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PALEOGEOLOGIC AND QUANTITATIVE LITHOFACIES ANALYSIS

OF THE SIMPSON GROUP, OKLAHOMA

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CHAPTER I

INTRODUCTION

Purpose and Scope of Study

Current renewed and increasing activity in exploration and development of the Simpson (Ordovician) Group in Oklahoma prompted this regional study of Simpson rocks with the hope of elucidating some stratigraphic problems inherent to the group. Although most of the oil produced to date from Simpson reservoirs is of structural origin, the possibility of stratigraphic entrapment must not be overlooked.

To evaluate properly the Simpson Group, it was first necessary to establish a correlation between measured and described outcrop sections of the Arbuckle Mountain region and those of the subsurface of the state. Although the ultimate object of this study was to construct a series of lithofacies, isopach and subcrop maps based on detailed regional correlations (from which potential areas of economic interest might be determined, and geologic history reconstructed), it became apparent that academic problems pertaining to age correlations between widely separated areas are solvable. In this regard, special emphasis was directed in proposing a solution to correlations between outcrops in the Arbuckle and Ozark Mountains.

The paucity of stratigraphic and paleontologic information regarding the Womble-Blakely sequence in the Ouachita geosyncline rendered ineffectual the quantitative study of Simpson formational relationships there. Hence, this region was not mapped. It is hoped that future studies of the Womble-Blakely will permit an integration of facies data with the remainder of the state.

A secondary, but no less important, purpose of this paper is to advance a technique of facies expression based on distance-function (Pelto, 1954). Most mapping of multicomponent systems has been accomplished previously with methods devised by Krumbein and Sloss (1951, p. 274), wherein expressions of composite lithologic aspect are determined from ratios of lithologies and considered simultaneously with reference to a triangle diagram. Distance-function maps have an advantage over corresponding composite maps based on percentages and ratios in that they are normally less cluttered in appearance, and the relative proportion of a specific end-member (i.e., lithologic type) within its own class is indicated.

Methods of Investigation

A total of 446 electric logs (226 supported by sample logs) and 11 measured outcrop sections were used as a basis of control for the maps of this report. With few exceptions, only those wells that penetrated the Arbuckle Group, or outcrop sections in which the entire Simpson Group is exposed and measured, were utilized. It is unfortunate that, although the total number of control points used for a regional study of this scope appears sufficient, the uneven dispersal of control locally falls short of affording an adequate network. Consequently, in areas that lack control, such as the Anadarko basin, the position of isopach contours and lithologic boundaries are to some extent hypothetical.

All logs were obtained from the files of Cities Service Oil Company. Sample logs had been "run" either by geologists of that company, or by several of the commercial log services operating in Oklahoma. Published measured outcrop sections, particularly those measured and described by Decker and Merritt (1931), Decker (1941, 1951) and Harris (1957) in the vicinity of the Arbuckle Mountains, provided the basis for stratigraphic nomenclature and correlation of Simpson formations for the remainder of the state (Fig. 1 and Plate I). The writer personally examined samples and cores of several wells, reviewed numerous unpublished core analyses, and visited several outcrops in order to examine lithologic characteristics of the units. Due to the scope of the study, it would have been impossible to analyze personally all the samples involved; nor would it have been necessary, inasmuch as critical evaluation and careful selection of commercial (and published) data led to valid results and permitted an extensive survey involving essentially the entire state.

Selected control points were applied to a base map of Oklahoma, with a scale of 1 : 750,000, compiled by the United States Geological Survey in 1960. A total of 13 maps, including 11 combined lithofacies and isopach maps, a paleogeologic map, a lap-out map, and a fence diagram were constructed. Data for the lithofacies maps were derived quantitatively by calculating the percentages of gross lithologic types for each formation. Classifying-functions and distance-

