DEPOSITIONAL TRENDS AND ENVIRONMENTS OF "CHEROKEE" SANDSTONES, EAST-CENTRAL PAYNE COUNTY, OKLAHOMA

By

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PREFACE

This thesis is primarily a study of sandstones in the Pennsylvanian (Desmoinesian) "Cherokee" Group in the subsurface of part of Payne County, Oklahoma. The sandstones are known, in ascending order, as the locally developed Burgess, Bartlesville, Red Fork, Lower Skinner, Upper Skinner, and Prue. Depositional trends and overall sandstone geometry were determined by use of correlation sections, isopach maps and log maps.

The writer is grateful to many individuals who assisted in this study. Dr. John W. Shelton suggested the problem and offered encouragement, time, and assistance in preparation of the maps and manuscript. Advisory committee members, Dr. Gary F. Stewart, Dr. John W. Trammell, and Mr. Joe Newcomb of Thomas E. Berry made helpful suggestions, comments, and criticisms. Enlightening conversations with fellow graduate students, especially Dale Shipley and Todd Wilson, proved to be very valuable.

Subsurface data were obtained from the Oklahoma City Geological Society Well Log Library, Cleary Petroleum Corporation, Thomas N. Berry and Company, and the Oklahoma Geological Survey Core and Sample Library. The writer is deeply indebted to Sun Oil Company and Mr. L. "Red" Collins of the Oklahoma City district office for drafting the maps. Appreciation is extended to Mrs. Margaret Kaiser for final typing of the manuscript.

The writer wishes to give special thanks to his parents, Mr. and Mrs. Arthur Astarita, his brother, Bruce, and his confidante, Ms. Candace Russell whose sacrifice, encouragement and guidance made this thesis possible.

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CHAPTER I

ABSTRACT

The "Cherokee" Group is a 500- to 600-foot sequence of predominantly terrigenous clastics. Sequences of shales, lenticular sandstones, thin limestones, and an occasional coal bed are repetitious; and five thin markers provide the basis for division of the "Cherokee" Group into transgressive-regressive couplets. Regressions which interrupted an overall transgression of the Cherokee Sea are represented by lenticular sandstones. In ascending order, these sandstones are known as the locally developed Burgess, Bartlesville, Red Fork, Lower Skinner, Upper Skinner, and Prue.

Major developments of "Cherokee" Sandstones apparently represent deposition in major and minor distributary channels of delta complexes which prograded southward and/or eastward. These sandstones are thought to have been deposited as delta-fringe units on distributary-mouth bars and offshore bars and in interdistributary bays. Local depositional trends of the Red Fork, Lower Skinner and Prue sandstones are generally north-south, whereas the Bartlesville and Upper Skinner sandstones have dominant east-southeast trends. Multilateral and multistoried characteristics of most of the sandstone bodies are expressed by complex trends.

In the study area the "Cherokee" Group unconformably overlies Mississippian limestone of Meramecian and Osagean age. Distribution of

lower "Cherokee" sediments, particularly the Bartlesville Sandstone, was influenced by pre-Desmoinesian faults and paleostructural folds as well as by paleotopography.

In comparison to the conventional isopach maps, log maps permit better definition of sandstone trends and edges by allowing detection of subtle sandstone variations which may be important in exploration for hydrocarbons.

CHAPTER II

INTRODUCTION

The stratigraphic section for study is informally referred to as the "Cherokee" Group of the Desmoinesian Series (Jordan, 1957). The area of investigation, approximately 216 square miles in east-central Payne County, Oklahoma, is T18-19N, R3-5E (Figure 1).

Although the "Cherokee" Group was formally divided by Oakes (1953) into the Krebs and Cabaniss groups, the term "Cherokee" is retained within this thesis because of its general usage in subsurface literature. The writer follows the definition of Jordan (1957) who regarded the "Cherokee" Group as the stratigraphic section extending from the base of the Oswego Limestone to the base of the Desmoinesian Series. This group is composed of cyclic sequences which include six lenticular sandstone bodies. To the subsurface worker, these sandstones are known, in ascending order, as the locally developed Burgess, Bartlesville, Red Fork, Lower Skinner, Upper Skinner, and Prue. The positions of these sandstones along with the positions of thin, persistent stratigraphic units (markers) are illustrated on a type log in Figure 2.

Objectives and Procedures

The objectives of this subsurface study are to delineate trends and overall geometries of the "Cherokee" sandstones within the study area, determine paleotopographic and/or paleostructural control of "Cherokee"

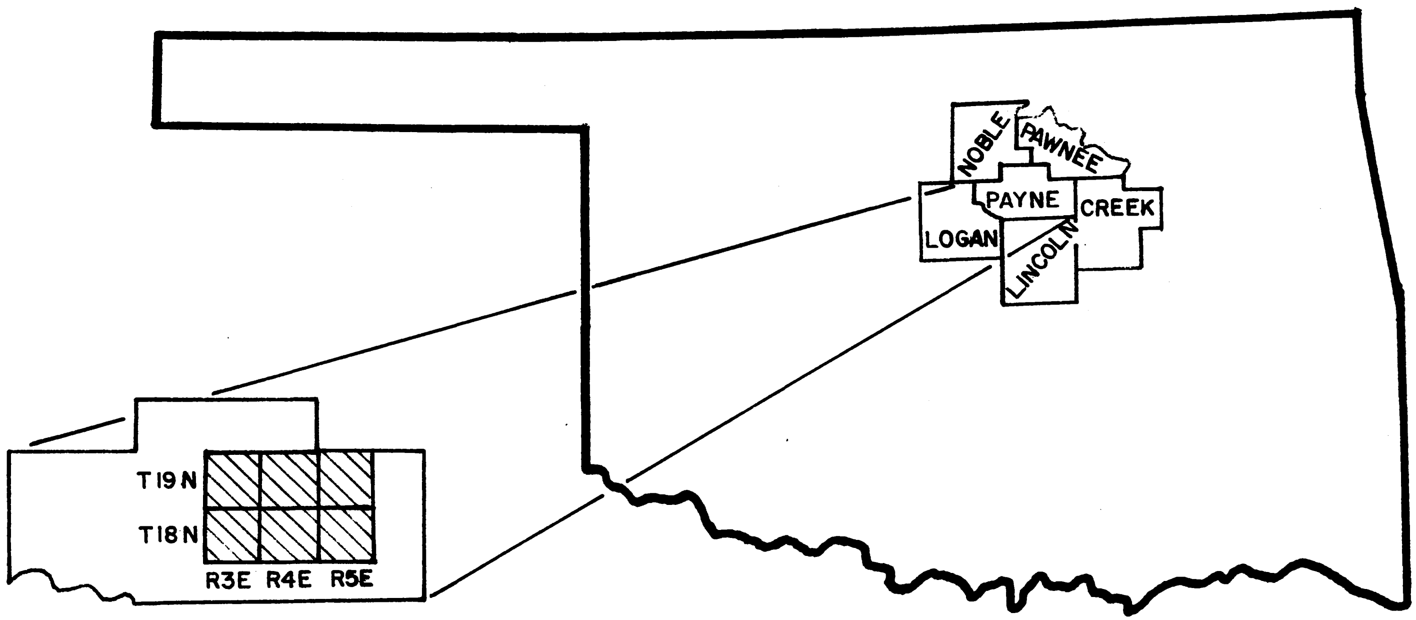


Figure 1. Location map

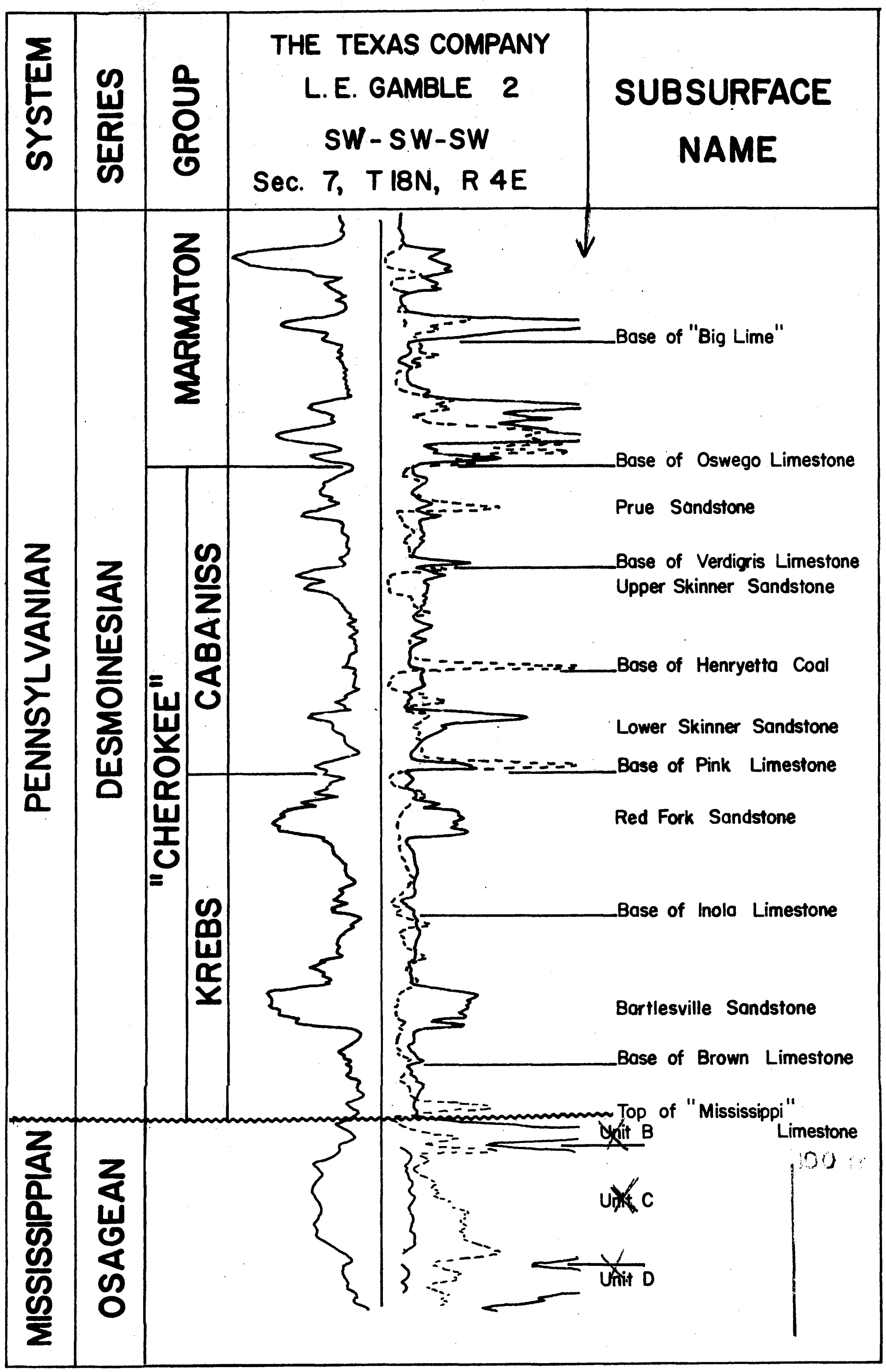


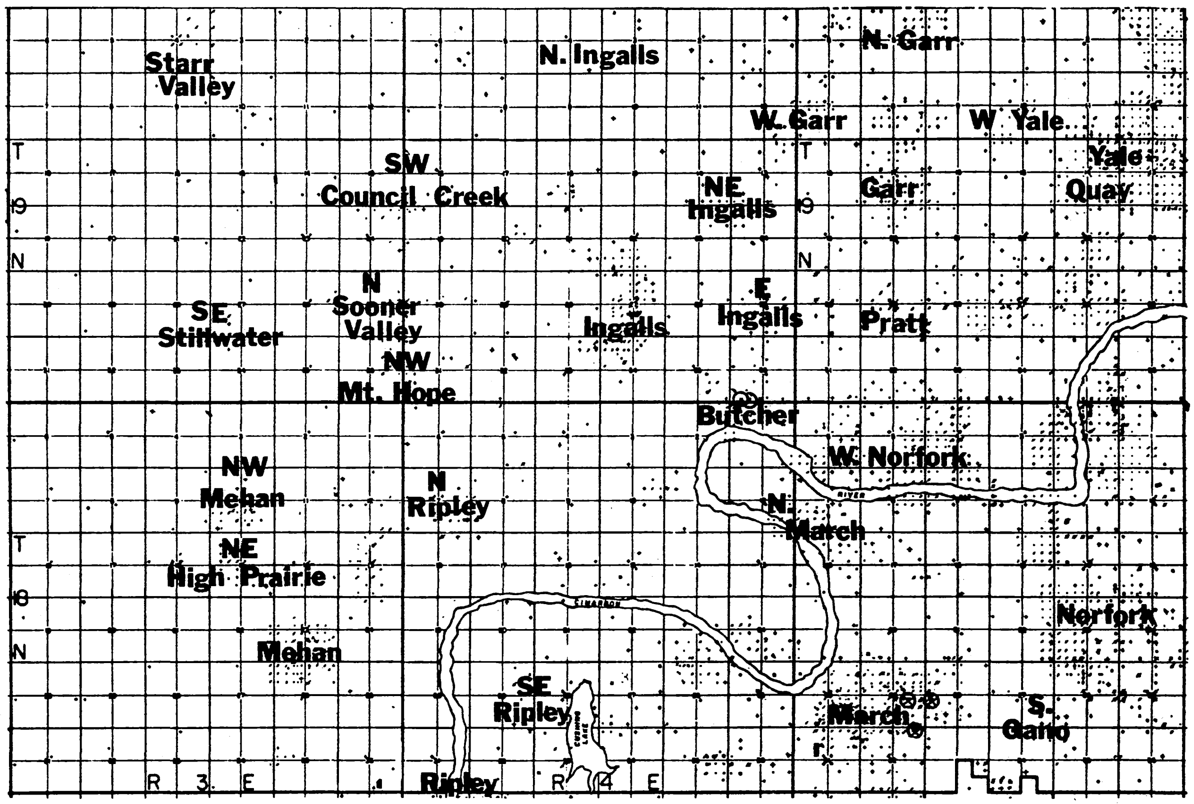
Figure 2. Type electric log

sedimentation, determine the genesis of the sandstone deposits, and compare certain techniques for mapping sandstones.

The principal data for the study are 672 electric logs and six cores of the Bartlesville, Red Fork, Lower Skinner, and Prue sandstones. With the exception of the Bartlesville core, all cores are from wells drilled within the study area (Figure 3). Well density and the oil-gas fields within the area are shown in Figure 3. Correlation of stratigraphic units, the basis for both structural and stratigraphic analyses, was determined primarily from the framework represented by eight correlation sections (Figures 4-11). Also, certain geometric elements of sandstones and variations in thickness are best exhibited on the sections, locations of which are shown in Figure 12.

Present structural configuration of the "Cherokee" Group is portrayed by a structural contour map on the base of the Oswego Limestone. Two isopach maps were prepared to determine possible paleotopographic and/or paleostructural control of "Cherokee" sedimentation within the area. As another aid in this part of the study, a geologic map of pre-Pennsylvanian rocks was constructed by using three markers within the "Mississippi" Limestone.

An isopach map was prepared for each sandstone, except the Burgess, as a means of delineating trend and distribution. Each map portrays the thickness of the section from the overlying marker to the base of the sandstone. Generally, sandstone is defined in this study as that portion of the SP curve of the electric log with a minimal deflection of 20 millivolts from the shale base line. Determination of sandstone includes comparison of SP deflections opposite sandstone intervals to those opposite limestones and calibration of electric logs from



Location of study cores

o Prue Sandstone ƀ Red Fork Sandstone ⊗ Lower Skinner Sandstone

Figure 3. Location map of wells, oil and gas fields, and cored wells

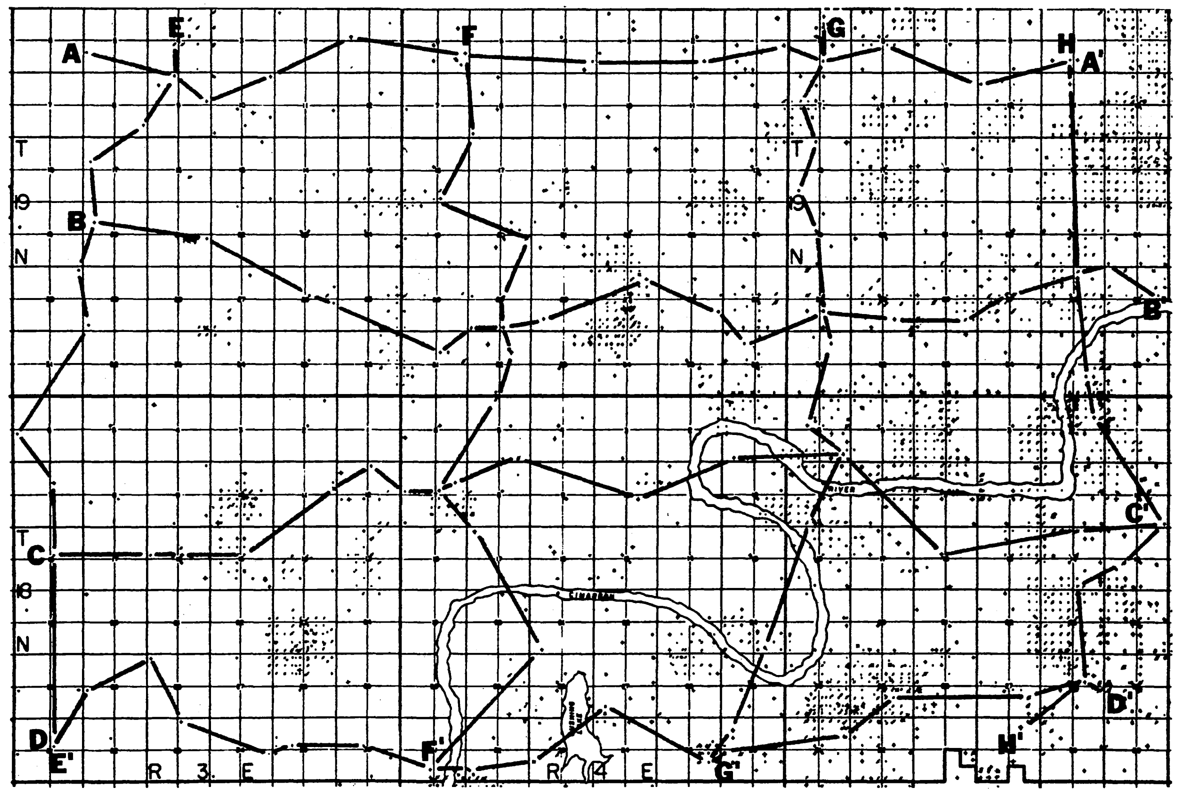


Figure 12. Index map of correlation sections

examination of cores.

Areal distributions of sandstones were determined in selected areas by means of log maps of the five sandstones, which have been used in comparing techniques for mapping sandstones.

Previous Investigations

Oakes (1953) divided "Cherokee" strata on outcrop into the Krebs and Cabaniss Groups. The contact between groups is the base of the Tiawah Limestone, surface equivalent of the Pink Limestone above the Red Fork Sandstone.

Since the early 1900's, the "Cherokee" Group has been the subject of extensive research due to proved hydrocarbon reservoirs within it. Pioneer work was by Bass (1934, 1936), Bass et al. (1937), Leatherock (1937), and Howe (1956).

The general geology of the subsurface within portions of the study area was studied by Graves (1955) and Dalton (1960). Clayton (1965) interpreted paleoenvironments of the "Cherokee" sandstones in the westernmost townships of the thesis area. Local investigations of nearby areas include those by Akmal (1953), Page (1955), Bowman (1956), Stringer (1957), and Sartin (1958). Clements (1961), Hawisa (1965), Hanke (1967), Scott (1970), and Shipley (1975) studied the "Cherokee" Group or parts of it in nearby areas.

Regional studies by McElroy (1961), Visher et al. (1968), Berg (1969), and Cole (1969) of Desmoinesian strata give a comprehensive insight to the subsurface geology of the Northern Oklahoma platform area.

The nature of the pre-Pennsylvanian surface and Mississippian rocks was studied by Heinzelmann (1957), Hyde (1957), Jordan and Rowland (1959), Jones (1960), and Jordan (1962).

CHAPTER III

STRUCTURAL FRAMEWORK

Regional Setting

The study area is a part of the Northern Oklahoma platform which is bounded on the east by the Ozark uplift, on the south by the Arkoma basin and the Hunton-Pauls Valley uplift, and on the west by the Nemaha ridge (Arbenz, 1956).

Formations of the "Cherokee" Group strike generally north-northwest and dip homoclinally to the west-southwest at approximately 50 feet per mile. According to Dalton (1960), Mississippian strata in eastern Payne County dips to the west-southwest at 70 to 80 feet per mile, on the average. The Cushing anticline, approximately six miles east-southeast of the study area, interrupts the homoclinal dip.

Local Structural Features

The base of the Oswego Limestone is the reference surface for a structural contour map (Figure 13). The Oswego is persistent over the platform area, and it directly overlies the "Cherokee" Group. The general westerly dip is interrupted by noses, saddles, and faults, which are regarded as steeply dipping normal faults. The longest structural trend is formed by the extension of the southwest-plunging nose in the vicinity of Pratt field (T19N, R5E) and Butcher Field (T19N, R4E), to Mehan field area (T18N, R3E).

Dome-like structures are at Mehan field (T18N, R3E), North Ripley, Broyles, and Georgia fields (T18N, R4E), March, North March, and Norfolk fields (T18N, R5E), Ingalls field (T19N, R4E), West Garr field (T19N, R5E), and Yale-Quay field. The intensity of deformation increases with depth (Koschmann, 1928; Graves, 1955; and Jordan, 1962).

Faults at the position of the Oswego are in the areas of March, North March, and West Norfolk fields (T18N, R5E), and Ingalls field (T19N, R4E). Displacement is as much as 80 feet at the Ingalls structure. En echelon faults in this area trend northwestward. Three faults in the Ingalls field have the same senses of displacement as three corresponding faults in the West Norfolk and March fields (T18N, R5E), a relationship which suggests continuity with depth.

The faults east of Mehan field (T18N, R3E) and North Ripley field (T18N, R4E) seem to be related to a basement fault mapped by Lyons (1950). An east-trending basement fault through the northern portion of T19N, R1W-R2E, may extend into R3E, based on abnormally thick lower "Cherokee" strata (Figure 14). Significant fault displacement is apparently restricted to pre-Pennsylvanian beds because the "Cherokee" shows minimal changes in thickness (Figure 8). In contrast, a "Cherokee" growth fault is present in the southeastern part of T18N, R4E (Figures 7 and 14).

Most local structures probably reflect deformation both before and after deposition of the Oswego Limestone.

