Scherck
190	Counts #1	Seaboard
191	Mims #1	Sorrels
192	Chapman	Davon Oil
193	Foster #1	Jones
194	March #1	Liecdtke
195	Johnson	Liedtke
196	Mendenhall #1	Highland
197	McCabe #1	Hunt
198	Harris #1	Tucker
199	Demere 1-A	Ohio
200	McCabe #1	Black
201	Mims #1	Norsworth
202	Burns #1	Chambers
203	Rawlings #1	Katz
204	Price #1	Norsworthy
205	Elwood #1	Miami
206	Millican #1	Sun Oil
207	Malone #1	Sun Oil
208	Bynum #1	Murray
209	Roe #2	Murray
210	Page #1	Blackmor
211	Wiginton #1	Fortune Drlg.
212	Leedy #1	Migell

Project Number	Well Name	Company
213	Forehand #1	Midwest Oil
214	Sheppard 1-A	Miami
215	Mims #1	Murray
216	McCabe #1	Woodward
217	Adams #1	Tucker
218	Runkles #1	Tucker
219	Weaver #1	Cont. Oil
220	Hixon #1	Barnes Oil
221	Augustine #1	Ah. Ref
222	Adams #1	Sun Oil
223	Schuch #1	Humble Oil
224	Halamcimik #1	Humphrey
225	Taylor #1	Hanley
226	Greene #1	Hanley
227	Willick #1	Dougherty
228	Harrington #1	Randle
229	Hartin #1	Humble Oil
230	Harris B-3	Humble Oil
231	Millican #1	Cosden
232	Wendland #2	Shamrock
233	Price #1	Maguire
234	March #1	Champlin

VITA

STANLEY MARK SCHACHTER

Candidate for the Degree of

Master of Science

Thesis: GEOPHYSICAL INTERPRETATION OF UPPER STRAWN (PENN-SYLVANIAN) DEPOSITIONAL SYSTEMS AND SANDSTONE HYDROCARBON PRODUCING UNITS IN COKE AND RUNNELS COUNTIES, TEXAS.

Major Field: Geology

Biographical:

Personal Data: Born in Charleston, South Carolina, November 16, 1959, the son of Mr. and Mrs. Stanley Schachter.

Education: Received Bachelor of Science degree in Geology, May 1982, from the University of Miami, Coral Gables, Florida; completed requirements for the Master of Science degree at Oklahoma State University in July, 1984.

Professional Experience: Geologist for Union Oil Company of California, Casper Wyoming, May to August 1983; Graduate Teaching Assistant, Department of Geology, Oklahoma State University, Stillwater, Oklahoma, August 1982 to May 1984.