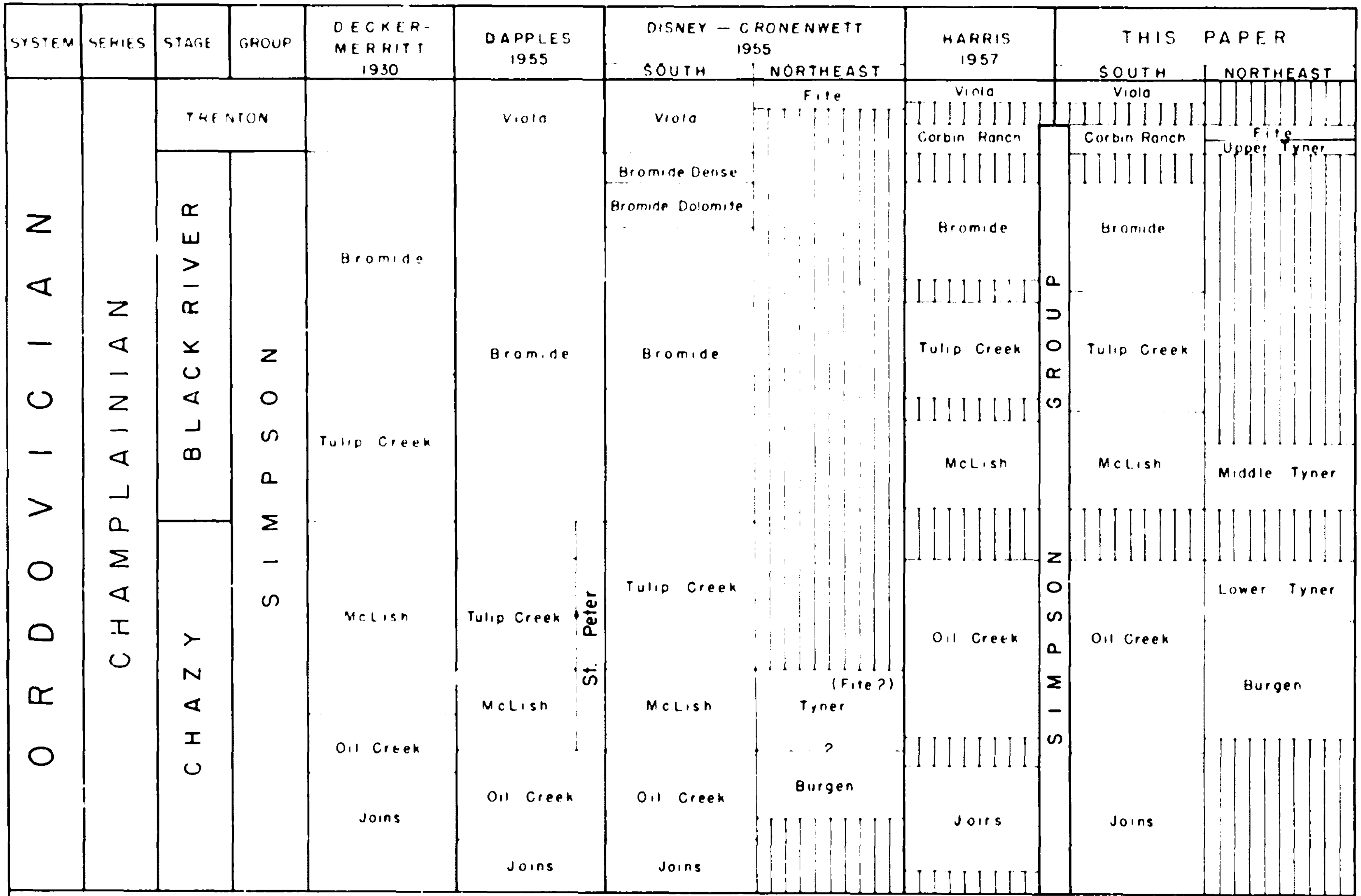


FIGURE I SELECTED COMPARATIVE CORRELATIONS OF THE SIMPSON GROUP, OKLAHOMA functions were computed in accordance with methods prescribed in Chapter II.

Although such calculations may be made manually, limited time and a considerable amount of data necessitated the utilization of a digital computer for this research.

In order to illustrate lithofacies relationships and depict where Simpson rocks are yet present, for purposes of economic expediency, it was decided to introduce to the maps major post-Simpson tectonic elements from which the Simpson rocks have been eroded. Paleo-facies and paleo-isopach homogeneity may be reconstructed by connecting contours through these elements.

Previous Investigations

The Simpson was first recognized and described as a formation in the Arbuckle Mountains by Taff (1902). Ulrich (1911, 1928, 1929) named five of the accepted formations of the Simpson Group (Joins, Oil Creek, McLish, Tulip Creek, and Bromide), in addition to formations that have since been discarded. Decker (1931, 1941) emphasized the status of the group, standardizing the five formational boundaries as they are generally accepted today. Decker and Merritt (1931) published a treatise which is currently one of the most practical works regarding Simpson stratigraphy. Included in this report are descriptions and illustrations of ostracodes and conodonts by Harris.

Disney and Cronenwett (1955) and Cronenwett (1956) made an excellent preliminary regional investigation of the group, correlating subsurface formations with Decker's recognized outcrop sections, and illustrated the relationship between those formations and subsurface producing "sands".

White (1926) presented the first subcrop map in northeastern Oklahoma purporting to show present disposition of the Burgen-Tyner-"Wilcox" sequence.

Cram (1930, pp. 534-548) studied in detail Simpson rocks exposed along the Illinois River north of Tahlequah, established the Fite Formation, and suggested existence of unconformities within the Tyner Formation.

Harris (1957, p. 94), on the basis of extensive research with Simpson Ostracoda, distinguished and named the Corbin Ranch Formation, whose type section is on the western side of Oklahoma Highway 99, three miles south of Fittstown, Oklahoma. The Corbin Ranch Formation is familiarly known as the Simpson "Dense" or Bromide "Dense" in the subsurface. Harris' ostracodal research revealed that interformational faunal discontinuities exist within the Simpson Group (Fig.

1). However, only those hiatuses between the Beekmantown, Chazy, Black River and Trenton Stages, and between the Corbin Ranch and Viola Formations (both Trenton) were considered to be significant (1957, p. 102). This research also disclosed profound discrepancies in age relationships of some of the formations.

Starke (1961, p. 18) correlated the lower part of the Tyner Formation of northeastern Oklahoma with the Oil Creek Formation (upper part) of southern Oklahoma on the basis of an Oil Creek faunule, and assigned the Burgen sandstone to the stratigraphic position of the Oil Creek sandstone, an assignment which had previously been suggested by Cram (1930, p. 538) and by Disney and Cronenwett (1955, p. 109).

These are but a few of the outstanding papers regarding Simpson stratigraphy. Specific reference to them has been made primarily because they contain establishments of accepted formation names and reflect major advancements in Simpson concepts. They are particularly important insofar as they have special significance pertinent to this study.

A comprehensive resume of Simpson investigations from 1902 to 1956 may be found in Harris' 1957 publication. The publication includes a brief summary and selected bibliography for both Simpson stratigraphy and Simpson Ostracoda.

CHAPTER II

DISTANCE-FUNCTION MAPS

General Statement

Pelto (1954) conceived the distance-function method as a means of mapping multicomponent systems, whereby three or more lithologic components, referred to a symmetrically subdivided composition triangle (or tetrahedron), may be expressed. A distance-function map may be constructed to correspond to any composite percentage or ratio map involving three or more end members.