CHAPTER IV

STRATIGRAPHIC FRAMEWORK

The "Cherokee" Group is a 500- to 600-foot sequence of predominantly terrigenous clastics, with repetitious sequences of shales, lenticular sandstones, thin limestone, and an occasional coal bed. On the Northern Oklahoma platform, rocks of Desmoinesian age unconformably overlie older, truncated Mississippian strata. According to Visher et al. (1971), a conformable contact between Pennsylvanian and Mississippian rocks is present in the eastern part of the platform and in the Arkoma basin. The study area is part of a regional stratigraphic investigation by Cole (1969), who recognized the unconformity at the base of the Desmoinesian Series and southeastward thickening of "Cherokee" strata away from the Nemaha ridge. Cole divided the section below the Brown Limestone into the Booch and Gilcrease Sandstones. Those strata are designated by Jordan (1957) as the Burgess Sandstone, the name used in this study.

Correlation

To ensure accurate correlation and to illustrate certain sedimentologic and structural relationships, four east-west and four north-south correlation sections were constructed with the Oswego Limestone as datum. Locations of these sections are shown on Figure 12.

Five markers are recognized within the "Cherokee" Group. In ascending order, they are the Brown Limestone, Inola Limestone, Pink Limestone, Henryetta Coal, and Verdigris Limestone. The thin, persistent characteristics of these markers provide the basis for subdivision of the "Cherokee" Group. The sequence of strata between two successive transgressive markers is thought to represent a transgressive-regressive couplet. In this study, sandstone bodies are classified initially by electric-log characteristics as channel or non-channel deposits. Channel deposits are represented by sharp basal contacts, suggestive of erosion of underlying units, and lenticular cross-sectional shape. Major channel deposits are arbitrarily regarded as those channel-like deposits which are thicker than 20 feet. Thin beds of shale within individual sandstones are not mapped.

Four informal units of the Mississippian Limestone, recognized on the basis of electric-log characteristics, are designated as Unit D, Unit C, Unit B, and Unit A, in ascending order.

Correlation Sections

The east-west correlation sections (Figures 4-7) portray an eastward increase in thickness of the "Cherokee" Group and a westward onlap of the Brown Limestone upon an irregular Mississippian surface. "Cherokee" thickness in the study area varies from approximately 460 feet in the northwest to greater than 590 feet in the southeast. The greatest change in thickness is between the base of the Pink Limestone and the top of the "Mississippi" Limestone.

North-south correlation sections (Figures 8-11) portray a general uniformity of thickness of the "Cherokee" Group. However, there is a marked variation in thickness between wells 3 and 4, Section E-E'

(Figure 8). The change probably reflects influence of a pre-Desmoinesian fault in development of a paleotopographic depression.

Mississippian rocks of Meramecian age, Unit A, are present in the southeastern portion of the thesis area, and they apparently are underlain unconformably by rocks of Osagean age (Heinzelmann, 1957; Hyde, 1957; Jordan, 1962). Osagean beds in Unit D thicken northward (Figures 8-11) (Heinzelmann, 1957; Hyde, 1957), whereas variations in the overlying units are obscured by intraformational thinning and truncation.

Paleotopographic and Paleostructural Influence of "Cherokee" Sedimentation

The interval from the top of the Mississippian unconformity to the base of the Pink Limestone thickens from 200 feet in the western part of the area to 350 feet on the eastern edge (Figure 14). Abnormally thick trends of this interval are related to structural and topographic features existent during deposition and to major development of Bartlesville Sandstone (Figure 15). An east-trending thick deposit in the northern portion of T19N, R3E, is thought to represent influence of a pre-Desmoinesian fault as well as the effects of paleotopography. Similar relationships may have existed in areas of the North Sooner Valley field (T19N, R3E) and Butcher field (T19N, R4E) where trends of thick lower "Cherokee" strata parallel faults.

Branching trends in T19N, R4E, and T18N, R3-4E, suggest the influence of stream drainage across the Mississippian surface (Figure 15). An area of abnormally thin section, across the Ingalls structure in T19N, R4E, may have influenced the bifurcation of the northerly trend of thick strata (Figure 14). The Ingalls structure is also reflected by a

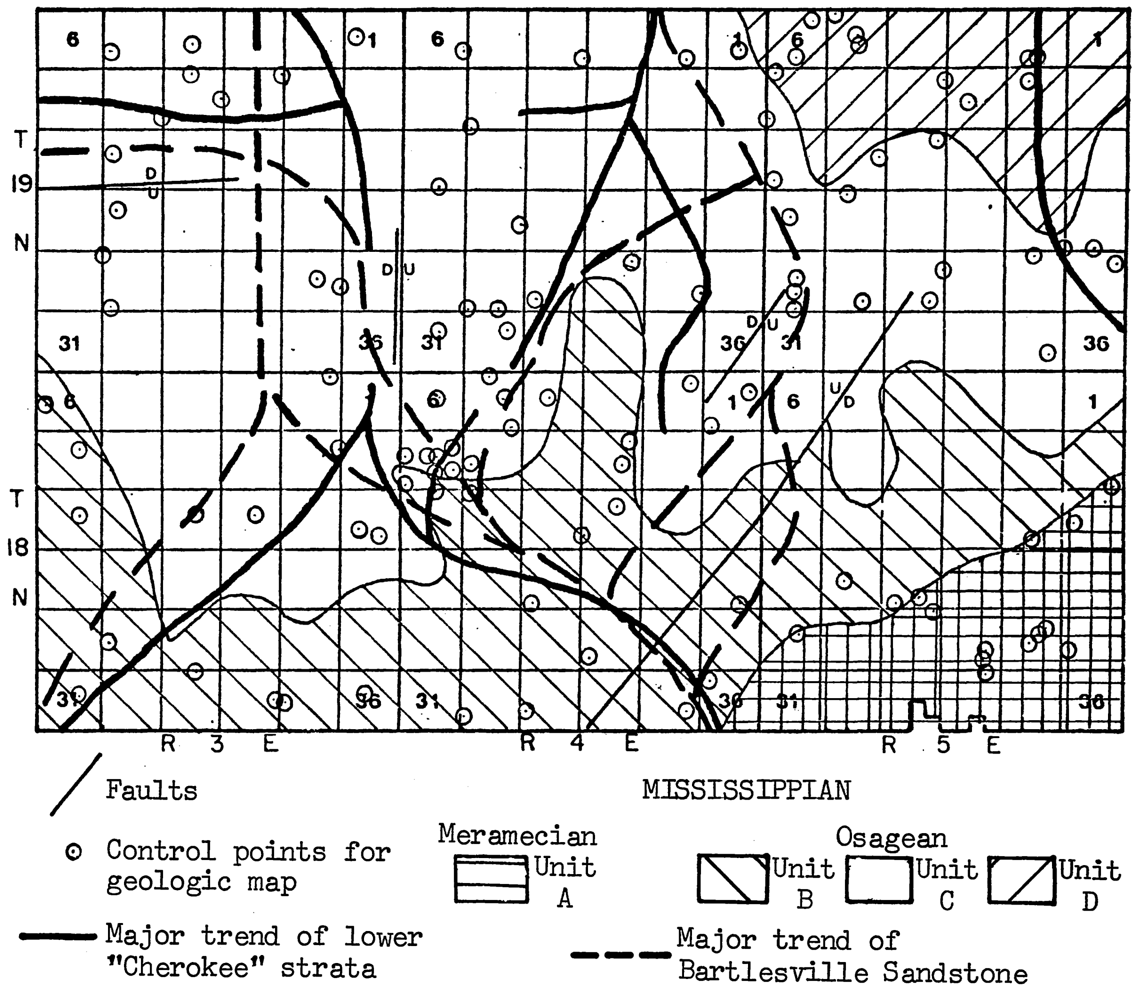
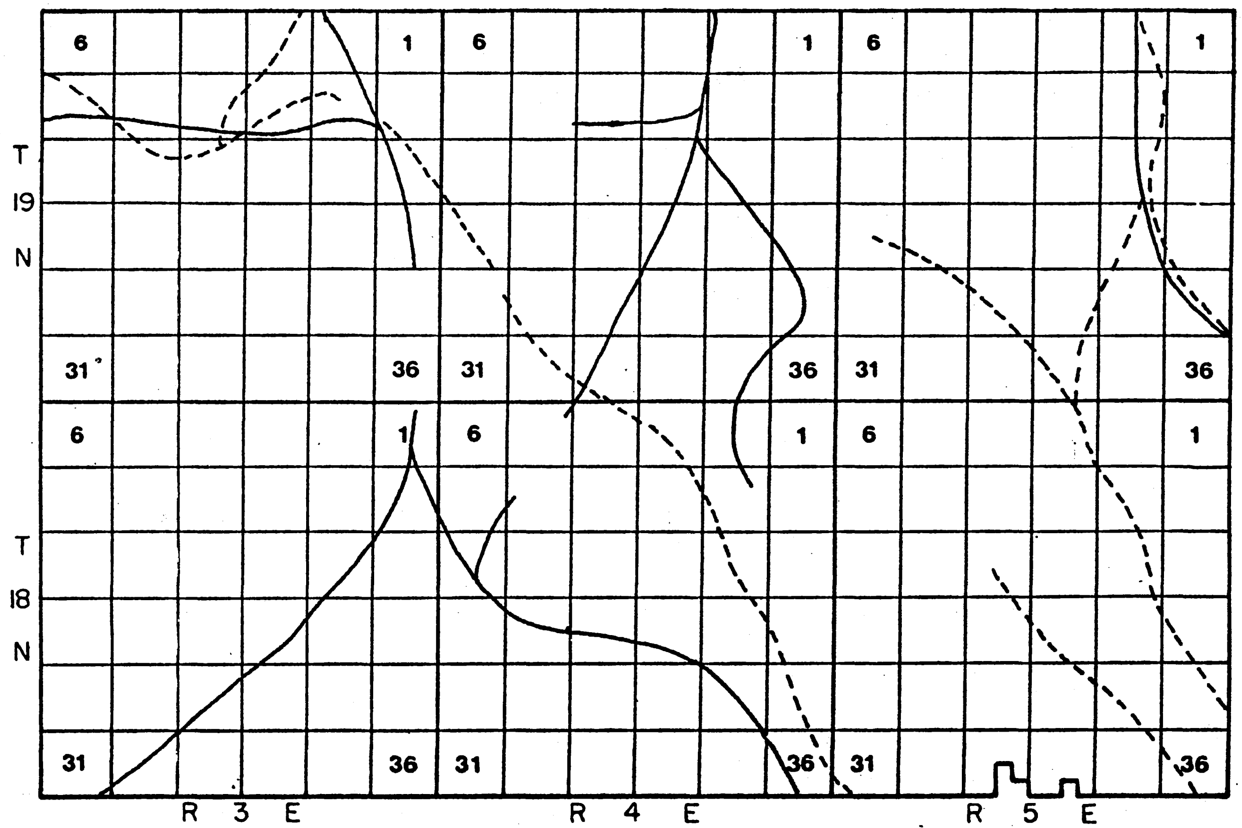


Figure 15. Geologic map of pre-Pennsylvanian rocks, with thick trends of lower "Cherokee" strata and Bartlesville Sandstone

lobe-like configuration of the Mississippian Unit B (Figure 15). Paleotopographic influence is shown by the trends of thick lower "Cherokee" in the Yale-Quay area and in the southern part of T18N, R3E. In the latter area there is also major development of Bartlesville Sandstone. Thick Bartlesville Sandstone also parallels the northwesterly trend of thick lower "Cherokee" in T18N, R4E.

Possible paleostructural influence of upper "Cherokee" deposition is shown by an isopach map of the interval between the base of the Oswego Limestone and the base of the Pink Limestone (Figure 16). The interval increases in thickness from less than 190 feet on the western edge of the study area to approximately 290 feet in the southeast corner (Figures 4-11). A north-northwesterly trend of thick upper "Cherokee" strata extends from the eastern part of T18N, R4E, to T19N, R3E. Several trends of anomalously thick interval are present in the eastern half of T18-19N, R5E. The easternmost trend, which is related to the older paleotopographic trend, may reflect differential compaction (Figure 17). The pre-Desmoinesian fault in the northern half of T19N, R3E, apparently influenced deposition of the upper "Cherokee," the trend of which parallels the lower "Cherokee" trend.

The Ingalls structure (T19N, R4E) and Norfolk structure (T18N, R5E), were active during "Cherokee" deposition; both are characterized by thin intervals of upper and lower "Cherokee" strata.



Thick trend of lower "Cherokee" deposits

Thick trend of upper "Cherokee" deposits

Figure 17. Relationships between thick trends of upper and lower "Cherokee" deposits

CHAPTER V

SANDSTONE TRENDS AND DEPOSITIONAL ENVIRONMENTS

An isopach map and a log map were prepared for each of five "Cherokee" sandstones as a means of delineating trends and distribution. Each isopach map portrays the thickness of the section from the overlying marker to the base of the sandstone. This type of map is thought to represent sandstone trends best where a sandstone is developed at a constant stratigraphic position with an abrupt basal contact. This is demonstrated in some areas by the development of the Upper Skinner, Lower Skinner, and Prue Sandstones.

The log map is an interpretative map based on the characteristics of electric logs opposite sandstone sections. Generally, log shapes define sandstone trends and edges better than the numerical values of thickness used in preparation of the isopach maps. Log maps permit an overview and easy comparison of subtle sandstone variation which may be important in estimating sandstone trends and depositional environments.

Burgess Sandstone

According to Jordan (1957), the Burgess Sandstone is a sandstone and conglomerate at the base of the Desmoinesian Series. It is included in the interval between the top of the "Mississippi" Limestone and the base of the Brown Limestone.

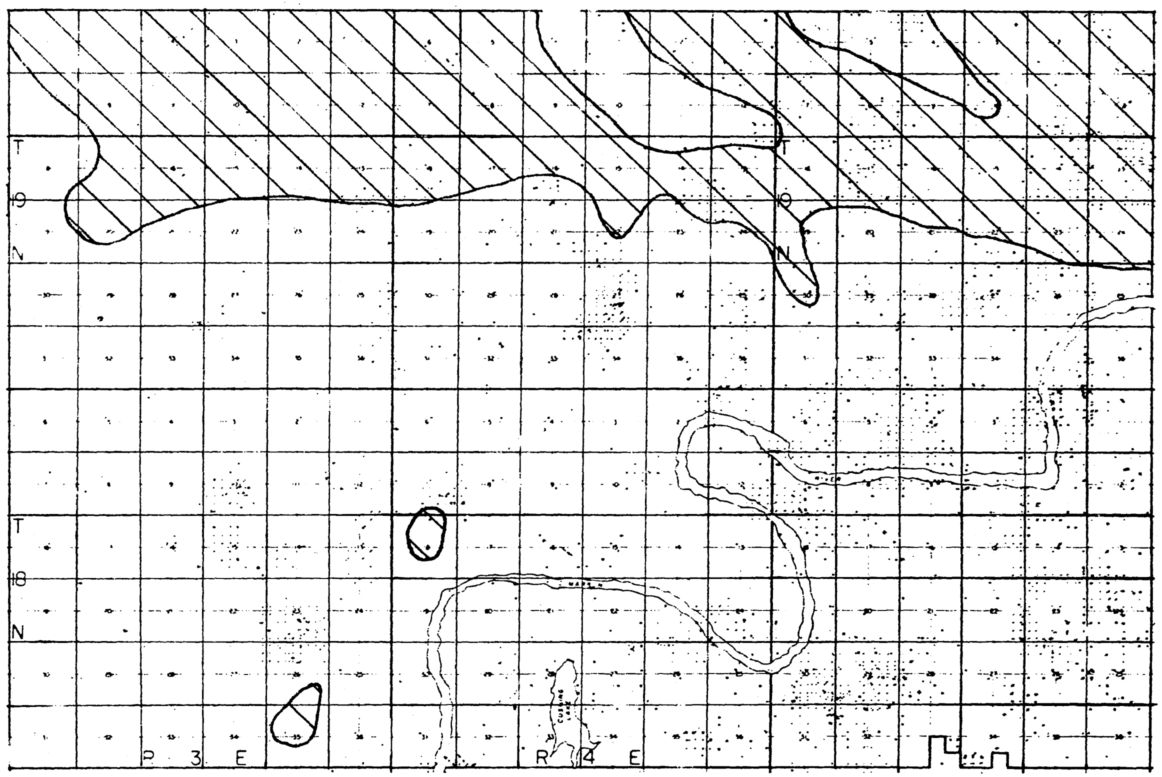
In some localities the Burgess Sandstone appears to lie directly on the "Mississippi" Limestone (Figure 5, well 1), but in most cases it is some 40 feet above the Mississippian. Average thickness is ten feet, and its development within the study area is limited (Figure 18).

Bartlesville Sandstone

The Bartlesville Sandstone was deposited during an overall regression which followed deposition of the Brown Limestone as an onlapping transgressive unit. According to Jordan (1957), the Bartlesville Sandstone is in the interval between the base of the Inola Limestone and the top of the Brown Limestone. This interval thickens from 80 feet in the northern part of the area to more than 100 feet in the southeast corner (Figures 4-11). A distribution map of the Brown Limestone, based on lateral-log deflection, indicates that it is absent in the north and west, apparently because of onlap (Figure 19). Erosion of the Brown Limestone may have preceded deposition of the Bartlesville in an elongated area in T18N, R4E.

Clayton (1965) described the Bartlesville Sandstone as a light gray, very fine- to medium-grained, angular to subangular, slightly argillaceous sandstone containing chert fragments. Sedimentary structures in a Bartlesville Sandstone core from Section 3, T17N, R7E, include interlamination deformed by flowage, massive bedding, and medium-scale crossbedding. Significant constituents include carbonized wood and filaments, claystone pebbles, pyrite, and carbonate cement.

A thick trend of the interval between the base of the Inola Limestone to the base of the Bartlesville Sandstone extends northwestward from the Georgia field in T18N, R4E (Figure 20). Major bifurcations of that trend occur in the North Ripley field (T18N, R4E), Northeast High



Burgess Sandstone

Figure 18. Distribution of Burgess Sandstone

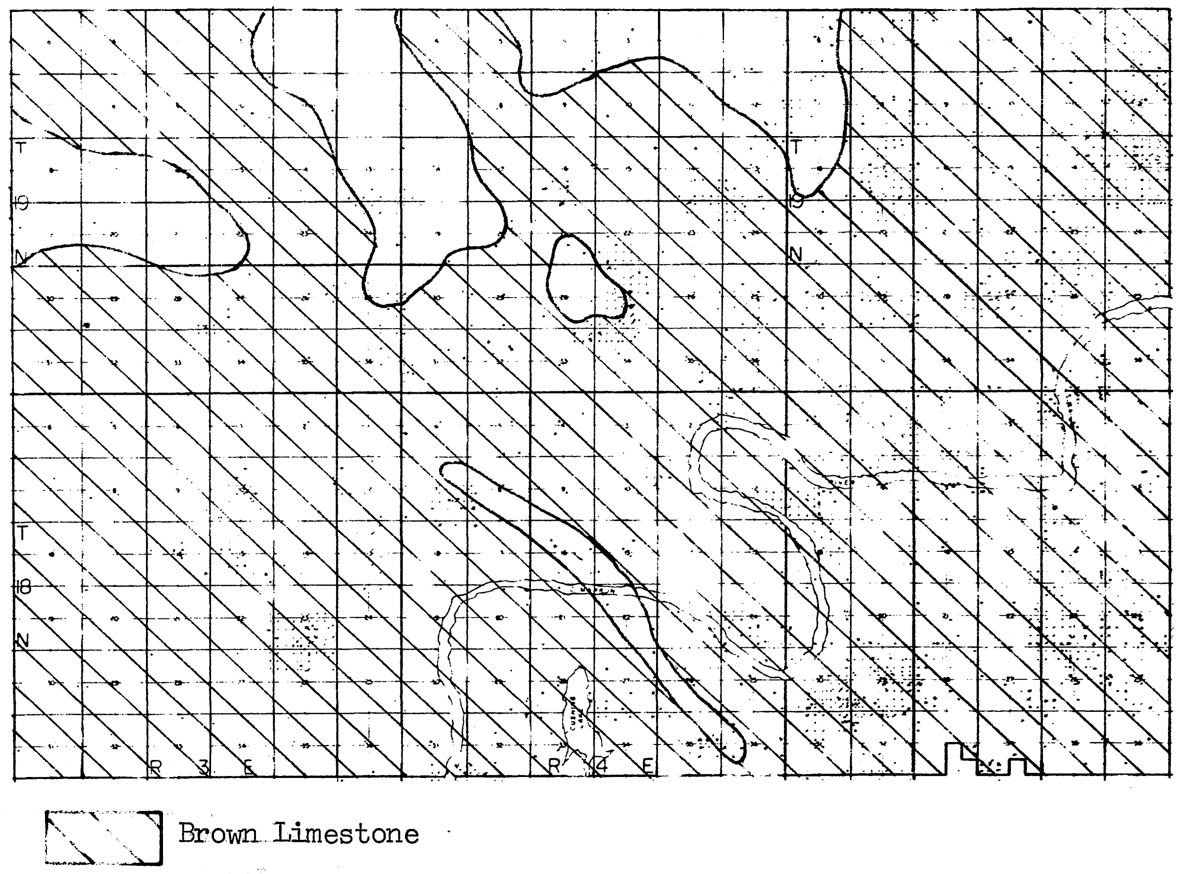


Figure 19. Distribution of Brown Limestone

Prairie field (T18N, R3E), and Starr Valley field (T19N, R3E). Two minor trends which intersect the major trend from the northeast are present in T18N, R4E. Maximum thickness is greater than 90 feet in Sections 11-12, T18N, R3E. Sandstone is absent in significant parts of T18N, R5E, and T19N, R4-5E.

Two arcuate belts of thick sandstone are delineated on the log map of part of T18-19N, R3E (Figure 21). The trend in T19N, R3E, parallels a paleostructural trend (Figure 17) and extends into T19N, R2E (Shipley, 1975).

Within the major trends, the self-potential curve shows a sharp deflection corresponding to the lower contact. This type of log is thought to represent deposition in a channel. Outside these trends typical gradational log deflections suggest non-channel depositional conditions. The southerly trend through the Southeast Stillwater field (T19N, R3E) on the isopach map (Figure 20) is not present on the log map (Figure 21). Variations in log shape and vertical position of sandstone development are probably best shown by the two trends on the log map. The general geometric pattern, displayed by the isopach and log maps, is one of elongated, anastomosing, and bifurcating sandstone bodies.

Visher (1968), Cole (1969), and Visher et al. (1971), from regional studies, have concluded that the Bartlesville Sandstone was deposited as part of a south-prograding, deltaic complex. In the area of study thick Bartlesville Sandstone is considered to have been deposited in deltaic distributaries with variable paleocurrent directions. Thinner, non-channel sandstone is thought to represent delta-fringe deposits, formed in interdistributary and/or delta-front areas.

Red Fork Sandstone

Jordan (1957) defined the Red Fork Sandstone as the units between the base of the Pink Limestone and the top of the Inola Limestone. The interval thickens eastward from approximately 90 feet on the western edge of the area to about 115 feet in the southeast corner of T18N, R5E (Figures 4-11).

The Red Fork Sandstone in a core from the Butcher field is characterized by interstratified shale and sandstone, small-scale crossbedding, flaser bedding, and abundant burrows (Figures 22-24). Sandstone, which is poorly developed, is very fine-grained. Intraformational fragments are present in sandy sections; muscovite and carbonaceous material decrease in abundance in sandstone beds.