For the purpose of this report only a three end-member system was considered, due to the masking effect imparted by a fourth component. The distance-function composition triangle is divided into seven sectors, as shown in Figure 2, representing three classes. There are three single-component sectors, located at the apices of the triangle; three two-component sectors, separating each of the single-component sectors; and one three-component sector

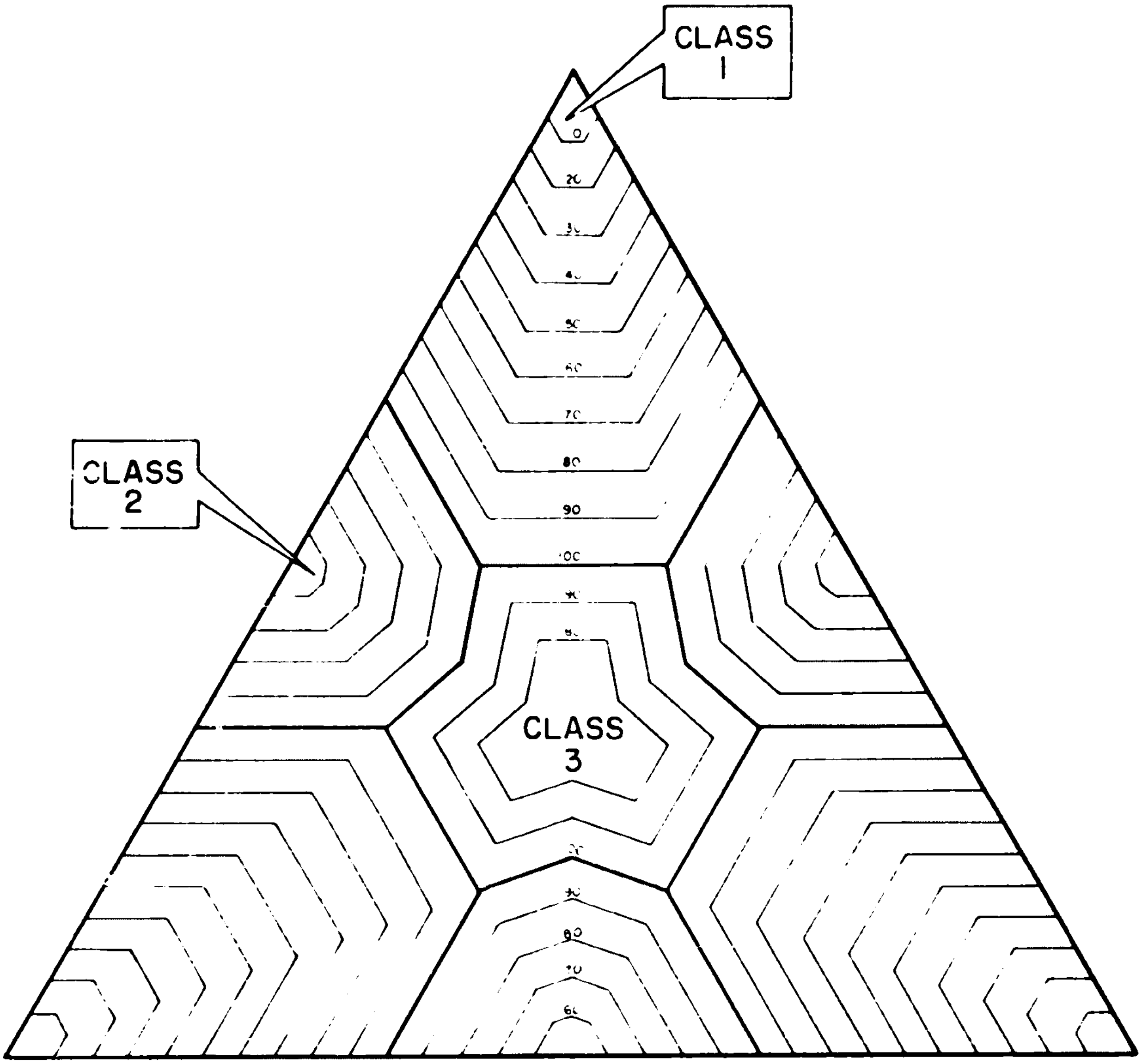


Figure 2

CLASSIFYING AND DISTANCE-FUNCTION TRIANGLE

(Adapted from Pelto, 1954)

located in the center of the triangle. Any gross lithology or characteristic thereof may be assigned to the single-component sectors. The remaining sectors represent approximately equal amounts of two lithologic types or, within the three-component sector, essentially equal amounts of three lithologic types.

In order to ascertain proximity to a pure end-member, each sector of the triangle, and hence each corresponding area on the map, is subdivided by "distance-function" lines. The distance-function values, not in any way to be construed as percentage values, disclose the "distance" from a pure end-member within each sector. Distance-function values decrease as a pure end-member is approached. Thus, a value of 0 would indicate, as an example, 100 percent limestone, and a value of 40 within the same sector would represent the occurrence of some other lithologic component.

Procedure

In order to construct a three-component distance-function map, both the triangle sector in which each control point belongs and a distance-function value for each control point to place its position within the sector must be determined. Calculations involve the determination of: (1) the percentages of each end-member, (2) the classifying number (function), and (3) the distance-function.

Assuming a formation 100 feet thick to be composed of 70 feet of sandstone, 25 feet of shale and 5 feet of non-clastics, the following percentages are computed:

$$\text{Sandstone \%} = \frac{\text{Sandstone thickness}}{\text{Total thickness}} = 70$$

$$\text{Shale \%} = \frac{\text{Shale thickness}}{\text{Total thickness}} = 25$$

$$\text{Non-clastic \%} = \frac{\text{Non-clastic thickness}}{\text{Total thickness}} = 5$$

The classifying number is determined by arranging the percentage values in order of increasing value, adding a null component on the left, and obtaining $(\Delta p)_1$, $(\Delta p)_2$, and $(\Delta p)_3$. Using the above percentages:

$$0 \underbrace{\qquad\qquad}_{\substack{(\Delta p)_3 \\ = 5}} 5 \underbrace{\qquad\qquad}_{\substack{(\Delta p)_2 \\ = 20}} 25 \underbrace{\qquad\qquad}_{\substack{(\Delta p)_1 \\ = 45}} 70$$

The subscript numbers of the Δp's represent the sector classifying numbers of the triangle. The subscript of the highest Δp value $[(\Delta p)_m]$ is the sector classifying number. In this example, the highest Δp value is 45, hence the classifying number is 1 (one-component sector allotted to sandstone).

The distance-function (D) is calculated from the following formula, where $(\Delta p)_m$ is the percentage value of the largest Δp, and $(\Delta p)_{vm}$ is the percentage value of the next largest Δp:

$$D = 100 \{1 - [(\Delta p)_m - (\Delta p)_{vm}]\}$$

$$D = 100 [1 - (45\% - 20\%0]$$

$$D = 75$$

Application

Although all calculations may be accomplished manually, the process is time-consuming, particularly when one is dealing with hundreds of control points. For this study, an IBM digital computer was utilized to perform all calculations and supply all needed data in tabulate form.

Having assigned a color code to the key triangle, with color representing a sector, the appropriate sector and distance-function value were registered at each control point. All excepting a few distance-function lines on the key triangles on the maps have been eliminated to prevent cluttering. Normally distance-function values would be contoured within each map sector to constitute the distance-function facies map, and an isopach map would be constructed independently. In order to reduce the total number of maps and to alleviate the problem of disjunction of two important maps, isopachs were combined with the basic facies map, and the distance-function values were left uncontoured. This procedure does not minimize the significance of the distance-function, however, inasmuch as the "purity" of the rock assemblage in terms of the end-members represented in each map pattern is yet registered at each control point.

Advantages of a facies mapping technique based on distance-function were mentioned on pages 2 and 3. One major disadvantage is that, while the relative proportion of a specific end-member within its class is provided by the distance-function value, the value does not distinguish which of the other two end-members is present. This was discovered not to be a serious problem with regard to the Simpson Group, in which facies changes are relatively unidirectional and constant.

CHAPTER III

DISCUSSION OF LITHOFACIES AND ISOPACH MAPS

Lithofacies Principles and General Approach

In this report, the term lithofacies is used in a general definitive sense; i.e., a lateral subdivision of a stratigraphic unit (formation) differentiated from adjacent subdivisions by distinctive lithologic character (Weller, 1960, p. 521). No temporal connotation is to be implied, inasmuch as units involved are purely rock-stratigraphic units.

Although the term facies is a general one which has been employed in many ways, it is used here specifically to distinguish gross lithologic characteristics or aspect of a formation, and hence is synonomous with lithofacies.

Lithofacies are statistically separated, and the boundaries depicted on the facies maps represent arbitrary vertical cutoff planes. The actual degree of intertonguing within each of the mapped formations is expressed and may be distinguished by the distance-function values within each lithologic class, or more readily, by the width of class 2 color bands representing sub-equal occurrences of two basic lithologic types. Narrow bands normally indicate abrupt lateral variations in lithologic types while wide bands denote extensive intertongues.

Uncertainties regarding perspicuity of facies expression are bound to arise due to truncation and onlap of beds. Each of the formations of the Simpson Group exhibits both truncation and onlap progressively outward from their depo-axes; hence, the comparison of facies from one area to another (particularly from the area of most complete accumulation to that of incomplete representation) may lead to spurious conclusions. This discrepancy, brought about by incomplete equivalency, must be considered with the analysis of each formation.

Joins Formation

General Statement

The Joins Formation (Ulrich, 1929, p. 73), basal formation of the Simpson Group, consists at its outcrops in the Arbuckle Mountains (Plate I) chiefly of thin-bedded light to dark gray limestones and less abundant dark green shales, with intraformational conglomerates near the base. Similar lithologic characteristics of the formation generally persist in the subsurface. Its homotaxial position with reference to underlying Arbuckle dolomite and superjacent basal Oil Creek sandstone and a characteristic high resistivity on electric logs serve to distinguish the formation. Where the limestones grade laterally into dolomites, however, it is difficult to discriminate the formation from the Arbuckle dolomite. Very little sand occurs in the Joins, except in its presumed Everton equivalent in eastern Oklahoma.

An abrupt faunal hiatus (Harris, 1957, p. 58) attests to its disconformable relationship with the underlying Arbuckle Group in outcrop sections. Presumably this relationship persists throughout the subsurface as well. Although there may be a slight faunal hiatus between the Joins and the overlying Oil Creek Formation, the break is not considered sufficiently significant to suggest a regional unconformity.

Facies Map (sandstone-shale-carbonate) on Isopach Base

The Joins Formation is restricted essentially to the south-central part of Oklahoma and to the extreme eastern part of the state, where it has been correlated with the Everton Formation of Arkansas (Plate II). It attained a maximum thickness of slightly more than 300 feet in Marshall and eastern Love Counties. The axis of deposition trends northwestward through Stephens into northeastern Kiowa County. Joins thickness in excess of 250 feet in southwestern Carter County suggests basinal development in the site of the present Marietta basin as early as Chazyan time. Joins sedimentation did not extend far enough southwestward to have been preserved in what is now the Hollis basin.

Carbonate deposition prevailed over most of the shelf areas. Although not restricted to the depoaxis, the occurrence of abundant shales coincident with the thicker Joins sediments suggests a basin environment along this trend. Local lenses of shale and some sandstone were deposited on the shelf in Cleveland and Pontotoc Counties.