The interval from the base of the Pink Limestone to the base of the Red Fork Sandstone shows a complex pattern of sandstone trends across the study area (Figure 25). Sandstone is locally absent in parts of the West Garr field (T19N, R5E), North March and Norfolk fields (T18N, R5E), Broyles field (T18N, R4E), and Northwest Mount Hope field (T19N, R3E) areas. The unusually thick trends and complex geometry indicate that the Red Fork Sandstone is multistoried.

Two log maps of the north-central part of the study area illustrates the multistoried nature of the sandstone (Figures 26 and 27). Edges of upper and lower sandstones can be delineated within the area. Permeable sandstone is locally absent in the southeast and southwest corners and in parts of the south-central and east-central sections of the map. The lower sandstone (Figure 26), with log characteristics of a channel deposit, is more widespread than the upper sandstone (Figure 27),

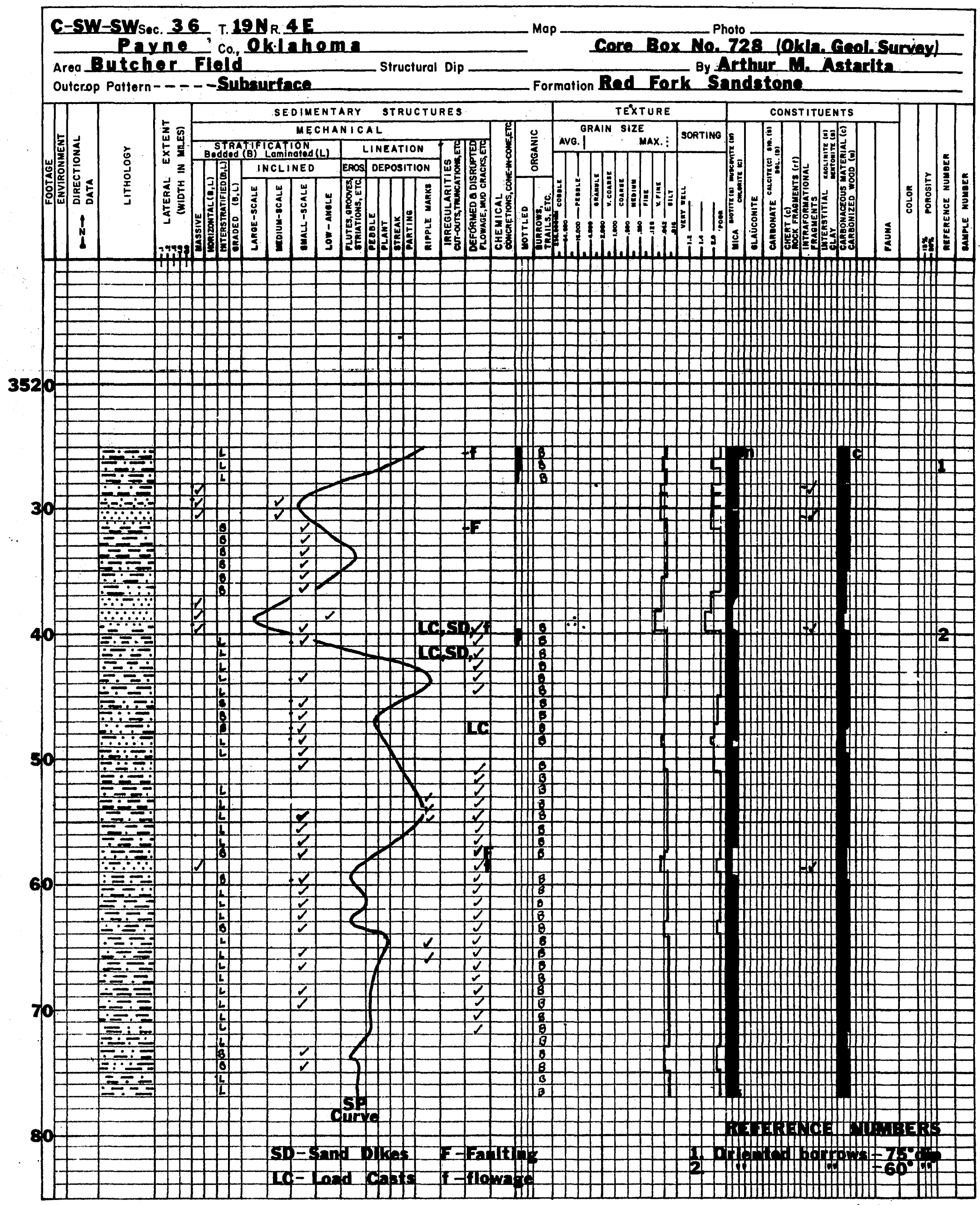


Figure 22. Core description of Red Fork Sandstone, Tenneco Oil Company, Butcher Line Injection Well No. 1 and electric log of interval

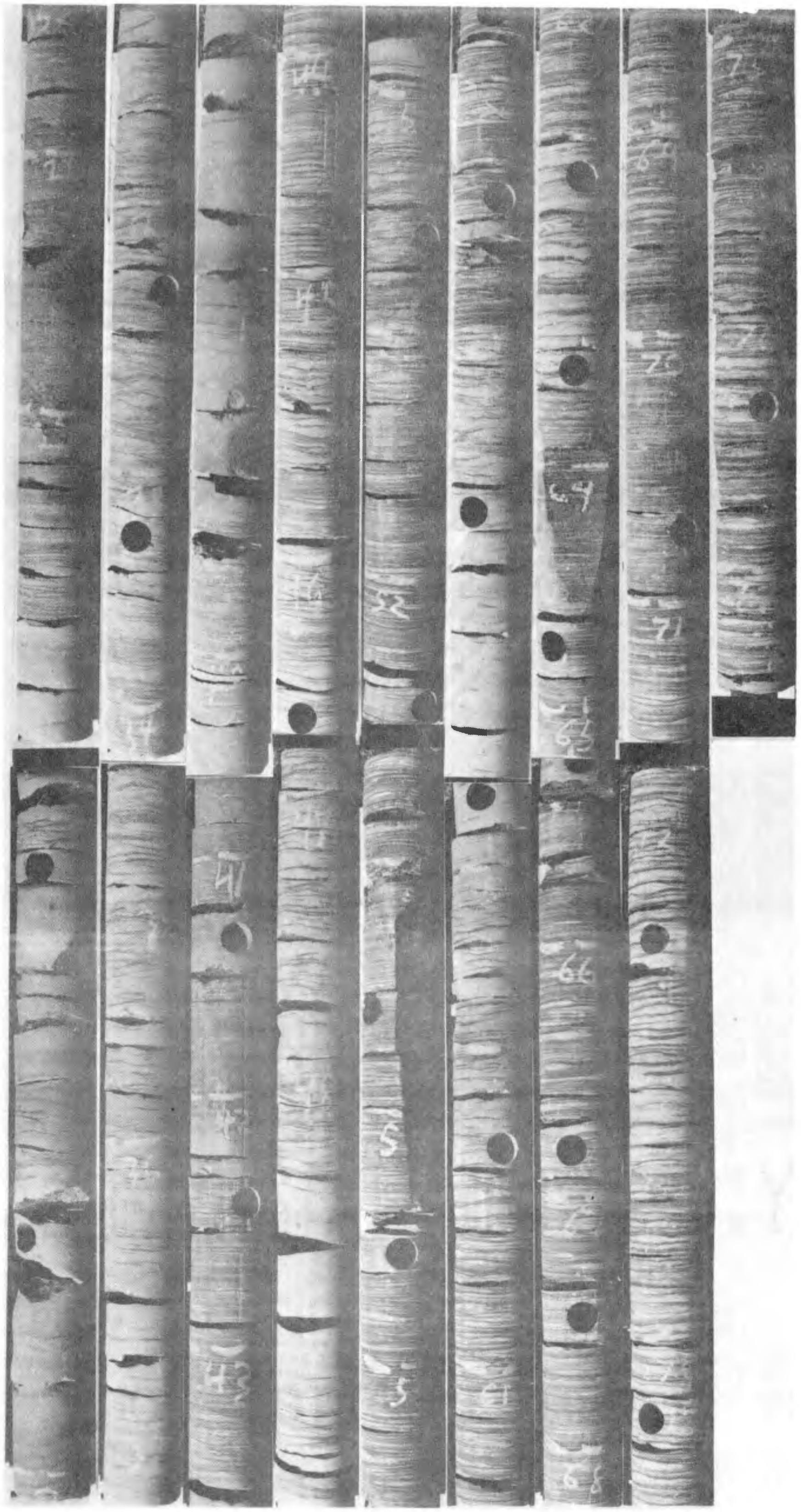


Figure 23. Photograph of Red Fork Sandstone, Tenneco Oil Company, Butcher Line Injection Well No. 1

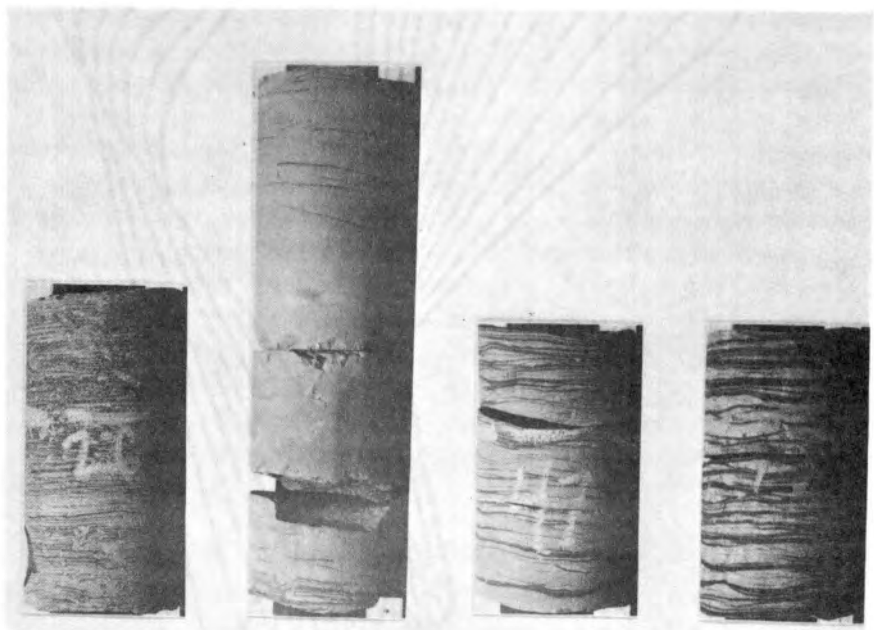


Figure 24. Significant sedimentary structures of Red Fork Sandstone, Tenneco Oil Company, Butcher Line Injection Well No. 1.
A, interlamination and burrows; B, massive bedding, low-angle, inclined bedding with interlaminae of shale, small-scale crossbedding, and load casts; C, interlamination, small-scale crossbedding, and load casts; D, flaser bedding.

development of which is more commonly restricted to relatively narrow belts. The upper sandstone also has the log characteristics of channel deposits, and the different trends probably represent different ages for channel positions.

Thick Red Fork Sandstone within the study area is thought to represent deposition in major and minor distributary channels of a deltaic system which prograded southward during a major regression (McElroy, 1961; Cole, 1969). Poorly developed sandstone outside major trends, similar to that observed in the core, probably represents interdistributary deposits.

Lower Skinner Sandstone

The Lower Skinner Sandstone was deposited during the regression which followed deposition of the transgressive Pink Limestone. The sandstone, as defined by Jordan (1957), is the interval between the base of the Henryetta Coal and the top of the Pink Limestone. This interval is thickest in the southeastern part of the study area which is as much as 95 feet thick (Figures 7 and 11).

The Lower Skinner Sandstone, as observed in three cores in the March field (T18N, R5E), is a very fine- to fine-grained sandstone with interbedded shale (Figures 28-33). Grain size is characterized by an overall upward increase. Small-scale crossbedding, low-angle inclined bedding, deformation due to flowage, and burrows are common structures (Figure 34). Sandstone is relatively well-developed in the W-6 core, which has several feet of medium-scale crossbedding overlying very fine-grained sandstone with small-scale crossbedding. The upper part is thought to represent a different environment than the underlying section.

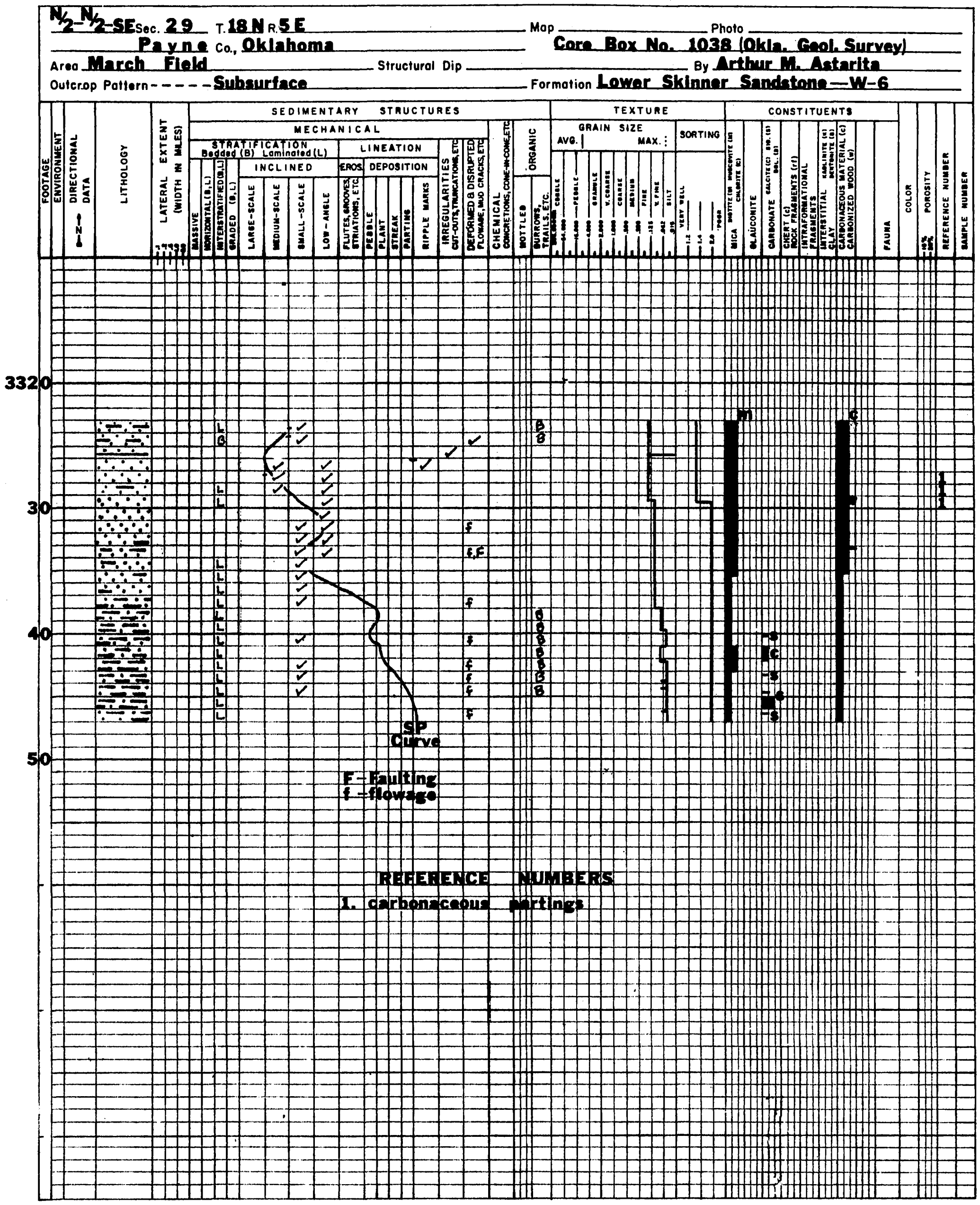


Figure 28. Core description of Lower Skinner Sandstone, Cleary Petroleum Corporation, March Lower Skinner Sand Unit W-6 and electric log of interval

Figure 29. Photograph of Lower Skinner Sandstone, Cleary Petroleum Corporation, March Lower Skinner Sand Unit W-6

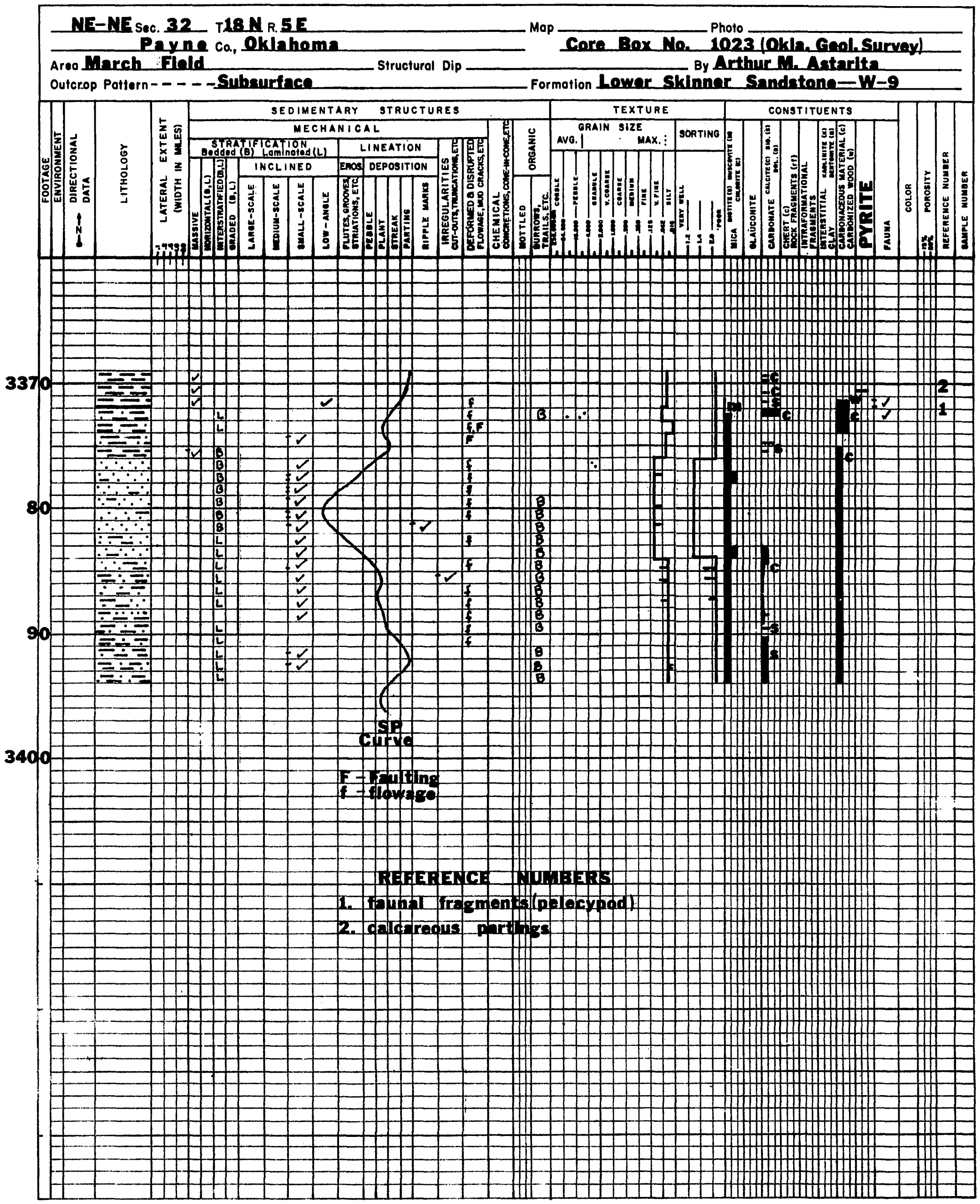


Figure 30. Core description of Lower Skinner Sandstone, Cleary Petroleum Corporation, March Lower Skinner Sand Unit W-9 and electric log of interval

Figure 31. Photograph of Lower Skinner Sandstone, Cleary Petroleum Corporation, March Lower Skinner Sand Unit W-9

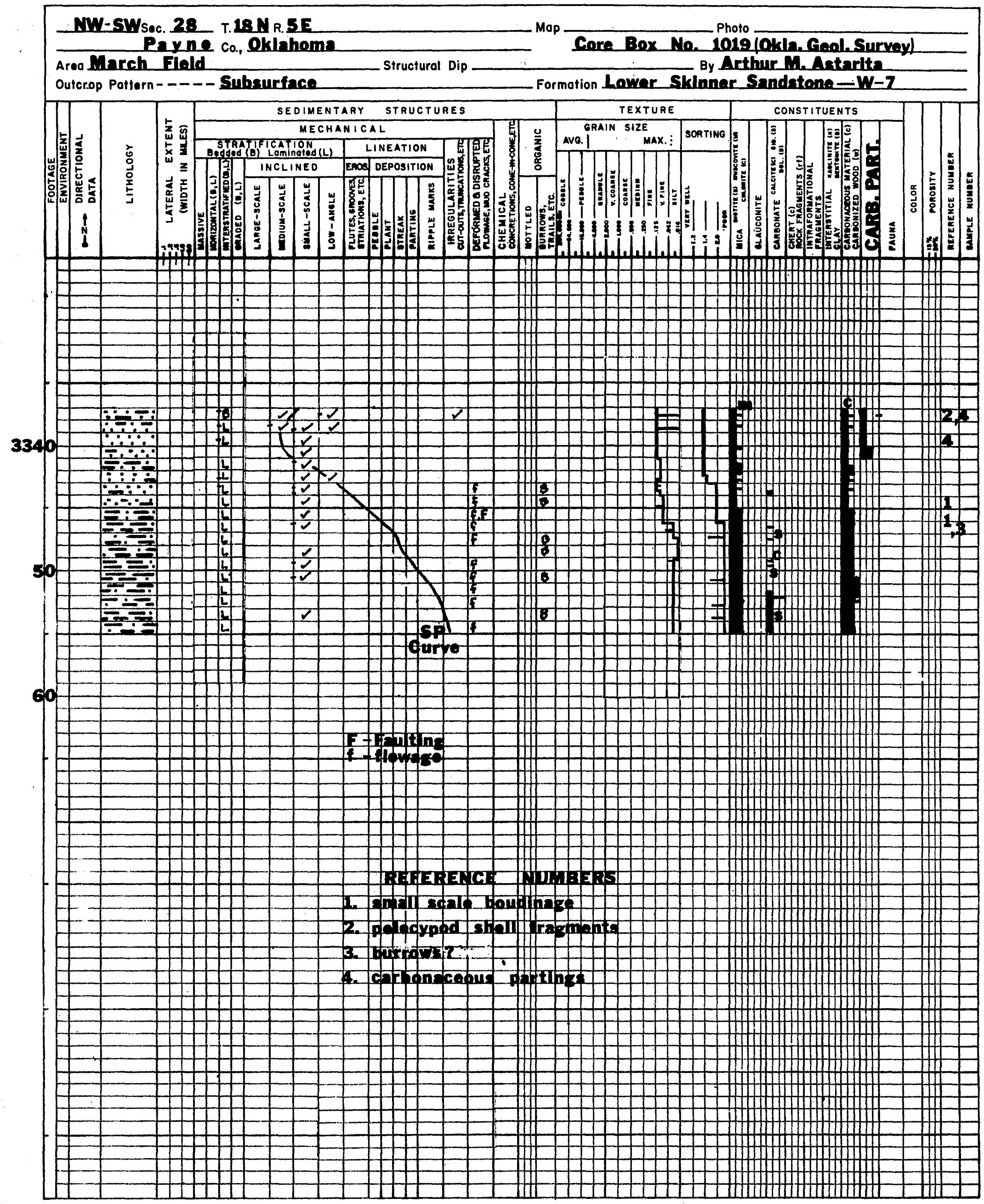


Figure 32. Core description of Lower Skinner Sandstone, Cleary Petroleum Corporation, March Lower Skinner Sand Unit W-7 and electric log of interval