Facies patterns of Everton equivalents of the Joins in eastern Oklahoma suggest that sands were deposited here as part of an influx of coarse clastics from southeastern Missouri or northern Arkansas.

Facies Map (limestone-dolomite-clastics)
on Isopach Base

This map (Plate III) portrays the abruptness of facies variation between limestones and dolomites upon the shelf, and provides evidence that the limits of the Joins Formation are primarily depositional. It is difficult to ascertain whether Joins sediments were deposited in the vicinity of Hughes County and later eroded or whether the presence of a positive tectonic feature prevented their deposition. Ham (1955, p. 30) suggested absence of Joins by truncation on and east of the Belton anticline.

The incipient development of an embayment, herein termed the Grady embayment, trending northeastward from Grady County into Oklahoma County and the peninsular occurrence of dolomite in McClain County are significant, inasmuch as these environmental patterns are reflected in isopach and lithologic trends observable in younger formations.

Oil Creek Formation

General Statement

The Oil Creek Formation (Ulrich, 1929, p. 73), which conformably overlies the Joins Formation, consists essentially of a basal sandstone member and an upper member of interbedded olive-green shales and thin-bedded, coarsely crystalline limestones. The basal sandstone member is restricted essentially to eastern Oklahoma, and is absent throughout the remainder of the state due to both onlap and facies change.

On the basis of Starke's (1961, p. 18) faunal collections and correlation of the lower part of the Tyner Formation of northeastern Oklahoma with the Oil Creek Formation (in part), and by detailed correlation through the subsurface from outcrop sections in the Arbuckle Mountains, the writer considers the Lower Tyner-Burgen sequence to be a formational equivalent of the Oil Creek Formation (Plate I). The basal Oil Creek sandstone and the Burgen sandstone comprise a continuous body of sandstone extensive throughout eastern Oklahoma.

A significant hiatus, separating the Oil Creek Formation of Chazyan age from overlying Black River sediments, is suggested by varying abruptness of faunal and stratigraphic discontinuities in the Arbuckle Mountain region (Harris, 1957, p. 65). Within the Tyner Formation of northeastern Oklahoma outcrops, a possible break in sedimentation between the lower and middle Tyner beds was noted significantly by Cram (1930, p. 542). It is this discontinuity which is considered herein the demarcation between the Oil Creek and McLish Formations. Although some hiatus of unknown magnitude undoubtedly exists locally, there is no suggestion from regional electric log and sample log correlation that a major unconformity exists

(Plate I).

Facies Map (sandstone-shale-carbonate) on Isopach Base

Although more widespread in extent, thickness trends of the Oil Creek Formation are generally consistent with those of the Joins Formation (Plate IV). Maximum deposition occurred in a northwestward trend from Marshall County to southern Washita County. This trend constituted the ancient Simpson basin, the axis of which straddles part of the northern edge of the present Wichita element.

A depositional embayment extending from Marshall County into southwestern Carter County is, as was depicted on maps of the Joins Formation, indicative of basinal evolution in the present locale of the Marietta basin as early as Chazyan time. A trend of thickening, so apparent on Joins maps, extends northeastward into Cleveland County. Deposition was sufficiently extensive southwestward upon the flanks of the Texas arch (Adams, 1954) to have been preserved in the present site of the Hollis basin.

The 200 foot isopach contour marks the depositional hinge-line separating the Simpson basin from the shelf at the time Oil Creek sediments were deposited. Rocks onlap progressively northward upon Joins and Arbuckle strata.

Very little limestone or dolomite was deposited throughout the shelf area. Carbonates (chiefly limestones) predominate only near the Arbuckle Mountains, along the southern part of the Tishomingo anticline, and in an isolated subsurface area of Cleveland County. Carbonates (chiefly dolomites) are abundantly represented north (and presumably south) of the Choctaw fault in southeastern Oklahoma, although their significance is masked by the influence of sandstones.

Shales predominate throughout the western two-thirds of Oklahoma. The preponderance of sandstone in the eastern part of the state results essentially from the thickening of basal Oil Creek sandstone in that direction. The relationship between shale and sandstone on this map is due to both facies change and onlap of the basal sandstones in westward and northwestward directions.

The gray pattern and high distance-function values in Cleveland and McClain Counties suggest the presence of abundant sandstone in that area. The influence of shales as shown on this map, however, is so overwhelming as to preclude the significance of the sandstone.

The non-contiguous belt of sandstone bordering the northern limits of the formation is not to be construed as a valid facies change. The patterns represent the encroachment of sandstone strata within the upper Oil Creek to a wedge where the shales have disappeared both by onlap and truncation. Discontinuity of the sandstone pattern along the wedgeout is indicative of truncation and it is to be assumed that the Oil Creek Formation was originally deposited beyond the limits presently shown.

Sandstone Isolith Map

Insofar as a distance-function lithofacies map is inadequate to portray the distribution of Oil Creek sandstones, it was necessary to supplement the more generalized facies map with one that would specifically depict the quantitative occurrence of those sandstones. Plate V depicts the net sand thickness relationships of the entire formation, and also the superimposed limits of the basal Oil Creek-Burgen sandstone.

Sandstone is present in varying amounts throughout most of the state, except within the Simpson basin proper and in three scattered localities along the northern limit of the formation.

Significantly, most of the sandstone that lies southeast and east of the basal Oil Creek-Burgen sandstone limit is attributable to that member.

Both the isolith patterns and the line representing the limit of the basal sandstone member, as well as overall facies relationships portrayed on Plate IV, suggest that the influx of coarse clastics was derived from the east.

Herein the so-called "Burgen" or "Hominy" sand of Osage and Pawnee Counties is not considered the correlative equivalent of Burgen exposures in Cherokee County, as was proposed by White (1926, p. 30). Despite a remarkably close stratigraphic parallelism between the two widespread areas, in which a series of green shales overlies a sandstone, the aforementioned "Burgen" or "Hominy" sand lies clearly within rocks younger than the true Burgen sandstone and its basal Oil Creek equivalent.