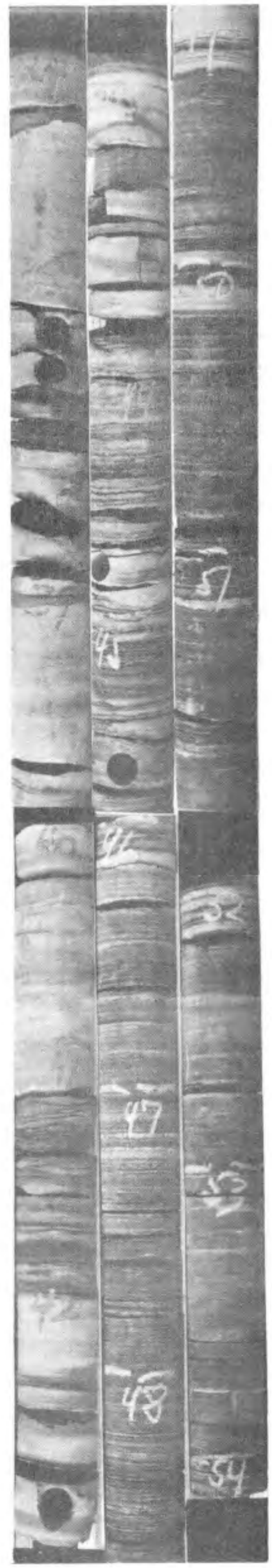


Figure 33. Photograph of Lower Skinner Sandstone, Cleary Petroleum Corporation, March Lower Skinner Sand Unit W-7

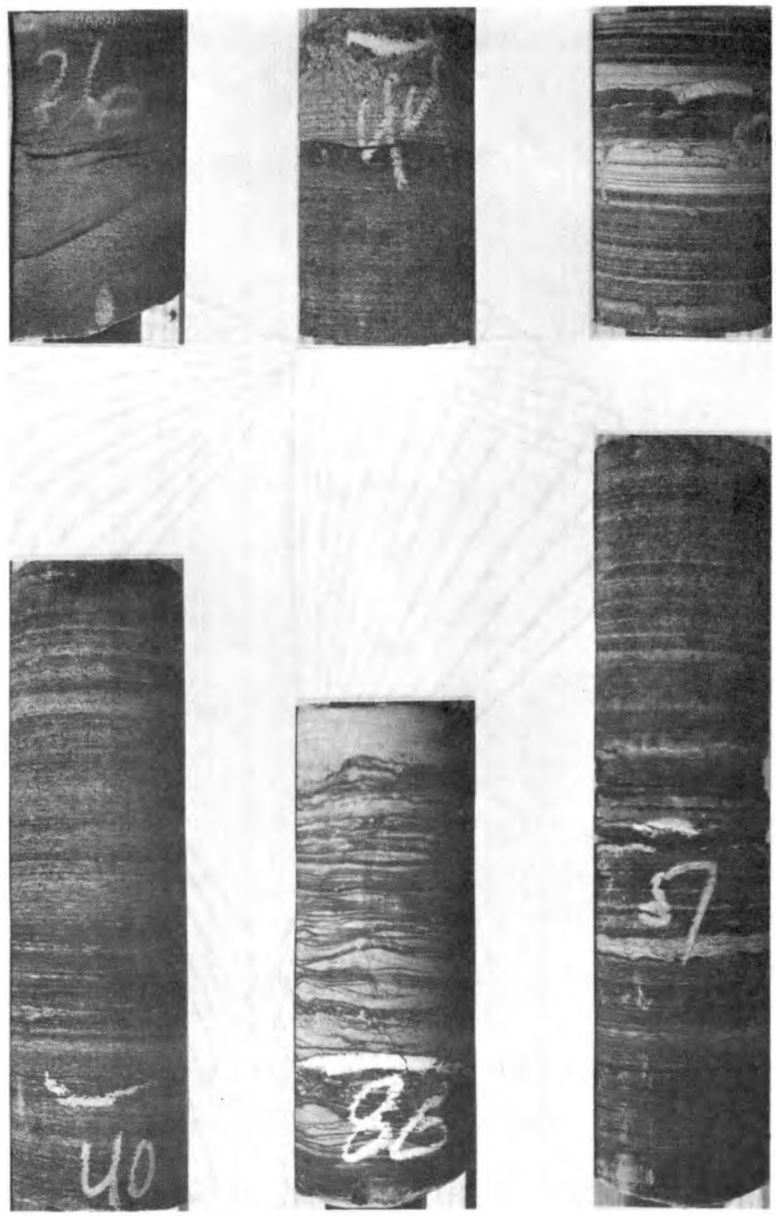


Figure 34. Significant sedimentary structures of Lower Skinner Sandstone, March field, Payne County, Oklahoma. A, medium-scale crossbedding (W-6); B, convolute bedding above sharp sandstone-shale contact, disturbed laminae (W-6); C, Burrows disturbing laminae of sandstone and shale (W-7); D, interlamination and burrows (W-6); E, flaser bedding and burrows (W-9); F, interlamination with bed of shale (at smaller diameter) and convolute bedding in thin sandstone (W-7)

The interval extending from the base of the Henryetta Coal to the Lower Skinner Sandstone depicts a complex pattern of sandstone distribution (Figure 35). A rather well-developed northerly belt in the eastern portion of T18-19N, R5E, is separated from other trends by a large area where sandstone is absent. A complex of trends extends generally northward and northwestward in the vicinity of the Broyles field (T18N, R4E). Minor trends are present in T18N, R3E. Large and small areas of no sandstone are present in the central part of the map.

An interpretation of the relative ages of different sandstone trends is given on the log map of an area which includes locations of the cored wells (Figure 36). A sandstone trend which extends southeastward from Section 25, T18N, R4E, is thought to be intersected by two northeasterly trends. The upper part of the cored interval in W-6 well is part of one of the northeasterly trends. Development of a lower sandstone is present in the eastern sections of the log map as a meandering northerly trend. Based on log character and core examination, these trends are interpreted as channel deposits. Narrow, elongated, upper sandstone bodies also are probably channel deposits; some of these trends closely parallel the lower channel deposits.

Based on core examination and the geometry portrayed by the isopach and log maps, the Lower Skinner Sandstone was deposited in a deltaic environment. Beter developed sandstone was probably deposited in distributaries, whereas sandstone such as that in W-7 and W-9 cores was deposited as delta-fringe units.

Upper Skinner Sandstone

The Upper Skinner Sandstone is between the base of the Verdigris

Limestone and the top of the Henryetta Coal (Jordan, 1957). The persistent and distinctive electric log response of the Henryetta Coal on most of the Northern Oklahoma platform may suggest that it is associated with a transgression (Shipley, 1975). The Upper Skinner Sandstone apparently was deposited during the subsequent regression. The interval has an average thickness of 65 feet; it is fairly uniform throughout much of the area (Figures 4-11).

The Upper Skinner Sandstone may be similar to the description of cuttings by Stringer (1957). He described the sandstone in western Payne County as off-white, buff, light, or dark gray, very fine- to fine-grained, subangular, clear, micaceous, argillaceous and silty, poorly sorted, and tight.

Large areas of little or no development of sandstone are present in the study area (Figure 37). Trends are present in the eastern and southern parts of the study. An east-trending, thick deposit in southern Yale-Quay (T19N, R5E) is bifurcated north of T18N, R5E. These resulting trends join a major northwest system which extends from the Georgia field area in T18N, R4E, to the North Ripley field (T18N, R3E). Log characteristics indicate that the Upper Skinner is a multistoried-multilateral channel complex within a relatively thin section (Figure 38). Possible relative sequences of trend development is shown on the log map. Trends are thought to be coincident in eastern parts of T18N, R4E.

The gradational basal contacts of sandstones outside the major trends are apparently representative of delta-fringe environments, and sharp log deflections on some logs near the top of the sandstone may represent deposits of minor distributaries.

Prue Sandstone

According to Jordan (1957), the Prue Sandstone is between the base of the Oswego Limestone and the top of the Verdigris Limestone. The Sandstone represents the final regressive phase of the "Cherokee" Group. Figures 4-11 portray thickening of this interval from about 65 feet in the western sections of the thesis area to more than 110 feet in the east. Locally, within T18-19N, R5E, the thickness is as much as 130-140 feet.

In a core of the Prue Sandstone from the Butcher field in T19N, R4E, the sandstone is very fine- to fine-grained with massive bedding and medium-scale, small-scale and low-angle crossbedding (Figures 39-41). The sandstone contains muscovite and carbonaceous material, with intraformational claystone fragments and siderite cement at different levels. Crystalline limestone at the base of the sandstone is thought to be Verdigris Limestone. Recognizable skeletal material includes crinoid plates, pelecypods, and bryozoan fragments. Approximately two feet of black shale underlain by coal are below the Verdigris in the lowest part of the core.

The interval of the base of the Oswego Limestone to the base of the Prue Sandstone is characterized by complex bifurcations of trends (Figure 42). Major development occurs in the eastern half of the area, where maximum thickness within a given trend varies from 80 feet to 140 feet. A complex, anastomosing pattern is exhibited by the system in T18-19N, R5E. The deposition of Prue Sandstone, after erosion of the Verdigris Limestone, accounts for the thick interval along these trends. Sandstone is locally absent in the Garr field (T19N, R5E) and Broyles

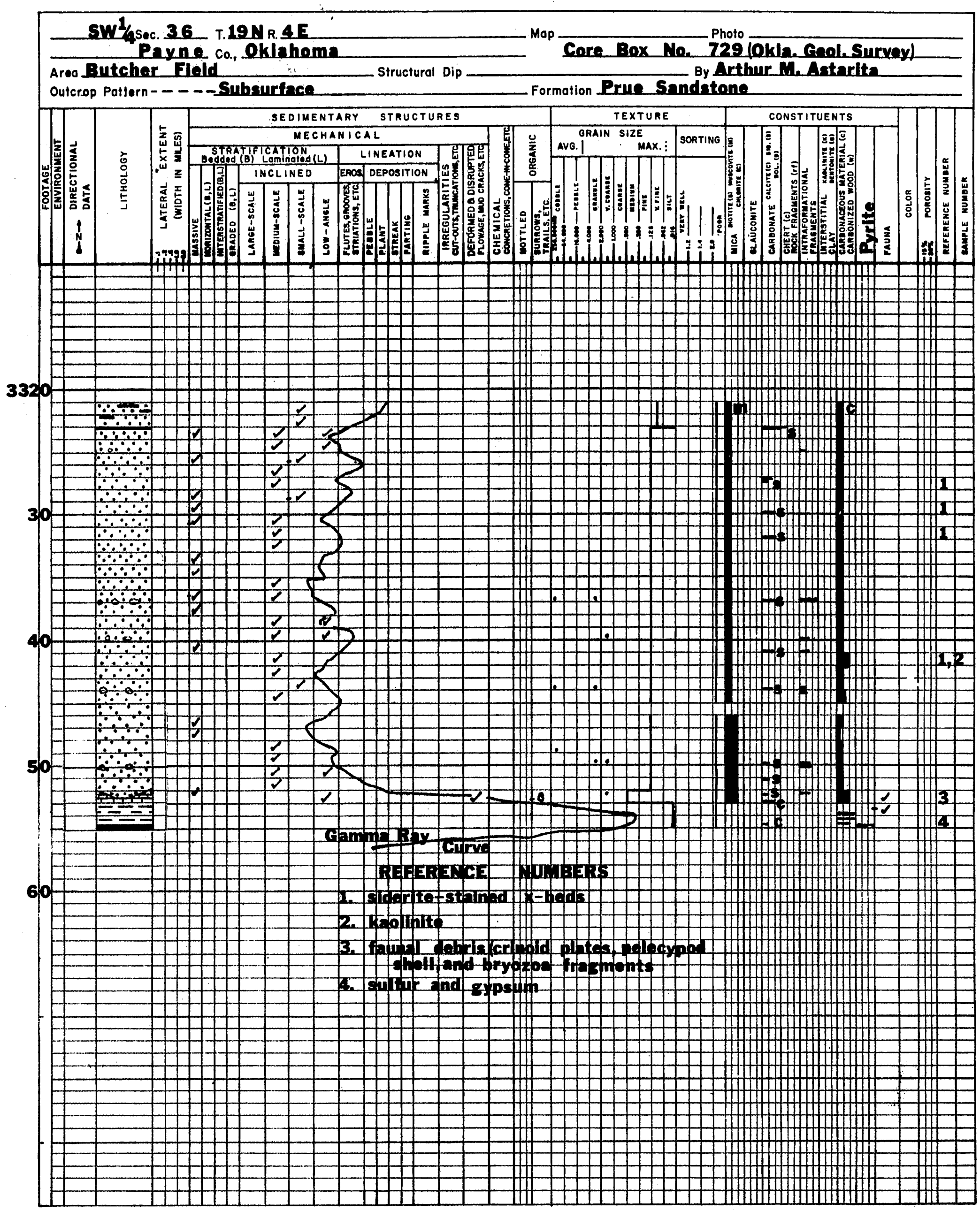


Figure 39. Core description of Prue Sandstone, Tenneco Oil Company, Butcher Line Injection Well No. 2 and electric log of interval

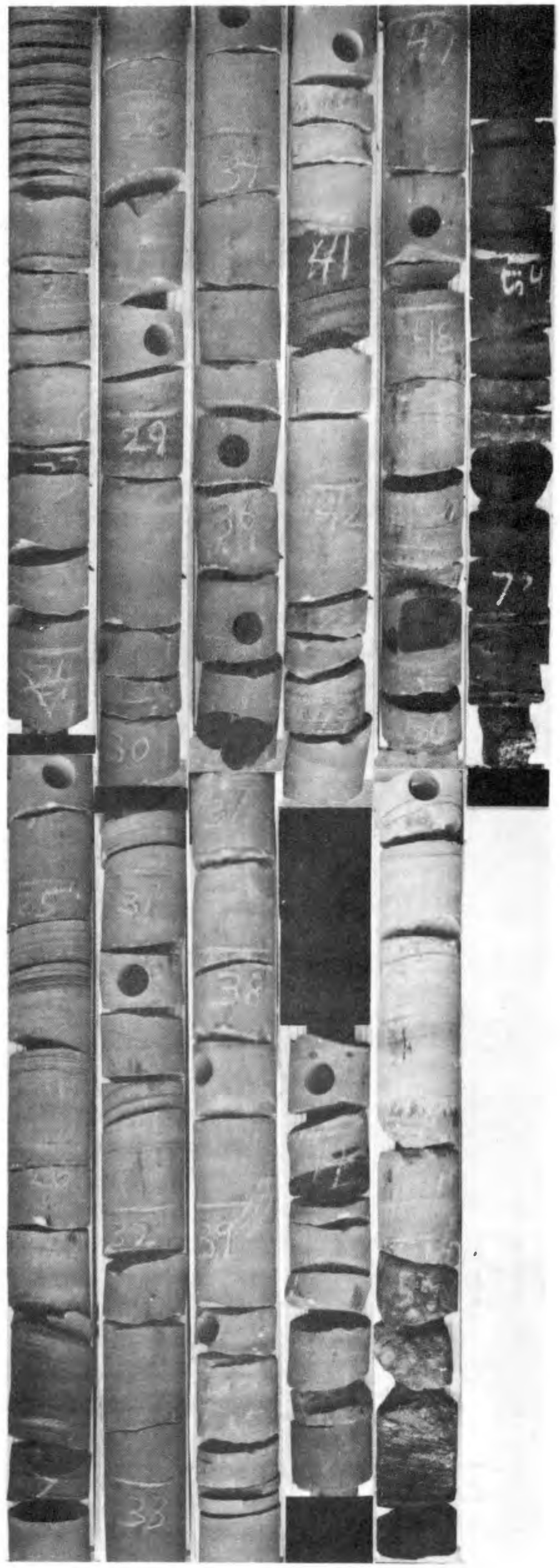


Figure 40. Photograph of Prue Sandstone, Tenneco Oil Company, Butcher Line Injection Well No. 2

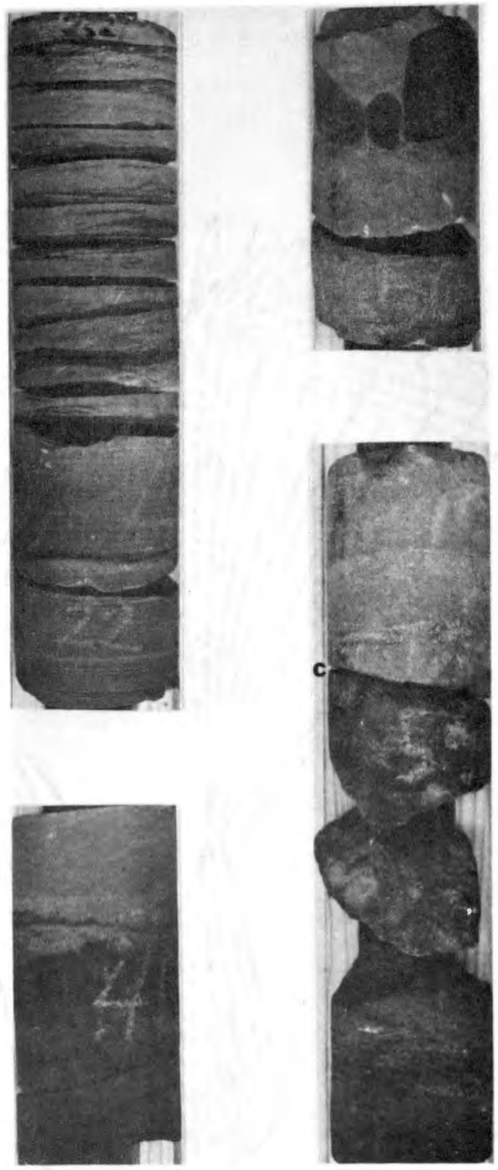


Figure 41. Significant sedimentary structures and other features of Prue Sandstone, Tenneco Oil Company, Butcher Line Injection Well No. 2. A, small-scale crossbedding above parallel bedding; B, intraformational fragments from disrupted sideritic clay drape; C, medium-scale crossbedding with sideritic cement and scattered patches of authigenic kaolinite; D, contact (c) with Verdigris Limestone; massive bedding in sandstone; bioturbation in limestone.

field (T18N, R4E) and west of the Ripley field (T18N, R4E).

On the log map of the area, which includes the cored well, trends are estimated from logs with sharp basal SP deflection, presence of thick sandstone at a significantly lower stratigraphic position than sandstone outside the trend, and erosion of the Verdigris Limestone (Figure 43). A northeast-trending channel sandstone in the western part of the map includes the cored well. Sandstone outside this trend is probably delta-fringe deposits. The eastern part of the map probably displays at least three multistoried and multilateral channel deposits. The Verdigris Limestone was eroded along a belt with branches both to the north (Sections 27 and 28, T19N, R5E) and south (Sections 10 and 11, T18N, R5E). The channel deposits apparently are composed of shale and rather poorly developed sandstone in the northern part of the map, whereas thick, well-developed sandstone is present as channel deposits in the southern sections. Prue Sandstone seems to be best developed east of where the Verdigris is absent (Sections 26 and 35, T19N, R5E; Section 11, T18N, R5E). In the easternmost sections, however, sandstone becomes more poorly developed especially in the upper part.

Isopach map, log map, and internal features suggest deposition in a deltaic environment. Major sandstone units may have been deposited in distributaries, whereas minor sandstone bodies were probably deposited in delta-fringe environments. Deposition of the "Cherokee" Group was terminated by the major transgression during which the Oswego Limestone was deposited.

CHAPTER VI

SUMMARY

The principal conclusions of this study are as follows:

1. Rocks of Pennsylvanian (Desmoinesian) "Cherokee" Group are the oldest Pennsylvanian rocks in the study area, and they are unconformably underlain by "Mississippi" Limestone of Meramecian and Osagean age.

2. The "Cherokee" Group is composed of repetitious sequence of shales, lenticular sandstones, thin limestone, and an occasional coal bed.

3. The sequence of strata bounded by successive transgressive markers represents a transgressive-regressive couplet.

4. Following regional uplift, stream drainage on the Mississippian surface was structurally controlled in areas such as the Ingalls and Starr Valley fields.

5. Distribution of lower "Cherokee" sediments, particularly the Bartlesville Sandstone, was influenced by paleostructure and paleotopography.

6. Major sandstone bodies are thought to have been deposited in major and minor distributary channels of south- to east-prograding deltaic complexes. Poorly developed sandstones within the "Cherokee" Group are thought to be delta-fringe in origin.

7. Local depositional trends of the Red Fork, Lower Skinner, and Prue sandstones are generally north-south. Bartlesville and Upper

Skinner sandstones have east-southeast trends.

8. Multilateral and multistoried sandstone bodies are geometically complex.

9. Use of log maps define sandstone trends and edge better than conventional isopach maps.

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APPENDIX

LOCATIONS OF ELECTRIC LOGS USED IN PREPARATION OF CORRELATION SECTIONS

No.	Operator and Well Number	Location

East-West Correlation Section A-A'

1.	Harper Oil Co., Glover #1	SW NW SW Sec. 5-19N-3E
2.	Foster Drilling Co., Hoyt #1	NE NE NW Sec. 9-19N-3E
3.	Flynn Oil Co., Hamby #1	SE SE NE Sec. 9-19N-3E
4.	Wilcox Oil Co., Denny #1	NE NE NE Sec. 10-19N-3E
5.	H. E. Reding, Harting #1	SE SW NW Sec. 1-19N-3E
6.	Helmerich & Payne Inc., Drumm #1	SE NE SE Sec. 6-19N-4E
7.	National Associated Petroleum Co., #1 Cullers et al.	NE SE SE Sec. 4-19N-4E
8.	Fullerton Oil Co., Clayton Rains #1	NE SW SE Sec. 2-19N-4E
9.	Van-Tex Petroleum Corp., Michele #1	NE NE SE Sec. 1-19N-4E
10.	Lion Petroleum Co., Pate #1	NW SW SE Sec. 6-19N-5E
11.	Sun Oil Co., Kolb #3	SW NW SE Sec. 5-19N-5E
12.	Sun Oil Co., Shephard #2	SW NW NW Sec. 10-19N-5E
13.	McElroy Ranch Co., Norman #1	NE SE SW Sec. 2-19N-5E

East-West Correlation Section B-B'

1.	E. J. Athens, Focht #1	NE SW NW Sec. 20-19N-3E
2.	Flynn Oil Co., Hunt #1	NE NE SE Sec. 21-19N-3E
3.	Royal Oil & Gas Corp., Jones #1	SW SW NE Sec. 26-19N-3E
4.	Don W. Jones, Leach #1	NE NE SE Sec. 26-19N-3E
5.	T. N. Berry & Co., Bennett #1	NW SW NE Sec. 31-19N-4E
6.	Lee Evans Drilling Co., & Basin Oil Co., Madison #1	SW SW SW Sec. 29-19N-4E
7.	Bay Petroleum Corp. & Viersen & Cochran, Stencamp #1	SW SW SE Sec. 29-19N-4E
8.	Fullerton Oil Co., Ezra Long Etux #1	NE SW SW Sec. 28-19N-4E
9.	W. G. Skelly, Fisher #1	SW NE NE Sec. 27-19N-4E
10.	J. E. Crosbie, Inc., Minnie Walker #1	SE NE SE Sec. 26-19N-4E
11.	Mid-Continent Petroleum Corp. School-Land #229, Well #1	SW NE NW Sec. 36-19N-4E
12.	Skelly Oil Co., Simpson #2	SW NW SE Sec. 30-19N-5E
13.	Josaline Production Co., Amerada #1	NE SW SE Sec. 29-19N-5E
14.	Great Plains Petroleum Corp., Berry #5	NW SE SE Sec. 28-19N-5E
15.	Skelly Oil Co., Anna Reed #1	SE SE NW Sec. 27-19N-5E
16.	Skelly Oil Co., Okeefe Heirs #1	NW NW NE Sec. 26-19N-5E
17.	Deep Rock Oil Corp., Gertie Little Chief #1	SW SW SW Sec. 24-19N-5E
18.	Lincoln Drilling Co., Shaw #2	SW SE NE Sec. 25-19N-5E

East-West Correlation Section C-C'

1.	S & K Oil Co., City of Stillwater #1	SW SW NE Sec. 18-18N-3E
2.	Deep Rock Oil Co., School Land #1	SW SW NW Sec. 16-18N-3E
3.	United States Smelting Refining & Mining Co., State "A" #1	SW SW NE Sec. 16-18N-3E
4.	John E. Buches, Gray #1	SW SW NE Sec. 15-18N-3E

No.	Operator and Well Number	Location

East-West Correlation Section C-C' (Continued)

No.	Operator and Well Number	Location
5.	L. B. Jackson et al., McGuire #1	NE SE NE Sec. 11-18N-3E
6.	Patton Brothers Drilling Co., Ross #1	NW NW NE Sec. 12-18N-3E
7.	Patton Drilling Co., Snider #1	SW SW NW Sec. 7-18N-4E
8.	Summit Drilling Corp., De Jarnette #1	SW SW NE Sec. 7-18N-4E
9.	T. N. Berry & Co., Sherrill #1	SW SE SE Sec. 5-18N-4E
10.	Mohawk Drilling Co., Horn #1	NE NW SE Sec. 10-18N-4E
11.	Ashland Oil & Refining Co., Morgan #1	SE SW SW Sec. 1-18N-4E
12.	J. E. Crosbie, Bryant #1-B	SE SE Sec. 6-18N-5E
13.	D & L Oil Co., & Wilcox & Henry, Patterson #1	SE SE NW Sec. 16-18N-5E
14.	O'Brien Co., Thurman #1	NW NW NE Sec. 14-18N-5E
15.	Gulf Coast Western Oil Co., Estate Land #1	SE SE SE Sec. 12-18N-5E

East-West Correlation Section D-D'

No.	Operator and Well Number	Location
1.	Gulf Oil Corp., Hattie Offield #1	SW SW NE Sec. 31-18N-3E
2.	H. E. R. Drilling Co., Johnson #1	NW NW SW Sec. 29-18N-3E
3.	Jones-Shelburne & Pellow Co., Courtwright #1	NW NW NW Sec. 28-18N-3E
4.	Fred T. Haddock, Nelson #1	NW NW NE Sec. 33-18N-3E
5.	Regan J. Caraway, State #1	NE NE SE Sec. 34-18N-3E
6.	Midland Cooperative Wholesale, Lovell #1	SE SW NW Sec. 35-18N-3E
7.	J. E. Trigg, State #1	SE SE NW Sec. 36-18N-3E
8.	Foster Drilling Co., Grimm #1	NE SE SW Sec. 31-18N-4E
9.	Delaney Drilling Co. et al., Ballard #1	NW SW SW Sec. 32-18N-4E
10.	H. Waggoner, Cook #1	SW NW SW Sec. 33-18N-4E
11.	T. W. & J. M. Loffland, Jr., Stanolind-Amerada #1	NE SW SW Sec. 27-18N-4E
12.	Time Petroleum Co., Mandeville #1	SW NE SE Sec. 35-18N-4E
13.	Josaline Production Co., State #2-C	NW NW SW Sec. 36-18N-4E
14.	Foster Drilling Co., Hall #4	NE SE NE Sec. 31-18N-5E
15.	J. M. Thompson, Harter #2	$N\frac{1}{2}$ SE Sec. 29-18N-5E
16.	Woods Drilling Co., #1 Carter Oil Co.	SW NE SE Sec. 27-18N-5E
17.	Bay Petroleum Corp., Thompson #2	SE SW NE Sec. 26-18N-5E
18.	W. H. Martgan, Freud #1	SE NW SW Sec. 25-18N-5E

North-South Correlation Section E-E'

No.	Operator and Well Number	Location
1.	Wood Oil Co., Hesser #1	NE NE SW Sec. 4-19N-3E
2.	Foster Drilling Co., Hoyt #1	NE NE NW Sec. 9-19N-3E
3.	Garr Woolley Oil Co., Leigh #1	NE SE SE Sec. 8-19N-3E
4.	Vierson & Cochran, Wilson #1	SW SW NW Sec. 17-19N-3E
5.	Wilcox Oil Co., Focht #1	NE SW NW Sec. 20-19N-3E
6.	W. H. Martgan, Goom #1	NE NE NE Sec. 30-19N-3E
7.	Beach & Talbot, Linsenmeyers #1	SW SW SW Sec. 29-19N-3E
8.	Ned Biffle, Sumner #1	NW NW SW Sec. 6-18N-3E

No.	Operator and Well Number	Location
	North-South Correlation Section E-E' (Continued)	
9.	Davidor & Davidor, Campbell #1	NW SW NE Sec. 7-18N-3E
10.	S & K Oil Co., City of Stillwater #1	SW SW NE Sec. 18-18N-3E
11.	Gulf Oil Co., Hattie Offield #1	SW SW NE Sec. 31-18N-3E
	North-South Correlation Section F-F'	
1.	Helmerich & Payne Inc., Drumm #1	SE NE SE Sec. 6-19N-4E
2.	Reaves Drilling Co., Inc., Dryden #1	SW SW SW Sec. 8-19N-4E
3.	Foster Drilling Co., Davis #1	SW SW SE Sec. 18-19N-4E
4.	Frankfort Oil Co., Case #1	NE NE SE Sec. 20-19N-4E
5.	Mid-Continent Petroleum Co., Pickering #1	SW SW NE Sec. 29-19N-4E
6.	Bay Petroleum Corp. & Viersen & Cochran, Steincamp #1	SW SW SE Sec. 29-19N-4E
7.	Apco, Stokes #1 State	NE SW NE Sec. 32-19N-4E
8.	Sun Oil Co., Linsenmeyer #1	NE NE NW Sec. 5-18N-4E
9.	Summit Drilling Corp., De Jarnette #1	SW SW NE Sec. 7-18N-4E
10.	Adair & Jenkins, Van Buskish #1	N½ NW NW Sec. 17-18N-4E
11.	G. C. Tisdale, Boyd #1	SE SW SW Sec. 21-18N-4E
12.	Foster Drilling Co., Gumm #1	NE SE SW Sec. 31-18N-4E
	North-South Correlation Section G-G'	
1.	G. B. & C. E. Suppes, Sun #1	SW NW NE Sec. 6-19N-5E
2.	Lion Petroleum Co., Pate #1	NW SW SE Sec. 6-19N-5E
3.	W. H. Martgan Drilling Co., Olinghouse #1	SE SW NW Sec. 7-19N-5E
4.	Midwestern Construction Inc., Wetzel #1	NE NE NW Sec. 18-19N-5E
5.	Ambassador Oil Corp., Hale #1	NE SW SW Sec. 18-19N-5E
6.	T. N. Berry & Co., Berry Estate #1	SE SE NW Sec. 19-19N-5E
7.	Skelly Oil Co., Pratt #1	SW SW NE Sec. 30-19N-5E
8.	Skelly Oil Co., Simpson #2	SW NW SE Sec. 30-19N-5E
9.	Skelly Oil Co., Simpson #3	SE NW NE Sec. 31-19N-5E
10.	Foster Drilling Co., Jessie Dobson #1	SE SE NW Sec. 6-18N-5E
11.	J. E. Crosbie, Bryant #1-B	SE SE Sec. 6-18N-5E
12.	Woods Drilling Co., John Goss #5	SW SE SW Sec. 7-18N-5E
13.	C. J. Brown, Thompson #1	NE SW SW Sec. 18-18N-5E
14.	T. N. Berry & Co., Slick #2	SE SW SE Sec. 24-18N-4E
15.	Carey & Derby Oil Co., State #1	SE NW NW Sec. 36-18N-4E
16.	Time Petroleum Co., Mandeville #1	SW NE SE Sec. 35-18N-4E
	North-South Correlation Section H-H'	
1.	McElroy Ranch Co., Norman #1	NE SE SW Sec. 2-19N-5E
2.	Arthur Finston, May #1	SE NE NW Sec. 11-19N-5E
3.	Skelly Oil Co., Okeefe Heirs #1	NW NW NE Sec. 26-19N-5E

No.	Operator and Well Number	Location
	North-South Correlation Section H-H' (Continued)	
4.	The Texas Co., W. T. Laughlin #13	SE NW SE Sec. 35-19N-5E
5.	Lafayette Oil Co., Laughlin Heirs #2	NW SE NE Sec. 2-18N-5E
6.	Gulf Coast Western Oil Co., Estate Land #1	SE SE SE Sec. 12-18N-5E
7.	Deep Rock Oil Corp., Tyrell #1-A	NW NE SE Sec. 13-18N-5E
8.	Falcon-Seaboard Drilling Co., Cruzan #1	SW SW SE Sec. 14-18N-5E
9.	Bay Petroleum Corp., Thompson #2	SE SW NE Sec. 26-18N-5E
10.	H. Waggoner, James #1	NW NE NE Sec. 34-18N-5E

VITA

Arthur Michael Astarita

Candidate for the Degree of

Master of Science

Thesis: DEPOSITIONAL TRENDS AND ENVIRONMENTS OF "CHEROKEE" SANDSTONES, EAST-CENTRAL PAYNE COUNTY, OKLAHOMA

Major Field: Geology

Biographical:

Personal Data: Born in the Bronx, New York, March 1, 1951, the son of Mr. and Mrs. Arthur Astarita.

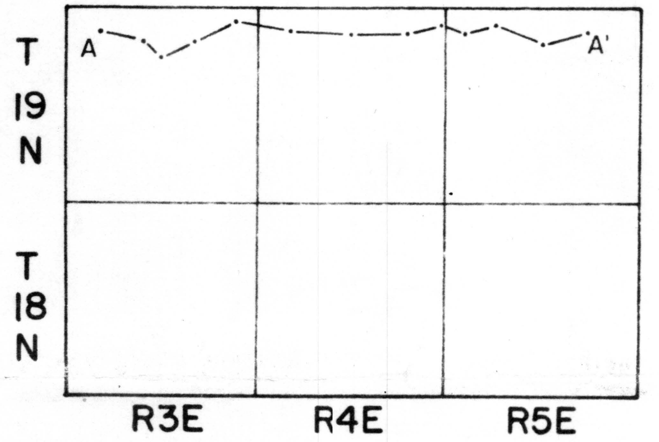
Education: Graduated from St. Paul High School, Norwalk, Ohio, in June, 1969; completed the requirements for a Bachelor of Science degree in geology from Bowling Green State University, Bowling Green, Ohio, in June, 1973; completed requirements for a Master of Science degree at Oklahoma State University in July, 1975, with a major in geology.

Professional Experience: Junior member of the American Association of Petroleum Geologists; member of the Oklahoma City Geological Society.

EAST-WEST CORRELATION SECTION A-A'

Figure 4

DATUM: BASE OF OSWEGO LIMESTONE



No Horizontal Scale

100 ft.
Vertical Scale
0

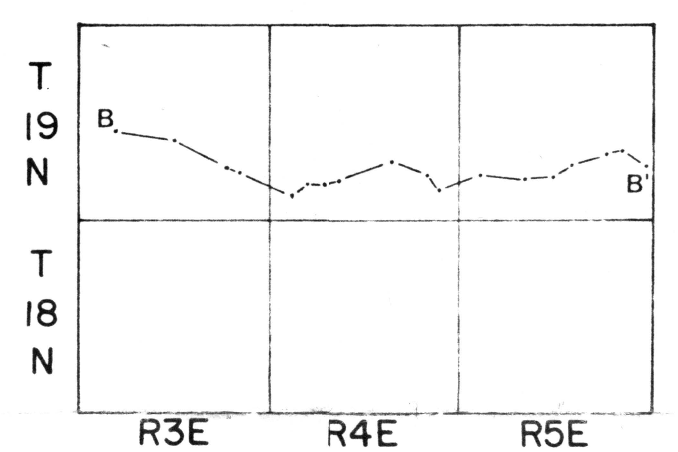
Channel Deposit

Arthur M. Astarita, 1975

EAST-WEST CORRELATION SECTION B-B'

Figure 5

DATUM: BASE OF OSWEGO LIMESTONE



No Horizontal Scale

100 ft.

Vertical Scale

0

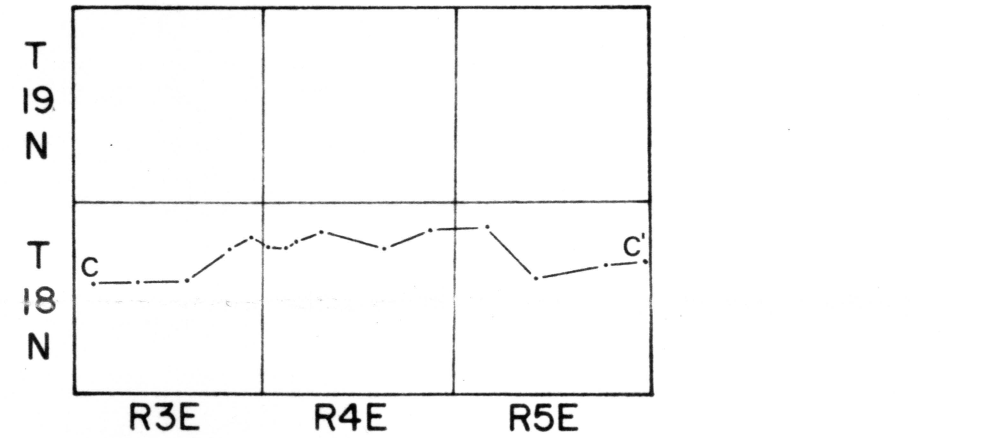
Channel Deposit

Arthur M. Astarita, 1975

EAST-WEST CORRELATION SECTION C-C'

Figure 6

DATUM: BASE OF OSWEGO LIMESTONE



No Horizontal Scale

100 ft.

Vertical Scale

0

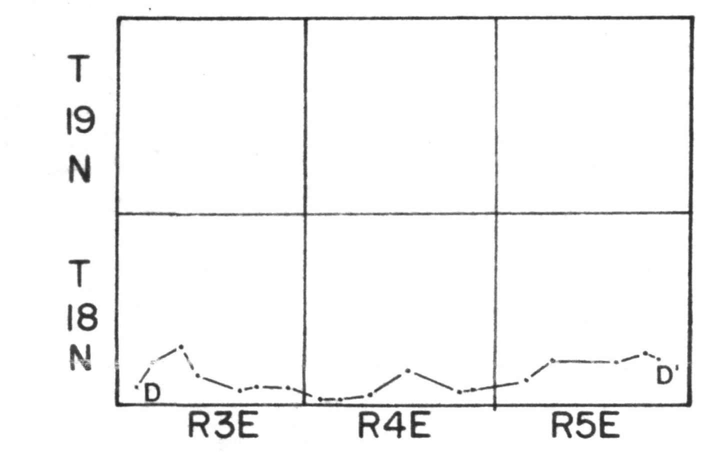
Channel Deposit

Arthur M. Astarita, 1975

EAST-WEST CORRELATION SECTION D-D'

Figure 7

DATUM: BASE OF OSWEGO LIMESTONE

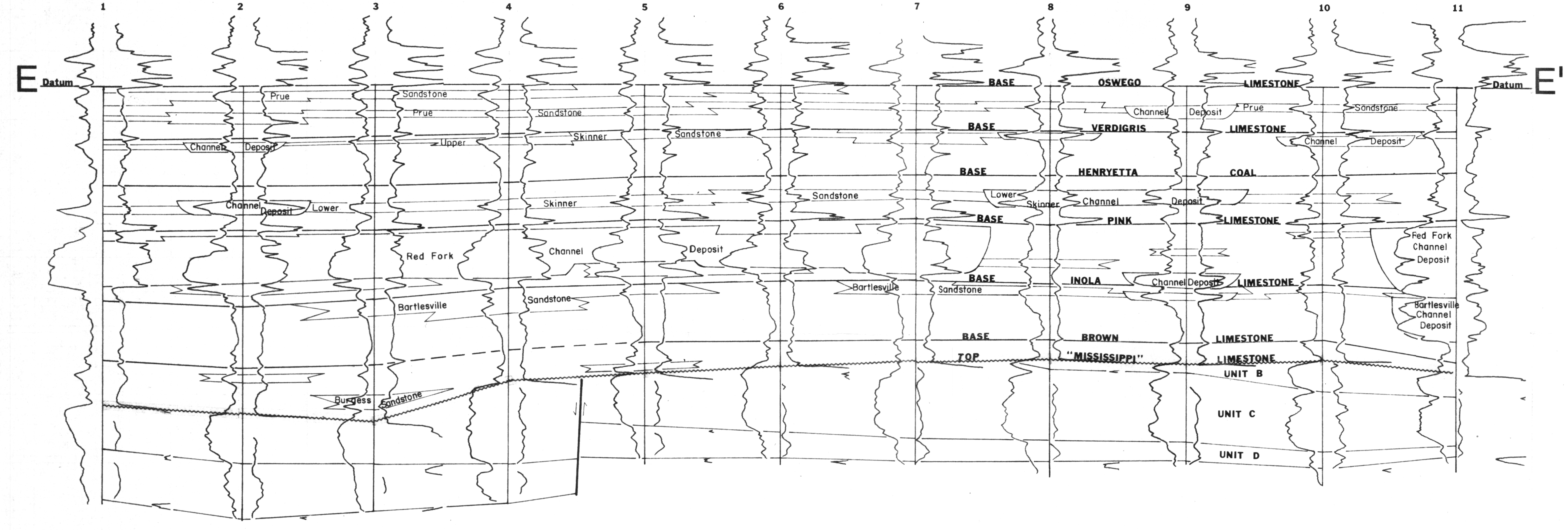


No Horizontal Scale

100 ft.
Vertical Scale
0

Channel Deposit

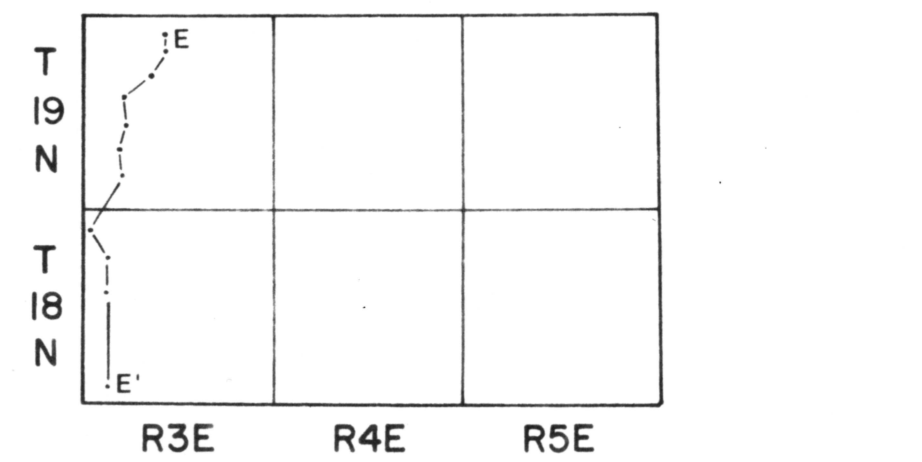
Arthur M. Astarita, 1975



NORTH-SOUTH CORRELATION SECTION E-E'

Figure 8

DATUM BASE OF OSWEGO LIMESTONE



No Horizontal Scale

100 ft.

Vertical Scale

0

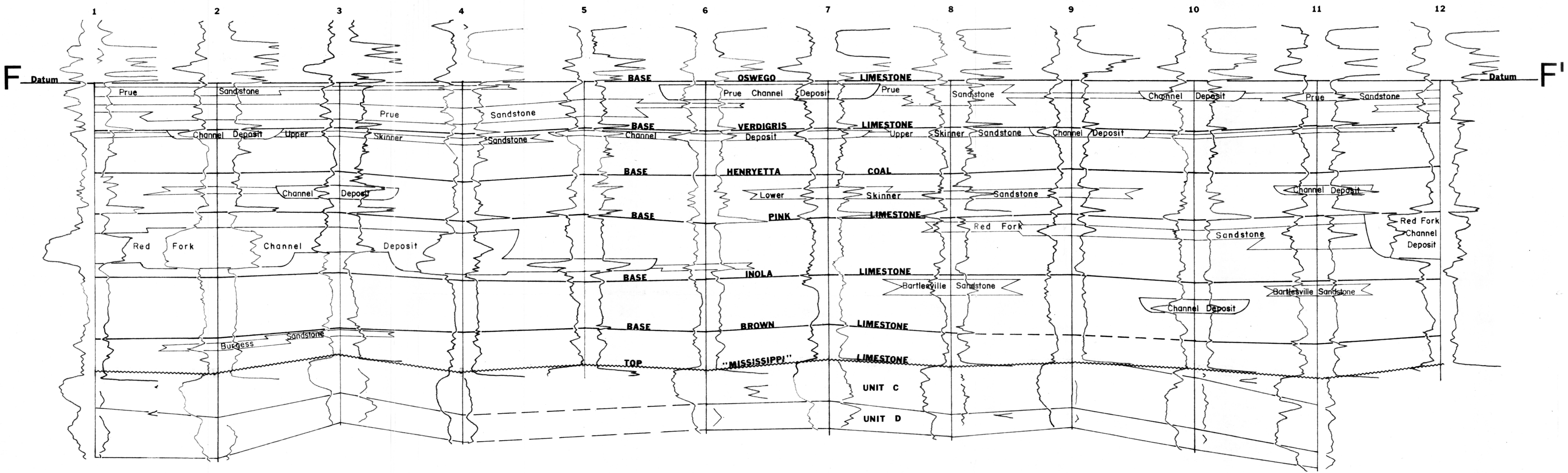
Channel Deposit

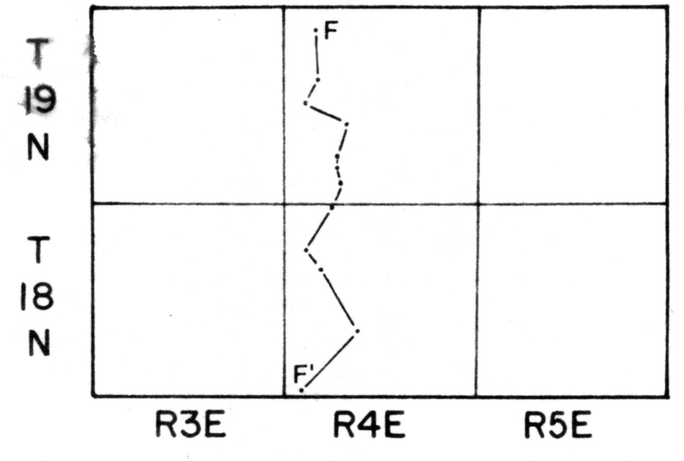
Arthur M. Astarita, 1975

NORTH-SOUTH CORRELATION SECTION F-F'

Figure 9

DATUM: BASE OF OSWEGO LIMESTONE





No Horizontal Scale

100 ft.