In a southwesterly direction the basal Oil Creek sandstone is replaced rather abruptly by facies change to shales and limestones of the Simpson basin proper. Dapples (1955) postulated the Simpson basin to be a locale of current energy dissipation during all of Simpson time, but nowhere in the section is that more apparent than in the Oil Creek Formation.

North-south thinning, as suggested by both sandstone isoliths and isopachs of the formation, in Seminole and eastern Cleveland Counties provides evidence that the Seminole and Central Oklahoma uplifts existed and were slightly positive, but quiescent, at this time. Sufficient energy, however, permitted sands to bypass these high areas to fill the Grady embayment and extrude northward and westward into Oklahoma and Canadian Counties.

McLish Formation

General Statement

The McLish Formation was named by Ulrich in 1928. It was considered to be Chazyan in age until ostracodal evidence induced Harris (1957, p. 76) to stipulate a Black Riveran age.

At its type-section in the Arbuckle Mountains and in the subsurface throughout most of Oklahoma, the formation is comprised of a basal sandstone and an upper section of interbedded green shales, minor maroon shales, and variable limestones and thin sandstones. Although maroon shales are present to some extent in the Oil Creek and Tulip Creek Formations, they are characteristic of the McLish Formation. Interbeds of maroon shales become more abundant northeastward and eastward, although green shales everywhere predominate. As was suggested by Cronenwett (1956, p. 15), the maroon color of these shales may have resulted from shallow water oxidizing conditions during sporadic periods of emergence in northeastern Oklahoma.

Harris (1957, p. 74) postulated a minor faunal hiatus between the McLish and overlying Tulip Creek Formations, and Decker and Merritt (1931, p. 16) reported that the Tulip Creek in the eastern part of the Arbuckle Mountains was absent due to unconformity and onlap on the McLish Formation. However, there is little stratigraphic evidence to support the presence of a regional unconformity between these two formations.

Facies Map (sandstone-shale-carbonate) on Isopach Base

Isopach trends are closely congruent to those of the Oil Creek Formation (Plate VI). Thicknesses in excess of 750 feet are encountered in Marshall County, which appears to be a depocenter for most Simpson sediments. Distinct thinning over the Seminole and Central Oklahoma uplifts is observable. The Grady embayment has all but disappeared, although there is slight suggestion of its existence slightly east of its normal axial position.

Two relatively pronounced structural features, as evidenced by isopach thinning, appear for the first time. One is a north-south trend extending from Wagoner County into Pittsburg County, paralleled on its eastern flank by a trend of thickening of carbonates. This feature may have acted as, or been an integral part of, the incipient axis of a relatively major tectonic element which induced erosion of later Simpson rocks.

The second and perhaps more economically attractive anomaly extends from Harper County southward to Kiowa County, where it is obscured by the present Wichita uplift. This positive trend is formally proposed herein as the Woodward arch after King (personal communication, 1963). It is postulated that the Woodward arch is a Precambrian positive element which has remained relatively stable throughout Champlainian time, yet was sufficiently high to induce structural interference to sedimentation. The predominance of shales in this area (as portrayed on this map) does not preclude the possibility of McLish sandstones having built up as the result of shoaling over the arch.

The sandstone patterns lying along the eroded edge of the McLish Formation in Osage County are influenced essentially by truncation and onlap of shales. The east-westward trending belt of sandstone through east-central Oklahoma, however, is a legitimate coarse clastic facies and is interpreted to have been a linear tongue derived from the east.

Carbonates are more prevalent percentage-wise in the

McLish than in the Oil Creek. It is interesting to note that the locus of limestone deposition, which in Oil Creek sediments was concentrated over the southern Arbuckle Mountains, shifted southward to encompass a position analogous to the present Criner Hills.

Dolomite Percentage Map

Obscuration of distance-function facies relationships between limestones and dolomites by a dominance of clastics demanded the construction of a map involving carbonates only. This exigency resulted in Plate VII, which portrays not only overall basin-shelf relationships, but complements the facies map involving clastic end-members.

The percentage of dolomite with respect to total net carbonates in the McLish was plotted and mapped in conjunction with carbonate isoliths.

The boundary between the Simpson basin proper and the shelf is well illustrated by abrupt facies change from limestone to dolomite. Within the basin, which extends from Marshall County northwestward into the Texas panhandle, and whose axis partially transcends the Wichita Mountains, there is practically no similarity between the isolith contours and the limestone pattern. Shelfward, however, there is some congruency between isoliths and percentage contours. Salient trends appear to coincide with and are presumably affected by structural trends depicted on Plate VI.

An abrupt southwestward transition from limestones to dolomites in what is now the Hollis basin strongly supports the contention that Simpson sediments are absent upon the Texas arch primarily due to non-deposition, and that the southwestern shoreline of the Simpson seas was restricted essentially to southwestern Oklahoma.

Tulip Creek Formation

General Statement

The Tulip Creek Formation was established and considered by Ulrich (1928) as Chazyan in age. Decker and Merritt (1931, p. 38) considered the formation to be chiefly Black Riveran, based on conodont and ostracode studies of Harris. Conflicting opinions as to whether the Tulip Creek is Chazyan or Black Riveran in age are reflected by its position on various correlation charts (Fig. 1). This thesis subscribes to Harris' contention that the Tulip Creek (and the subjacent McLish as well) is Black Riveran (1957, p. 82).

In most outcrop sections and throughout the subsurface where a "complete" section is recognizable, the Tulip

Creek Formation consists essentially of two members: a basal sandstone, and an upper section of olive-green shales with some interbeds of maroon shale, thin-bedded limestones, and minor sandstones.