Vertical Scale

0

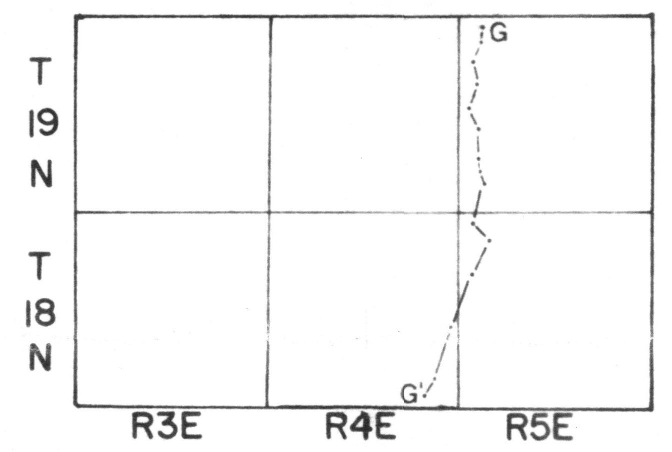
Channel Deposit

Arthur M. Astarita, 1975

NORTH-SOUTH CORRELATION SECTION G-G'

Figure 10

DATUM: BASE OF OSWEGO LIMESTONE

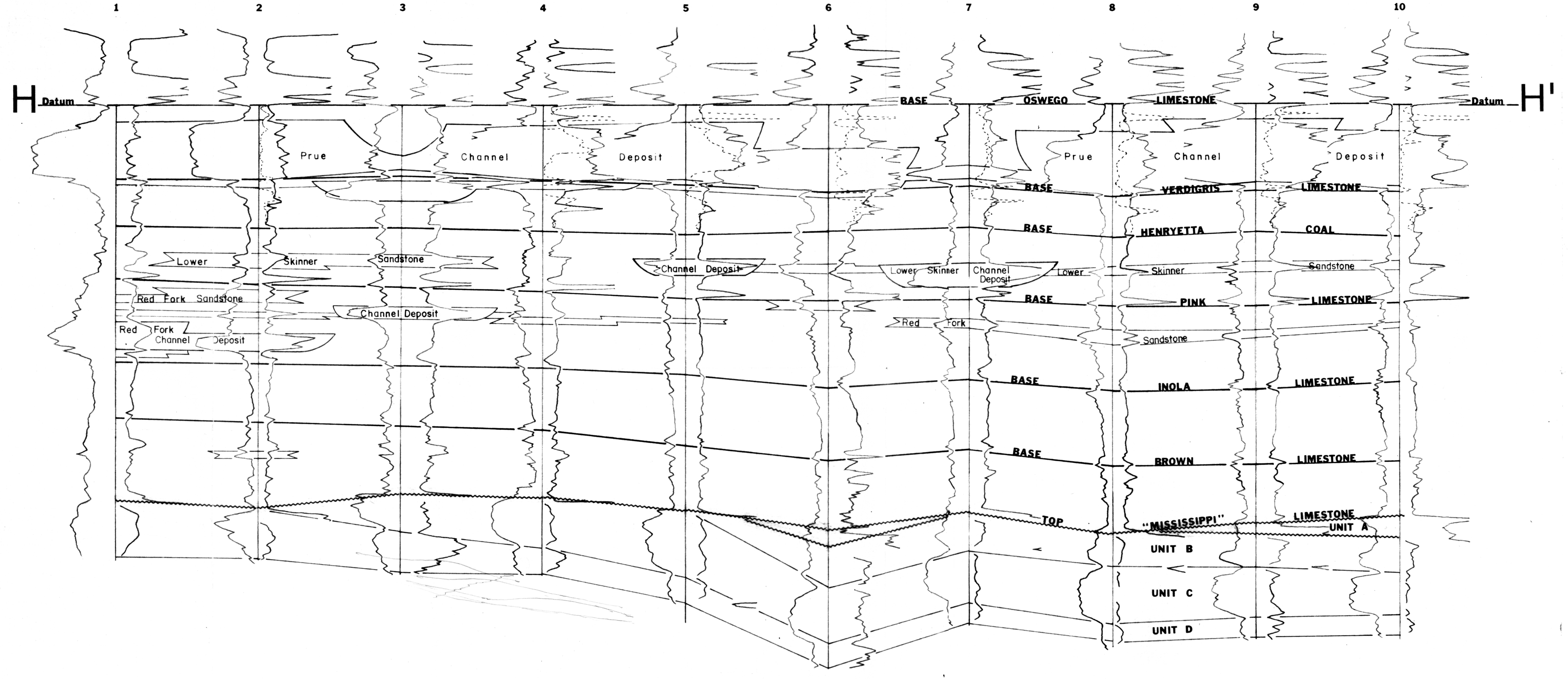


No Horizontal Scale

100 ft.
Vertical Scale
0

Channel Deposit

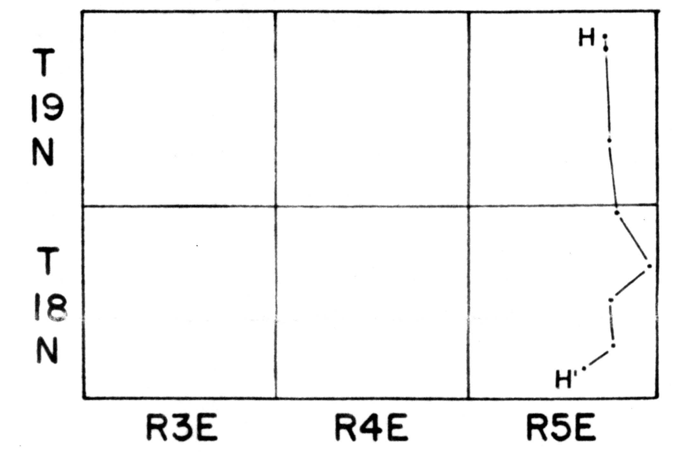
Arthur M. Astarita, 1975



NORTH-SOUTH CORRELATION SECTION H-H'

Figure 11

DATUM: BASE OF OSWEGO LIMESTONE



No Horizontal Scale

100 ft.
Vertical Scale
0

Channel Deposit

Arthur M. Astarita, 1975

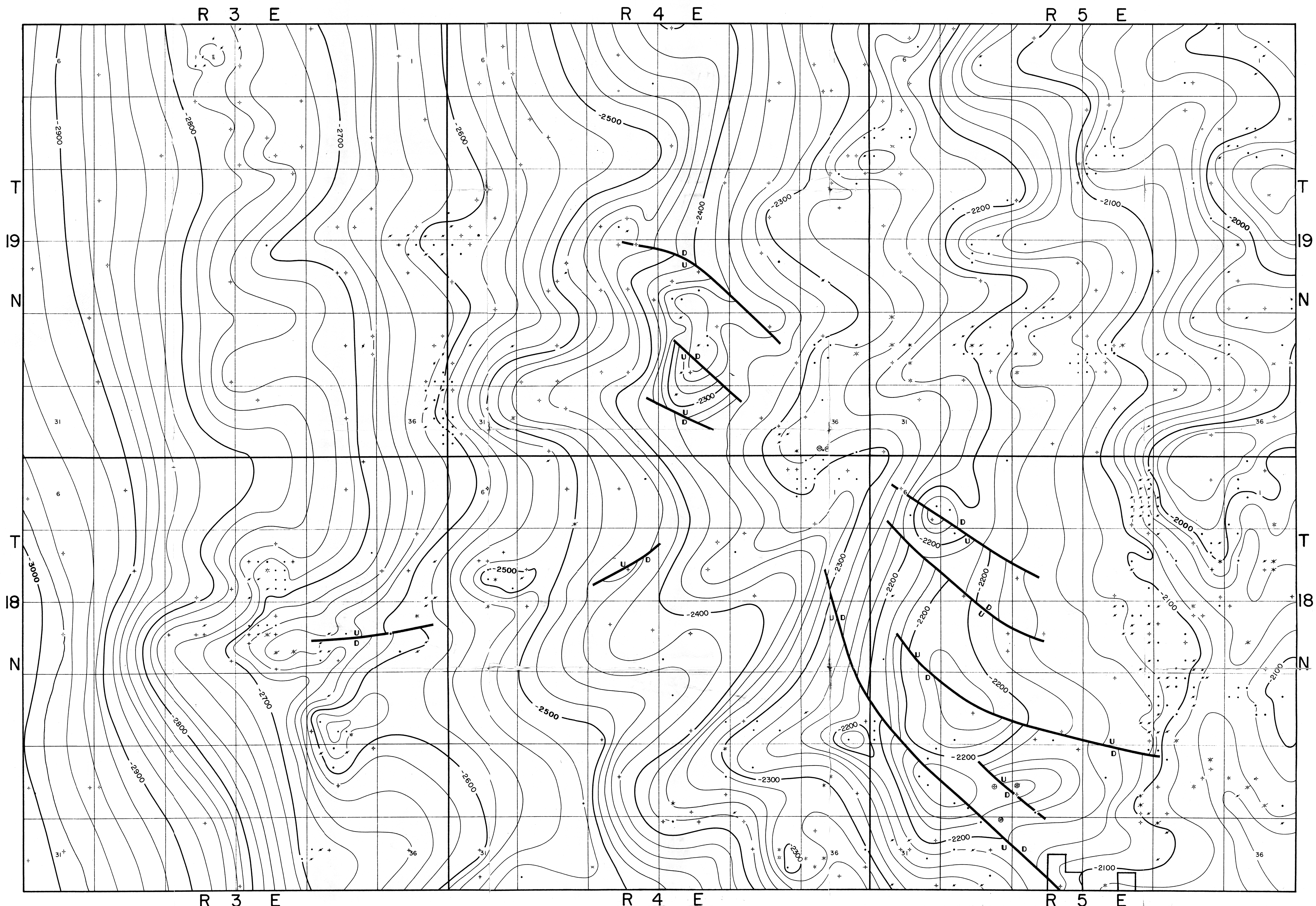


Figure 13

STRUCTURAL CONTOUR MAP
BASE OF OSWEGO LIMESTONE

C.I. 20 ft.

Payne Co., Okla.

SCALE IN MILES

1/2 1/4 0 1/2 1

1:31,680

N

EXPLANATION

- ◎ Cored Well
- • Oil Well
- Oil Well - Abandoned
- ✧ Dry & Abandoned
- ☼ Gas Well
- ✱ Oil & Gas Well
- Oil & Gas Well - Abandoned

Arthur M. Astarita 1975

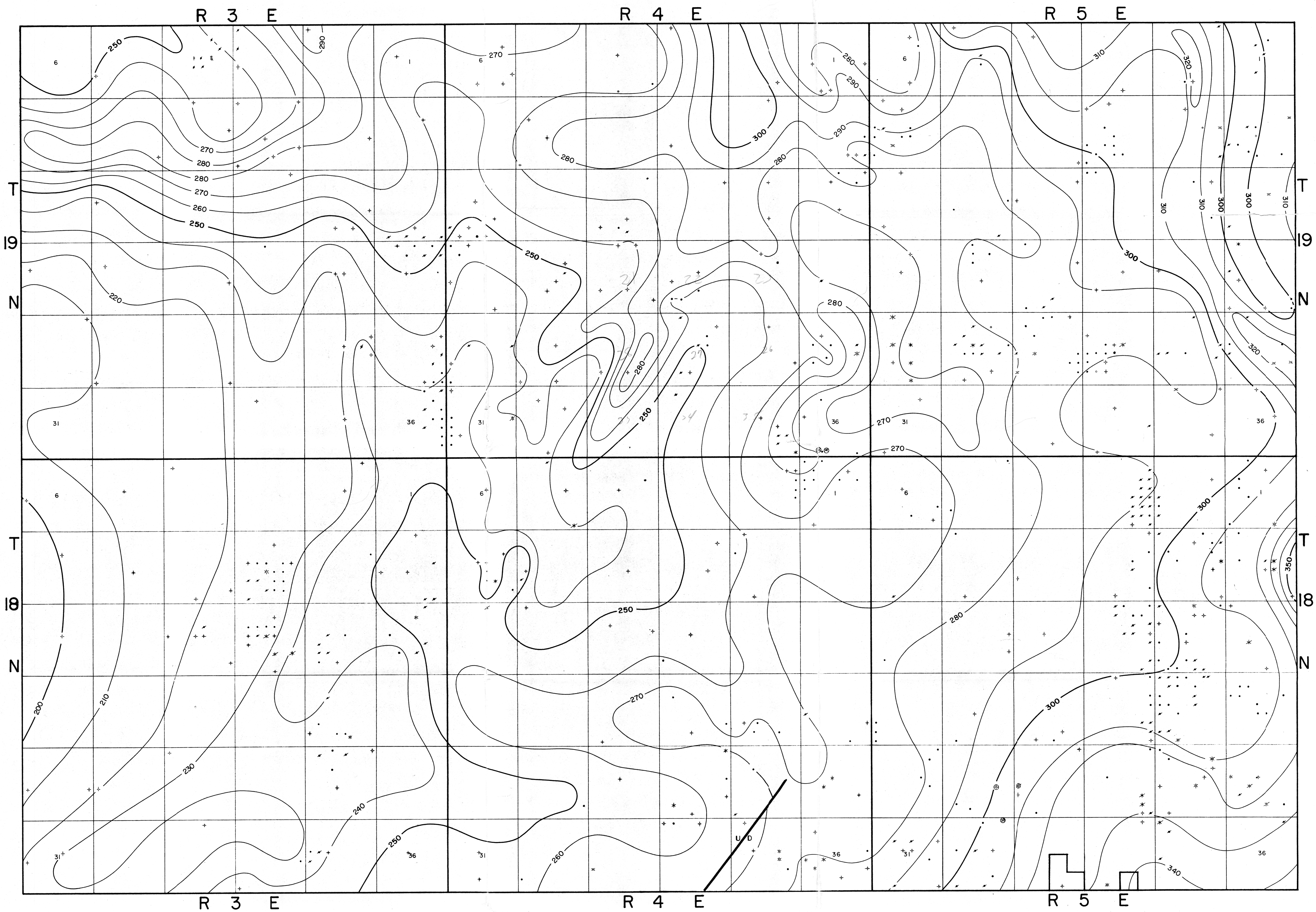


Figure 14

ISOPACH MAP
BASE OF PINK LIMESTONE
TO
TOP OF "MISSISSIPPI" LIMESTONE

C.I. 10 ft.

Payne Co., Okla.

SCALE IN MILES

1/2 1/4 0 1/2 1

1:31,680

N

EXPLANATION

- Cored Well
- Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned

Arthur M. Astarita 1975

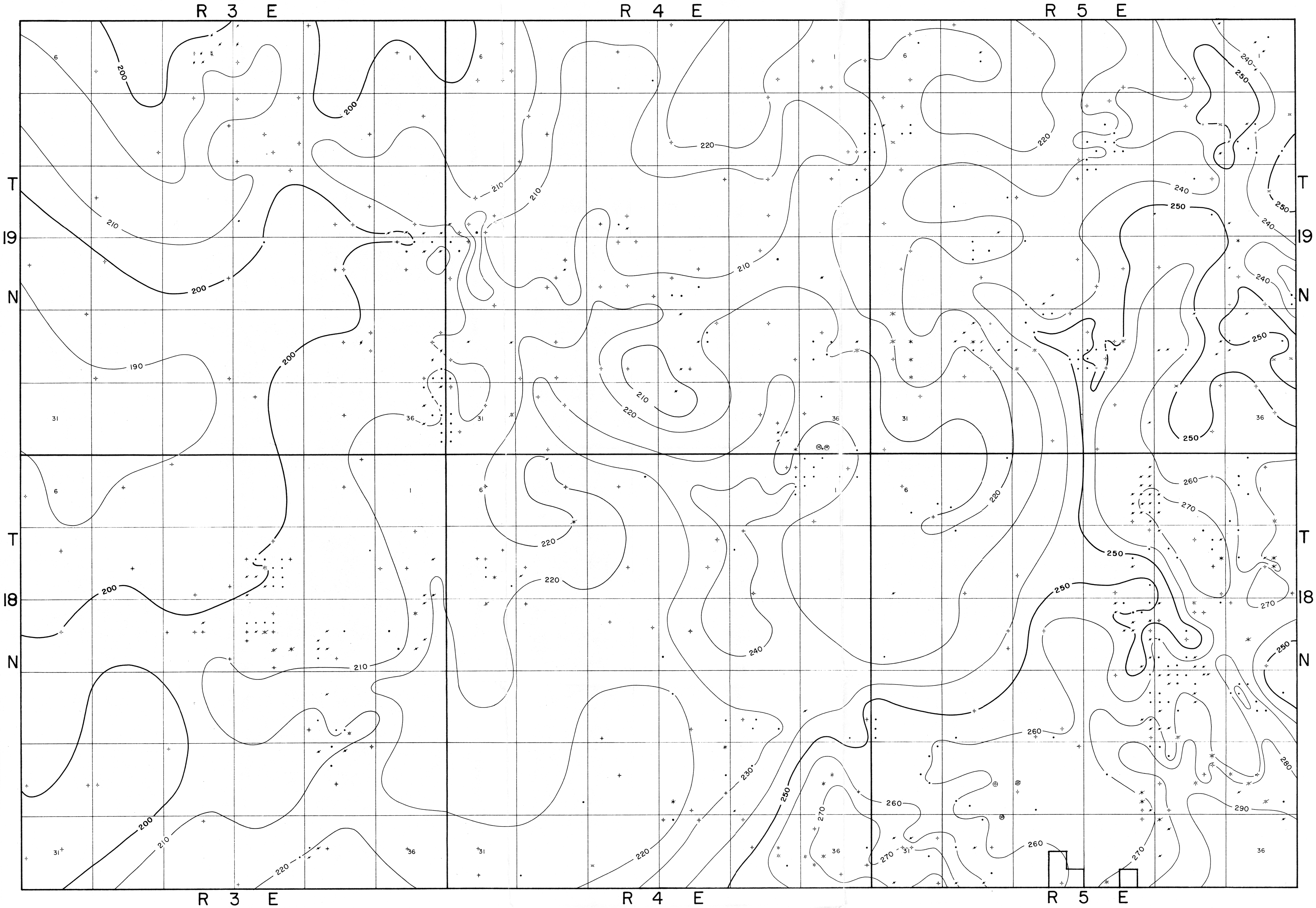


Figure 16

ISOPACH MAP
BASE OF OSWEGO LIMESTONE
TO
BASE OF PINK LIMESTONE

C.I. 10 ft.

Payne Co., Okla.

SCALE IN MILES

1/2 1/4 0 1/2 1

1:31,680

N

EXPLANATION

- Cored Well
- Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned

Arthur M. Astarita 1975

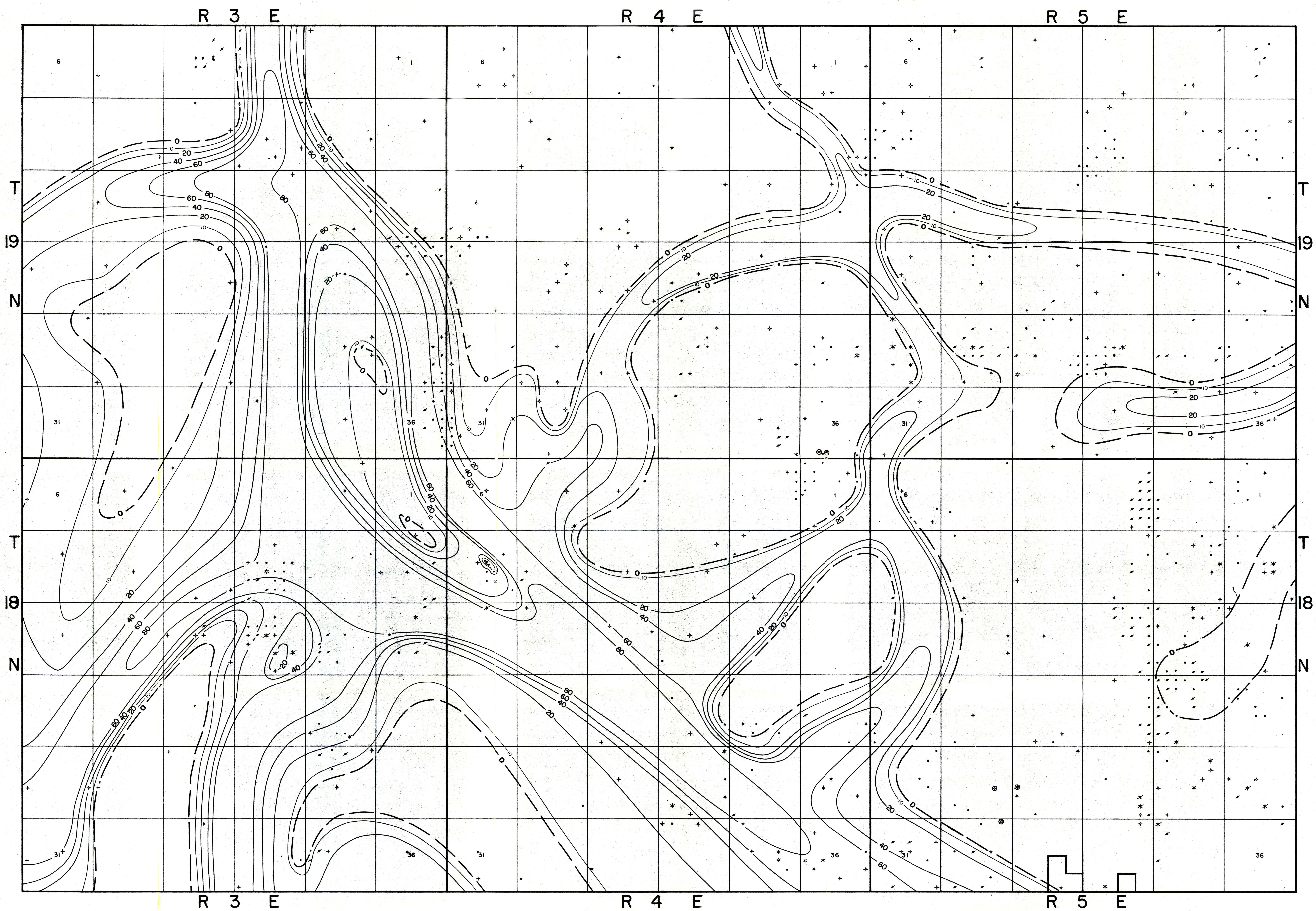


Figure 20

ISOPACH MAP
BASE OF INOLA LIMESTONE
TO
BASE OF BARTLESVILLE SANDSTONE

C.I. 20 and 10 ft.

Payne Co., Okla.

SCALE IN MILES

1/2 1/4 0 1/2 1

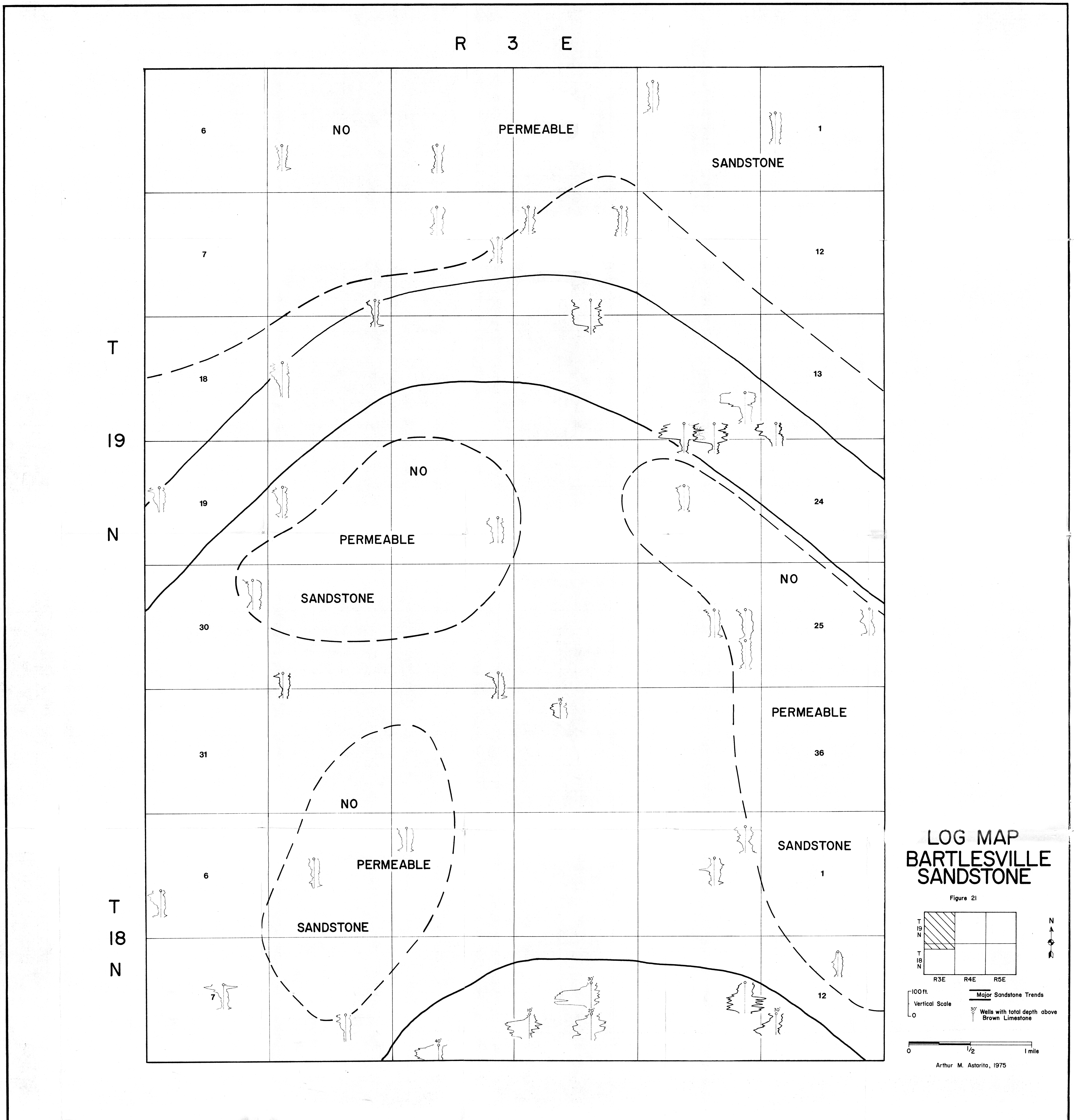
1:31,680

N

Arthur M. Astarita 1975

EXPLANATION

- Cored Well
- Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned


R 3 E
T 19 N
T 18 N
6
NO
PERMEABLE
1
SANDSTONE
7
12
18
13
19
NO
PERMEABLE
SANDSTONE
24
NO
30
25
31
PERMEABLE
36
NO
PERMEABLE
SANDSTONE
SANDSTONE
6
1
7
12
15'
30'
20'
10'
30'
40'
LOG MAP
BARTLESVILLE
SANDSTONE
Figure 21
T 19 N
T 18 N
R3E
R4E
R5E
N
100 ft.
Vertical Scale
0
Major Sandstone Trends
30'
Wells with total depth above Brown Limestone
0
1/2
1 mile
Arthur M. Astarita, 1975

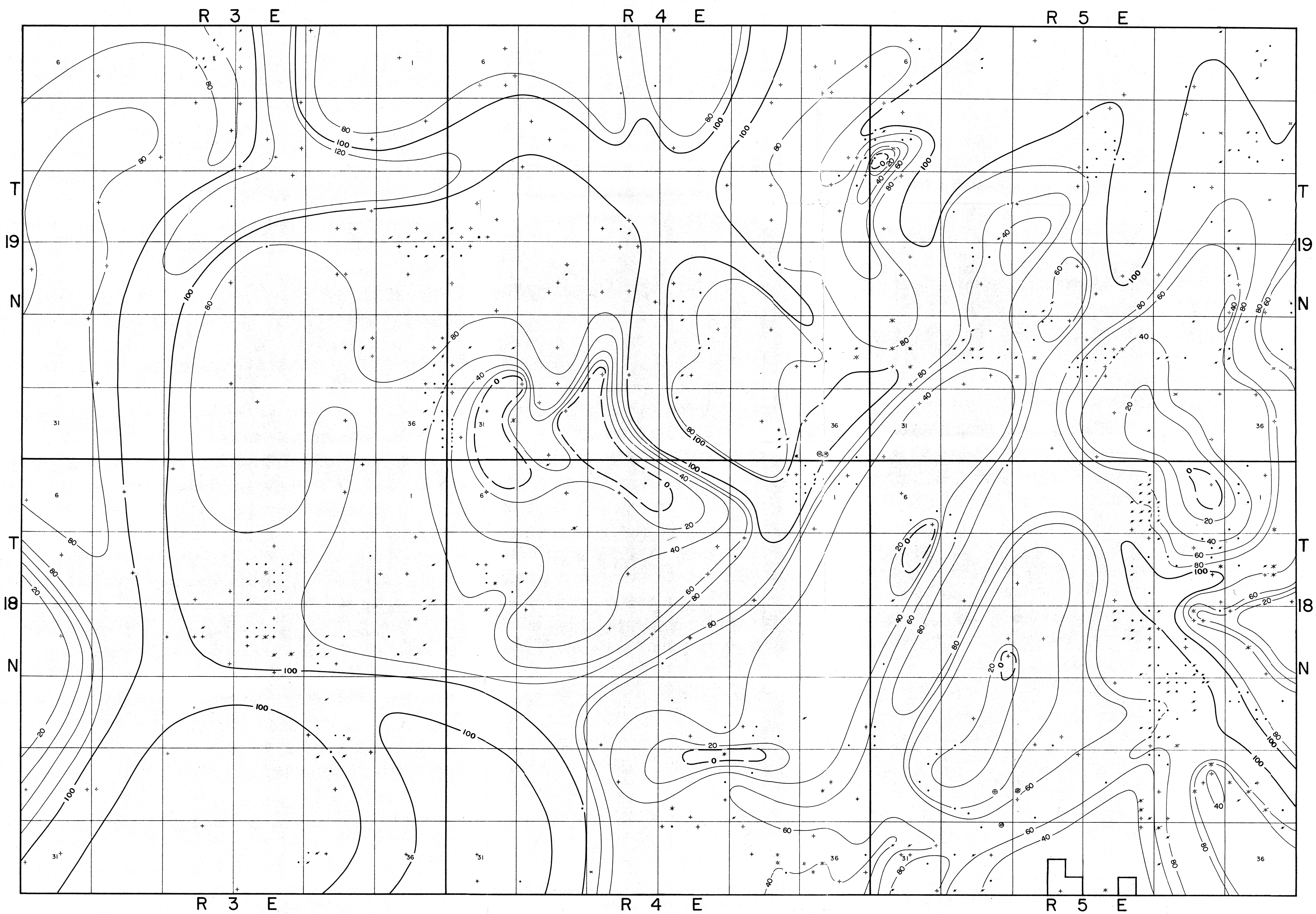


Figure 25

ISOPACH MAP
BASE OF PINK LIMESTONE
TO
BASE OF RED FORK SANDSTONE

C.I. 20ft.

Payne Co., Okla.

SCALE IN MILES

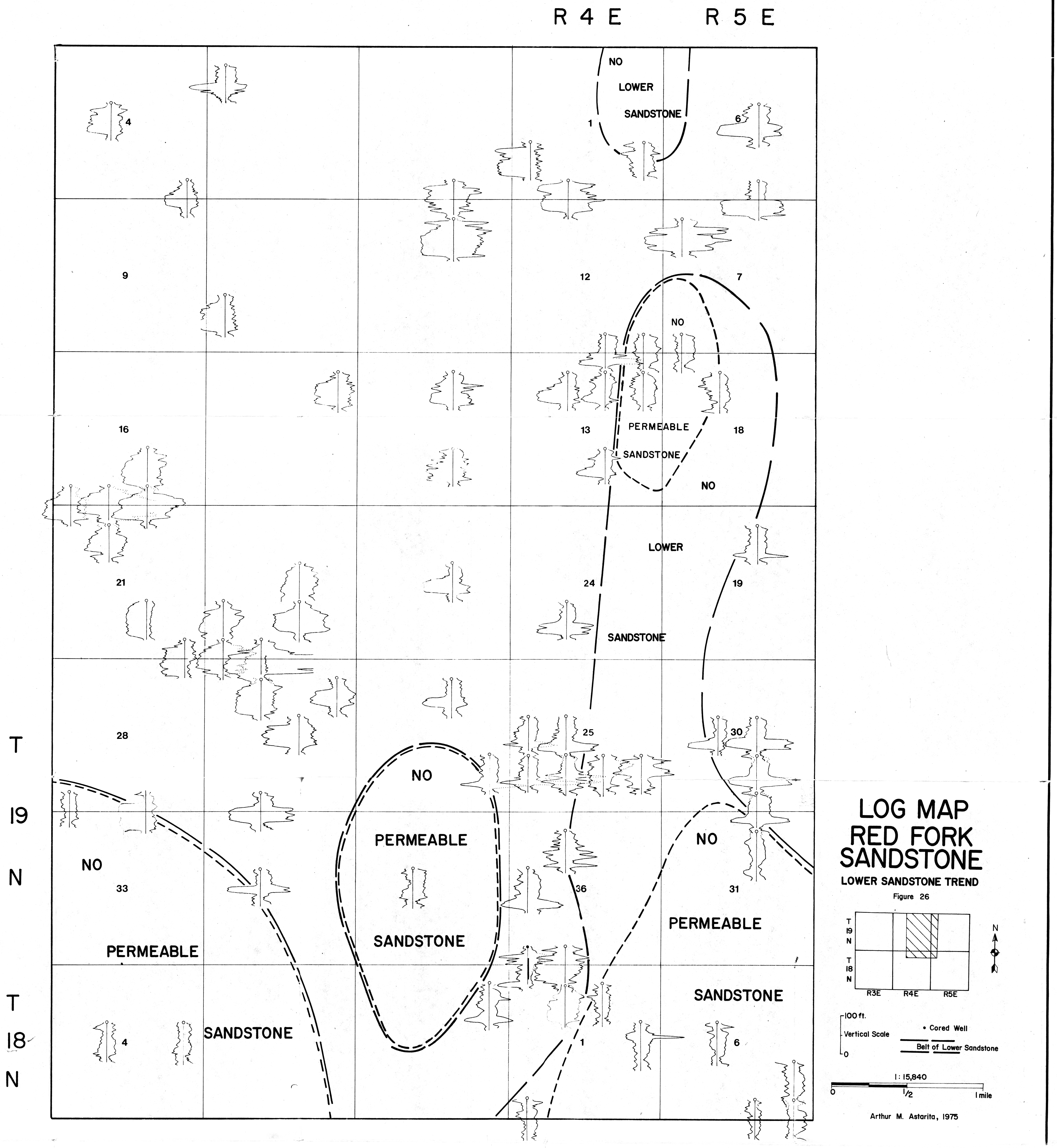
1/2 1/4 0 1/2 1

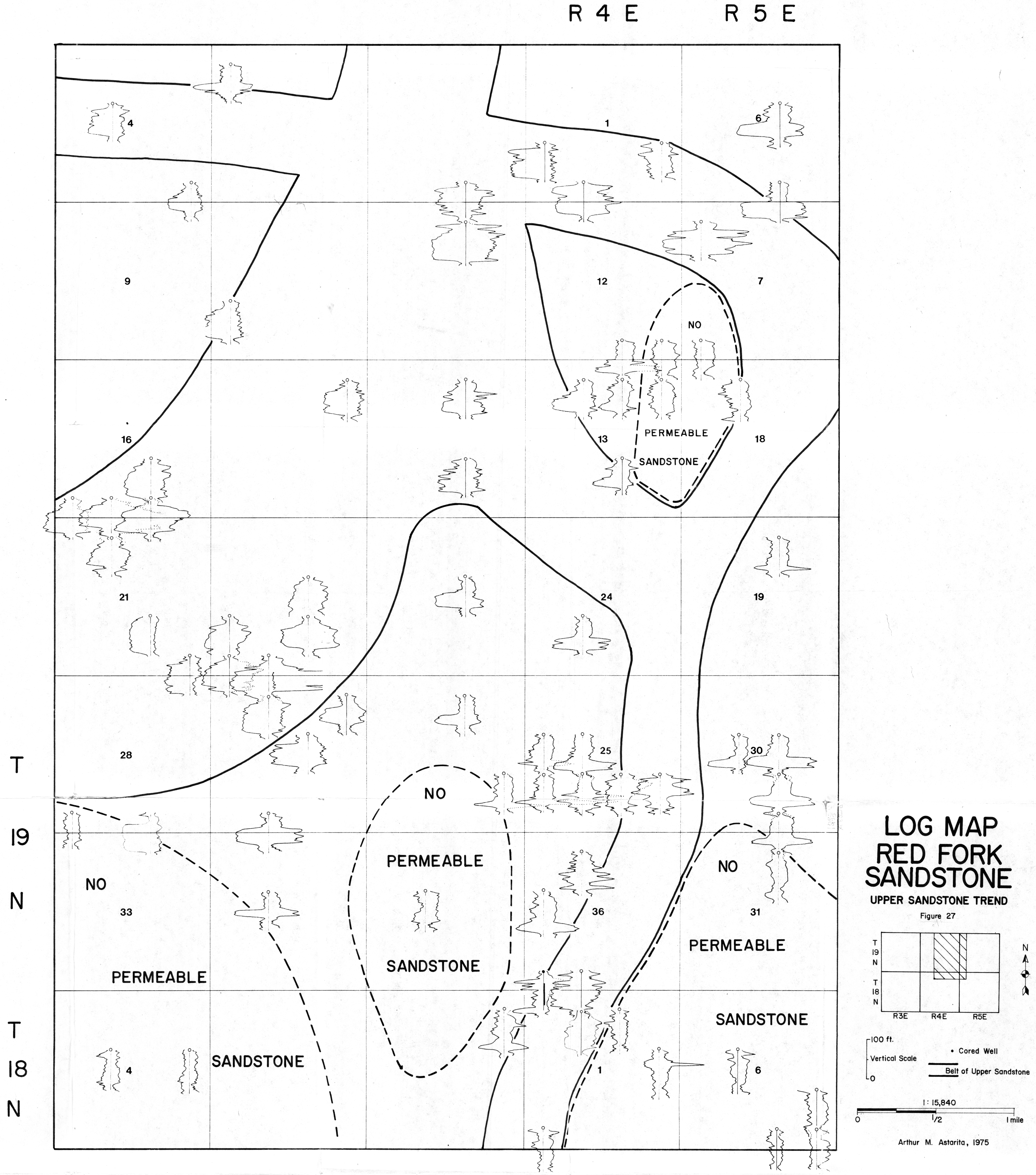
1:31,680

Arthur M. Astarita 1975

EXPLANATION

- Cored Well
- Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned


R 4 E
R 5 E
T 19 N
T 18 N
NO LOWER SANDSTONE
4
1
6
9
12
7
NO
PERMEABLE SANDSTONE
16
13
18
NO
LOWER
SANDSTONE
21
24
19
28
25
30
NO
PERMEABLE
SANDSTONE
NO
33
36
31
PERMEABLE
SANDSTONE
NO
PERMEABLE
SANDSTONE
4
1
6
SANDSTONE
LOG MAP
RED FORK
SANDSTONE
LOWER SANDSTONE TREND
Figure 26
T 19 N
T 18 N
R3E
R4E
R5E
N
100 ft.
Vertical Scale
0
• Cored Well
Belt of Lower Sandstone
1:15,840
0
1/2
1 mile
Arthur M. Astarita, 1975



LOG MAP
RED FORK SANDSTONE
UPPER SANDSTONE TREND
Figure 27

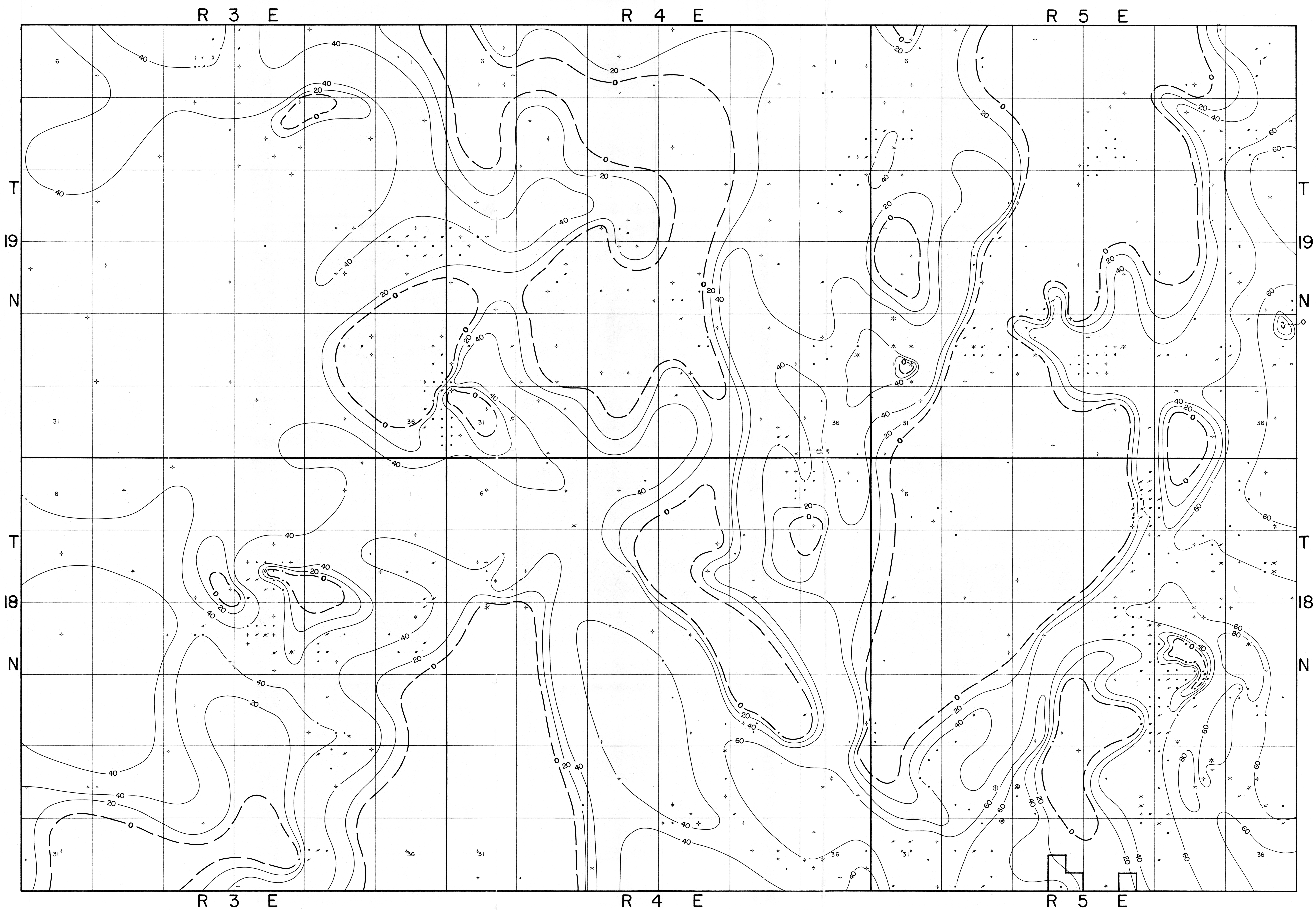


Figure 35

ISOPACH MAP
BASE OF HENRYETTA COAL
TO
BASE OF LOWER SKINNER SANDSTONE

C.I. 20 ft.

Payne Co., Okla.