Near eastern Garvin County and southeastern McClain County it is extremely difficult to distinguish the Tulip Creek-Bromide contact due to increase in sandstone facies at the expense of shales of the upper member of the Tulip Creek. The writer considers the "Third Bromide" sand in this area to be equivalent to the Tulip Creek sandstone, as was suggested by Cronenwett (1956, pp. 18-19) and as is generally recognized by petroleum geologists; locally, the lower part of the "Second Bromide" sand as well may represent a sandstone facies of the upper member of the Tulip Creek.

The nature of the contact between the Tulip Creek and the overlying Bromide Formation is a subject of some controversy. Ham (1955, p. 29) stated that the Tulip Creek disappears eastward from the Arbuckle Mountain region by facies intergradation into the lower part of the Bromide. Earlier (1945, p. 30) Ham conceded that even within the Arbuckle Mountains there was insufficient evidence to warrant recognition of the Tulip Creek as a separate formation and included all strata lying above the McLish in the basal part of the Bromide.

Tulip Creek Ostracoda, on the other hand, are sufficiently distinctive from those of the Bromide to justify retention of the Tulip Creek as a separate formation (Harris, 1957, p. 78). Although the hiatus is unquestionably brief, there is suggestion of discontinuity.

Herein the Tulip Creek is depicted disappearing eastward by abrupt truncation (Plates I and VIII). Erosion was brought about by post-Tulip Creek epeirogenesis along an extremely broad, north-southward trending tectonic feature covering the eastern part of the state.

Elsewhere in the state, the Tulip Creek apparently wedged out as a result of normal depositional onlap with possible minor truncation.

Facies Map (sandstone shale-carbonate) on Isopach Base

The Tulip Creek Formation is restricted to the south and west-central part of the state primarily by depositional onlap, except at its eastern limits, where it has been truncated (Plate VIII). The sandstone pattern portrayed in eastern Seminole and neighboring counties was constructed, in this particular instance, on the basis of electric log data, which shows the basal Tulip Creek sandstone rising to a postulated surface of unconformity.

Extending from Lincoln County southward to Pontotoc County, both the shale pattern (representing there only the upper member of the Tulip Creek) and the isopachs attest to onlap of this formation over a prominent feature. Presumably this feature is the Seminole uplift, but minor effects of the Guthrie-Holdensville arch (Tarr, 1955) may have affected, tectonically, the depositional environment of this area.

Carbonates are so exiguous as to be revealed only as secondary or tertiary lithologic components.

As was true of the Oil Creek and McLish Formations, so Tulip Creek sands appear to have been derived from the east as a linear tongue. Sands were then redistributed and concentrated as the result of shoaling effects along the Central Oklahoma arch in Cleveland, McClain, and Garvin Counties.

Isopach trends are generally consistent with those of older Simpson formations, except that the axial trend of the basin has shifted northward from Carter County into Murray County, and the depositional embayment emanating westward from Marshall County is incongruent to its former position in northern Love County.

The Grady embayment again may be observed as a prominent northeastward extention of the basin.

Dolomite Percentage Map

Carbonates are restricted to the basin and its immediate environs, the maximum net thickness (210 feet) occurring in the embayment in southern Carter County (Plate IX). Minor amounts of limestone characterize the Grady embayment, and provide further evidence for its justification as a distinct sub-basin.

Dolomite occurrence is irregular and, except for a noticeable eastward increase in dolomite, the pattern bears little resemblance to dolomite patterns of other formations; neither is there obvious close relationship to Tulip Creek structural elements.

Bromide Formation

General Statement

The Bromide Formation of Black Riveran age lies in stratigraphic position between the Tulip Creek and Corbin Ranch Formations. In Arbuckle Mountain outcrops, and generally in the subsurface as well, the formation displays the cyclic arrangement characteristic of most of the other Simpson formations: lower sandstone member, middle section of light green shales, and uppermost thin to massive limestones. The topmost Simpson lithographic limestone recognized in the subsurface as "Bromide dense" or "Simpson dense" has been designated as the Corbin Ranch Formation (Harris, 1957, p. 98).

Stratigraphic relationship with the underlying Tulip Creek Formation has been postulated previously as being regionally conformable, except along the eastern truncated wedge of Tulip Creek; the faunal hiatus between the two formations is considered relatively insignificant.

Contact with the overlying Corbin Ranch Formation, however, is distinctly disconformable. Not only are Ostracoda of the two formations sufficiently distinctive to suggest a hiatus of major proportion, but the transgression of Corbin Ranch northward and eastward over progressively older Simpson strata is clearly illustrated (Plate I).

Facies Map (sandstone-shale-carbonate) on Isopach Base

Isopach trends of the Bromide Formation indicate parallelism with older Simpson units, but the axis of deposition has shifted slightly northeastward (Plate X). A locus of thickening trends southeast-northwestward across northeastern Washita County, thereby constituting a departure from isopach patterns of older Simpson formations.

The Grady embayment is much more pronounced, and its axis departs from its "normal" position to extend northward through Canadian County into eastern Blaine County.

Separating the Grady embayment and the locus of thickening in western Oklahoma is a pronounced thinning which indicates the presence of an underlying positive element which is vaguely revealed on maps of the McLish Formation. The name Blaine arch is suggested herein for this feature. The presence of a trend of thickening of McLish strata (Plate VI) in eastern Washita and Custer Counties would suggest that the Blaine arch and the Woodward arch are entirely different elements. Carbonate patterns in western Oklahoma represent the influence of two factors: the development of limestones in the thicker Bromide section of Custer and Washita Counties, and the occurrence of lower Bromide dolomites at what appears to be a conjunction of the Woodward and Blaine arches in Harper County (Plate XI).