SCALE IN MILES

1/2 1/4 0 1/2 1

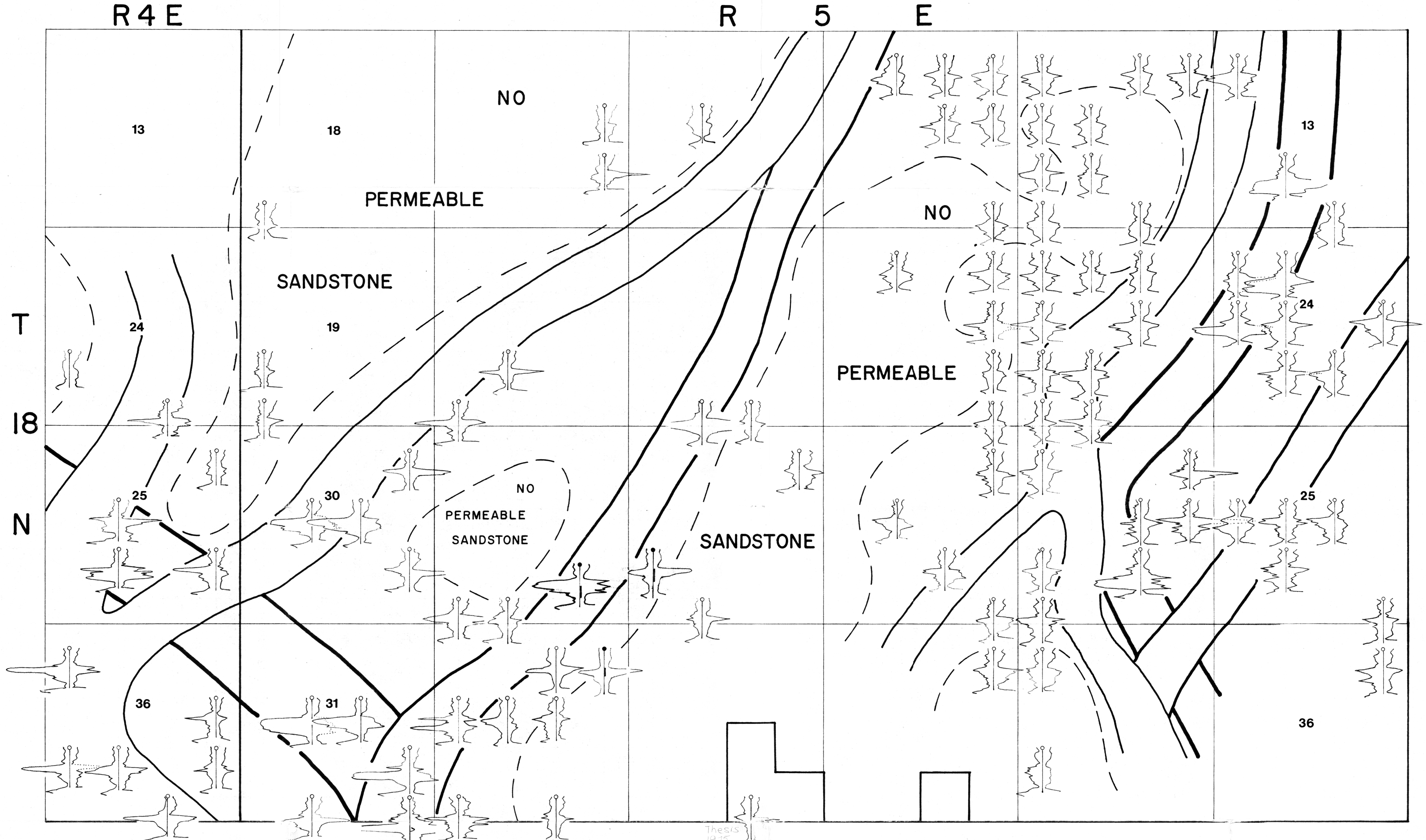
1 : 31,680

N

EXPLANATION

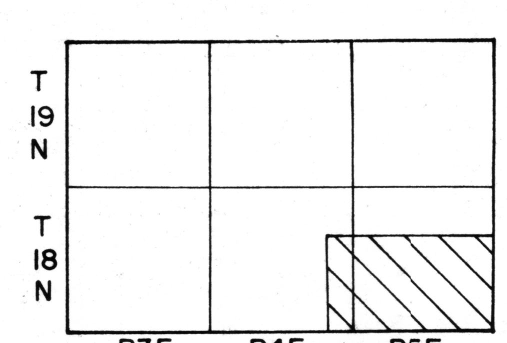
- Cored Well
- Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned

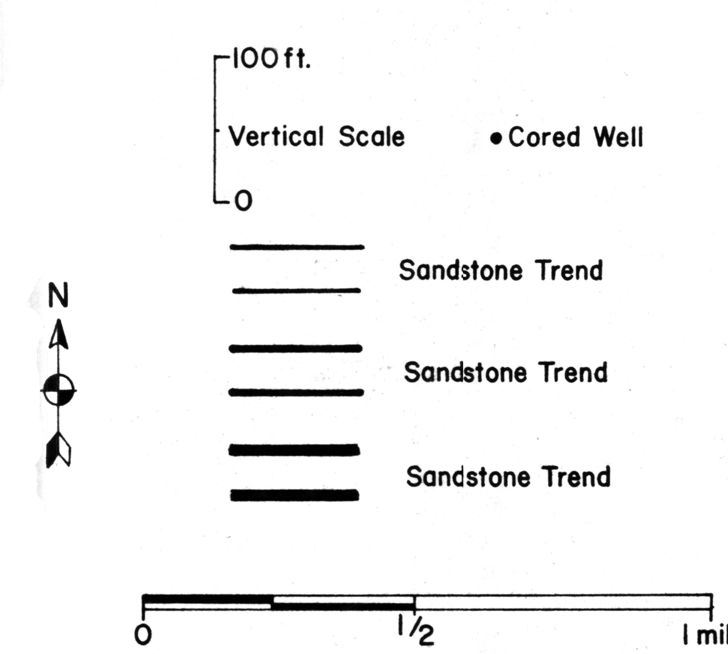
Arthur M. Astarita 1975



LOG MAP LOWER SKINNER SANDSTONE

Figure 36





Arthur M. Astarita, 1975

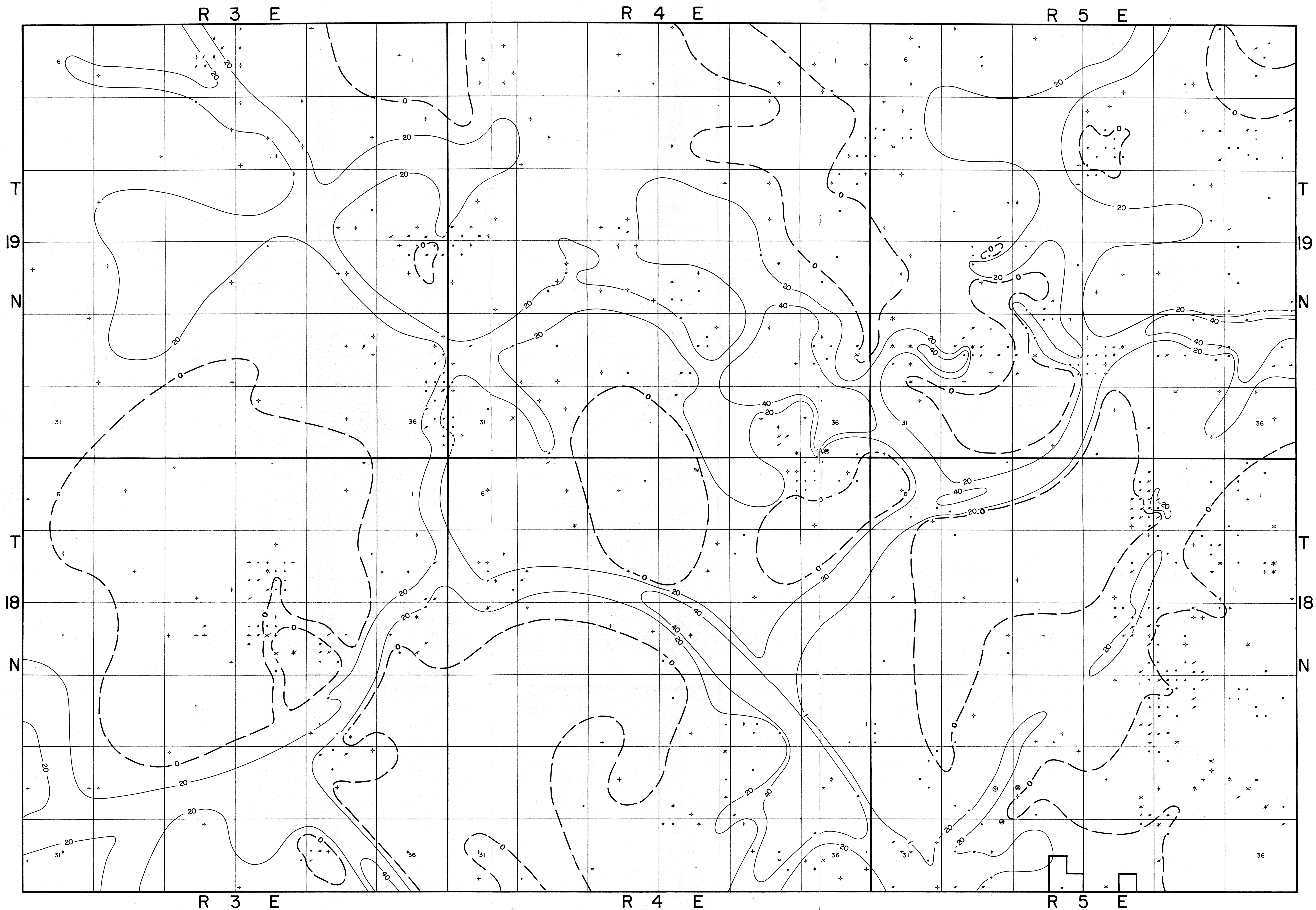


Figure 37

ISOPACH MAP
BASE OF VERDIGRIS LIMESTONE
TO
BASE OF UPPER SKINNER SANDSTONE

C.I. 20 ft.

Payne Co., Okla.

SCALE IN MILES

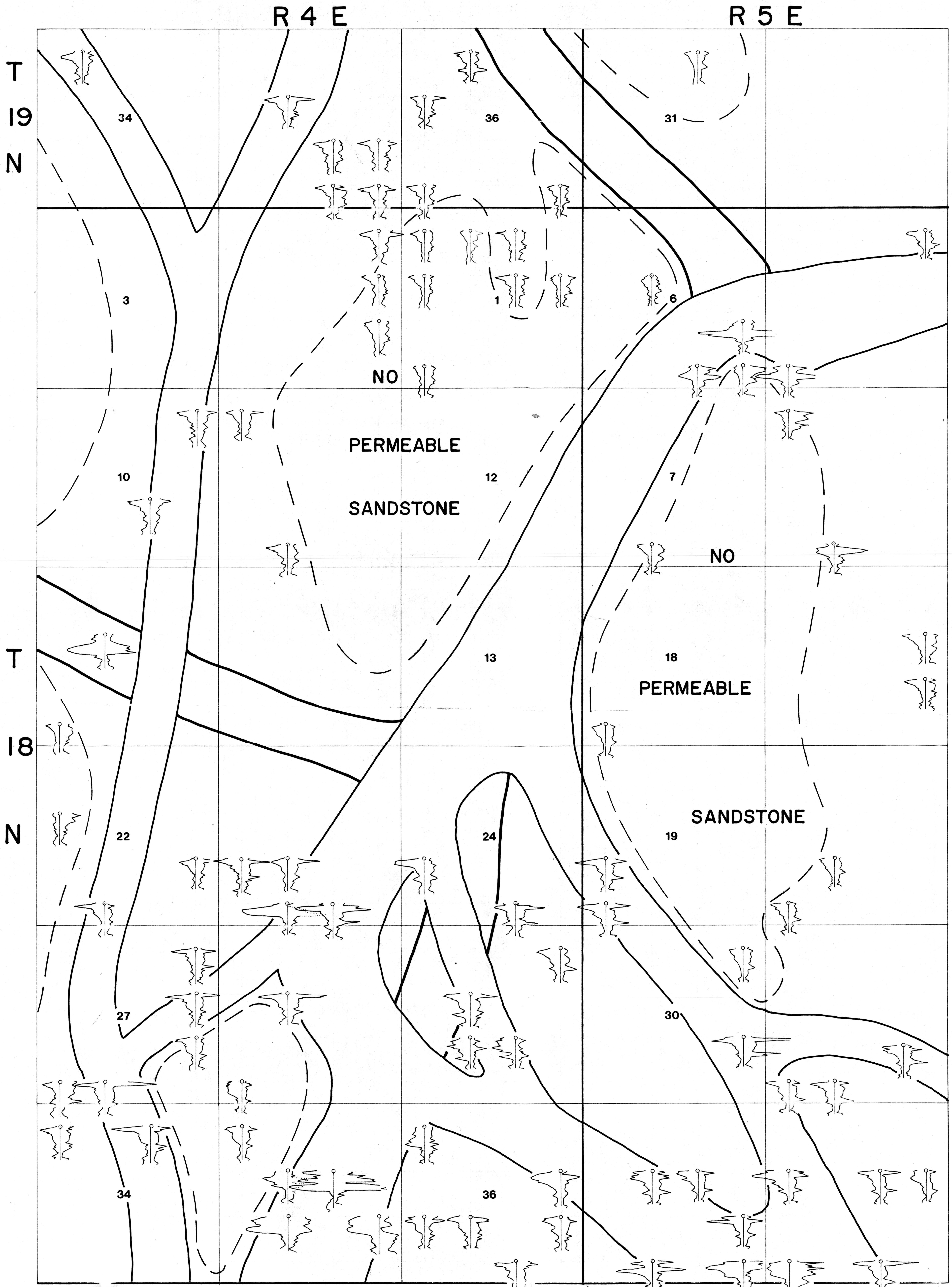
1/2 1/4 0 1/2 1

1 : 31,680

Arthur M. Astarita 1975

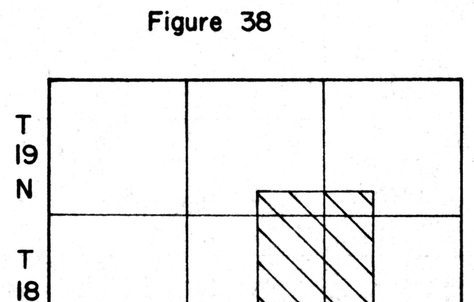
EXPLANATION

- ⊛ Cored Well
- • Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned



LOG MAP UPPER SKINNER SANDSTONE

Figure 38



N

100 ft.
Vertical Scale
0

Sandstone Trend

Sandstone Trend

1:15,840

0 1/2 1 mile

Arthur M. Astarita, 1975

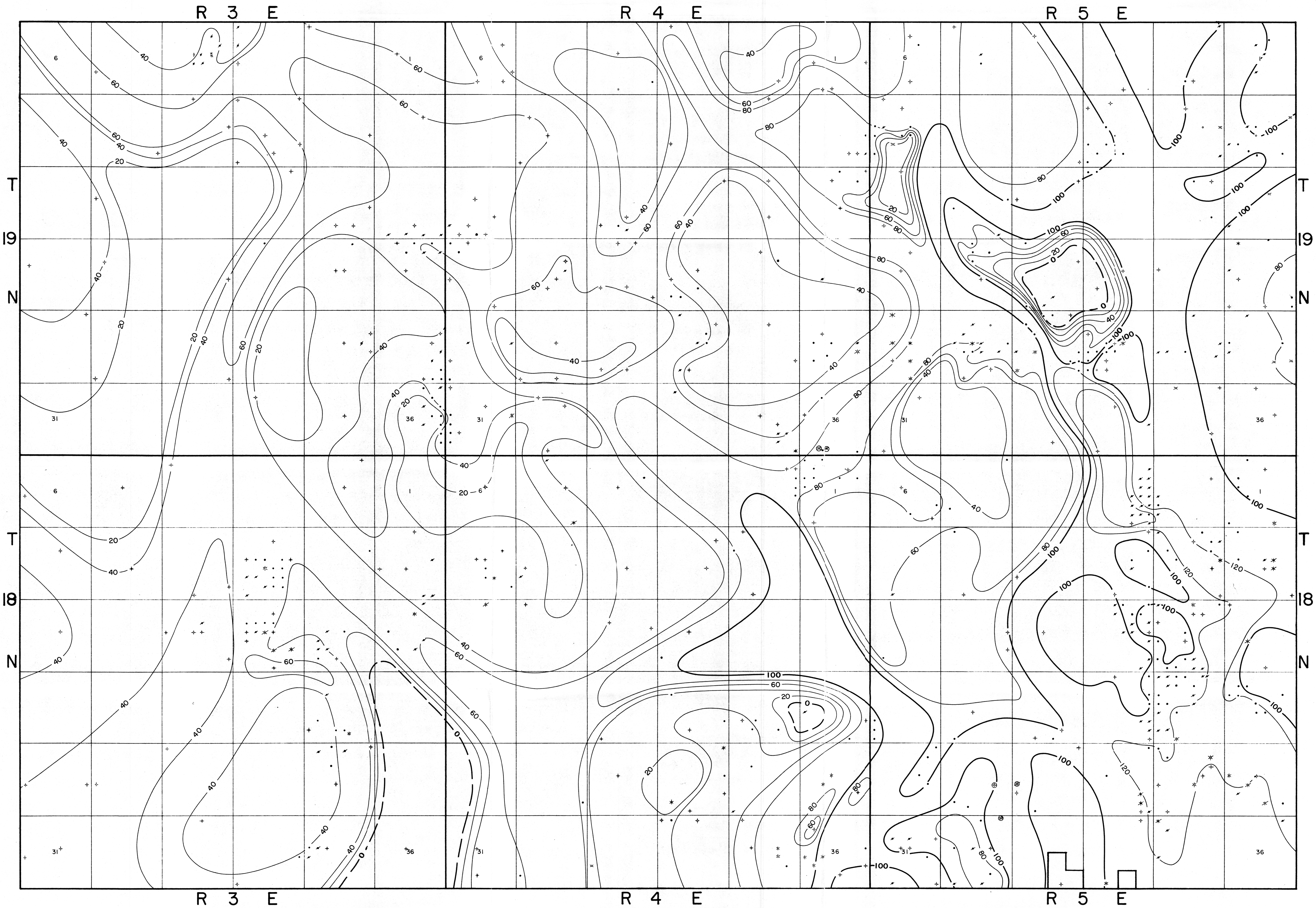


Figure 42

ISOPACH MAP
BASE OF OSWEGO LIMESTONE
TO
BASE OF PRUE SANDSTONE

C.I. 20 ft.

Payne Co., Okla.

N

SCALE IN MILES

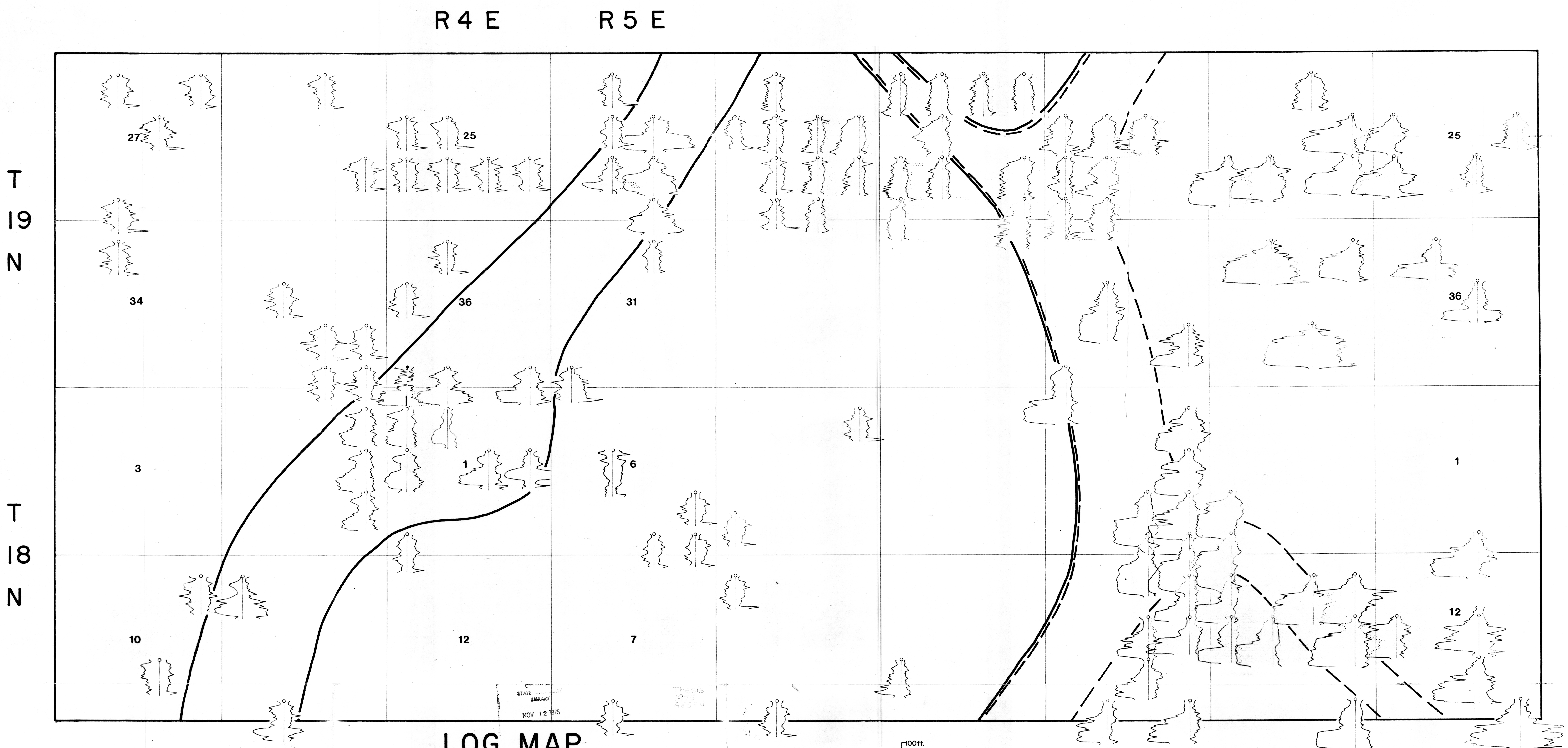
1/2 1/4 0 1/2 1

1:31,680

EXPLANATION

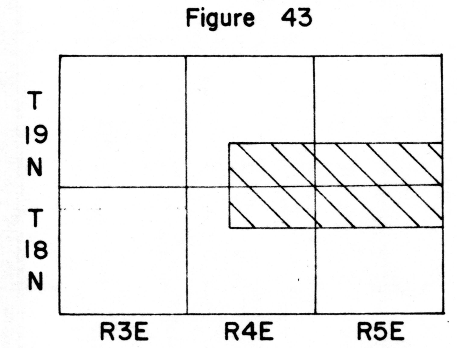
- Cored Well
- Oil Well
- Oil Well - Abandoned
- Dry & Abandoned
- Gas Well
- Oil & Gas Well
- Oil & Gas Well - Abandoned

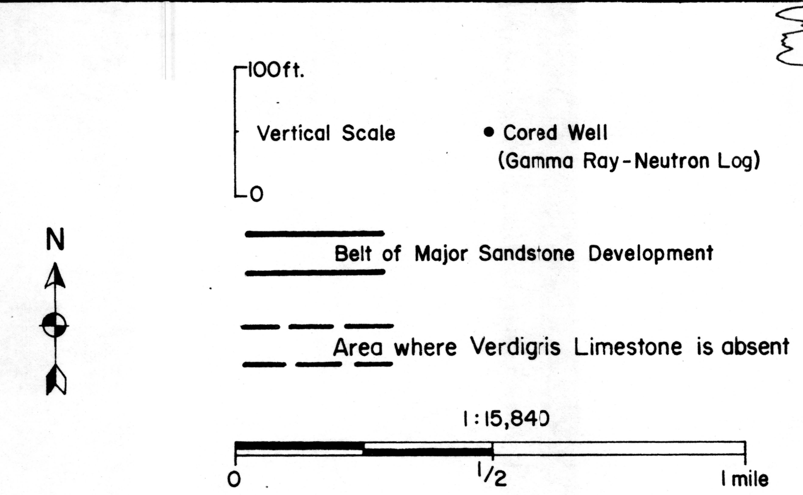
Arthur M. Astorita 1975



LOG MAP
PRUE SANDSTONE

Figure 43





Arthur M. Astarita, 1975