The Blaine arch is particularly significant because of the predominance of sandstone throughout its extent. Regional facies and isopach relationships are strikingly similar to those of the prolifically productive trend related to the Central Oklahoma uplift.

Sandstone is by far the most extensive and predominant lithology of the Bromide Formation. Even though the sandstone patterns north, east, and west of the eroded limit of the upper Bromide represent basal lower Bromide sandstones exposed at a surface of truncation, the truncation progressing outward to extinction of the formation, the ubiquitousness of sand suggests derivation from the north as well as from the east.

Barrett (1963, personal communication) postulated that only the upper Bromide is present in the Hollis basin. In this research no definitive evidence was available to substantiate discrimination of Bromide strata in this area. The absence of a lower sandstone member here is not considered evidence that the lower Bromide is missing, insofar as the sandstones are essentially restricted to the northeastern side of the Simpson basin. A normal thinning of the upper and lower Bromide and facies change to carbonates southwestward upon the flanks of the Texas arch is congruent with concepts derived from analyses of other Simpson formations.

A substantial quantity of Bromide rock has been eroded from parts of Oklahoma where it is thought to have been deposited originally, although some of the lateral thinning from the Simpson basin is attributable to onlap and normal convergence. The formation was completely eroded in eastern Oklahoma during a renewed post-Bromide pulsation of what appears to have been a southern attenuation of the Ozark uplift. Further erosion in northeastern Oklahoma was induced by pre-Chattanooga activity in that area. In the Oklahoma panhandle, a thin veneer of Bromide strata was eroded to its present limit as a result of minor activity near the Sierra Grande uplift.

Facies Map (limestone-dolomite-clastics) on Isopach Base

Dolomites are more common and extensive in the formation than Plate XI would indicate. Cursory investigation of dolomite percentage data revealed that this lithologic type predominates limestone throughout most of northern Oklahoma, and over the Blaine arch and Central Oklahoma uplift as well.

The purpose of introducing a clastic component was to bring out the significant facies change from coarse clastics to dolomite within the lower Bromide in Harper and Woodward Counties (see also Plate I). Bifurcation of the class 2 pattern representing approximately equal amounts of dolomite and clastics (chiefly sandstone) attests to the presence of two arches (Woodward and Blaine arches) branching from a common locus.

Both the overlying Viola Formation and Hunton Group exhibit profound dolomitization in the same area. Hunton isopachs (Shannon, 1962, p. 15) portray a pronounced trend of thinning southward into Dewey County coincident with the Woodward arch, but there is no thinning in Blaine County to suggest the influence of the Blaine arch.

Corbin Ranch Formation

General Statement

Harris (1957, p. 94) established the name Corbin Ranch for the uppermost lithographic limestone unit of the Simpson Group. The formation has long been recognized in the subsurface and in Arbuckle Mountain surface exposures as a persistent lithic unit comprising the uppermost part of the Bromide Formation. In subsurface sections in particular the unit has been termed "Bromide dense" and "Simpson dense" to distinguish it from the lithologically similar "Viola dense."

Harris' extensive research on Ostracoda, however, reveals a fauna distinctly different from the underlying Bromide and overlying Viola and suggests that the Corbin Ranch is separated from these formations by significant erosional hiatuses (Fig. 1). A Trentonian age for the Corbin Ranch is indicated indirectly by the absence of distinctive Black

River Ostracoda (Harris, 1957, p. 101) and directly by the presence of graptolites and other "Bromide" fossils considered to be Trenton forms (Decker, 1951, p. 913).

The exact correlation of the Fite Limestone (Cram, 1930, p. 546) of northeastern Oklahoma has been a matter of controversy. Cram considered the Fite not to be correlative with the dense limestones (Corbin Ranch) of the Arbuckle Mountain region, and questioned its correlation with the subsurface "dense lime" chiefly on the basis of Ulrich's (personal communication with Cram, 1930) faunal identification of the Fite beds as pre-Fernvale Richmond in age.

On the basis of regional subsurface correlations from Cleveland County eastward to Cherokee County, Disney and Cronenwett (1955, p. 110) tentatively correlated the Fite Limestone with either the upper Viola or with a non-identified limestone ("birdseye?") within the McLish Formation.

Huffman and Starke (1960, p. 271) and Frezon (1962, p. 42), however, suggested equivalency of the Corbin Ranch and Fite on the basis of lithologic similarity and stratigraphic appearance, and Harris (1957, p. 101) tentatively correlated the Fite with the Corbin Ranch subject to further ostracodal research.

The writer considers not only the Fite Limestone but the upper Tyner dolomitic limestones of the Illinois River section northeast of Tahlequah to constitute the Corbin Ranch (Fig. 1 and Plate I). Cram (1930, p. 542) pointed out that a distinct break in sedimentation and the cherty character of the basal portion of the upper dolomitic limestones indicates disconformity between the upper and middle Tyner. It is this "break" which the writer believes to represent the unconformity separating the Corbin Ranch from the McLish Formation. The inclusion of upper Tyner beds with the Fite is consistent with subsurface sections in eastern Oklahoma in which dolomitic limestones and dolomites prevail at the base of the Corbin Ranch.

Facies Map (limestone-dolomite-clastic) on Isopach Base

The Corbin Ranch Formation is limited to the southern two thirds of the state (Plate XII). Its thickness ranges anywhere from 0 to 150 feet. The maximum thickness trend, as revealed by isopach, extends from Marshall County northwestward into Caddo County. Distinct north-southward trends of thinning in Washita County, Cleveland, and McClain Counties and in Seminole County are diagnostic of positive structural elements which have persisted throughout the deposition of the Simpson Group.

Apparent subsidence of the southern part of the Ozark uplift permitted the deposition and overlap of the Corbin Ranch north and eastward progressively upon Bromide and McLish strata.

The dense, lithographic limestone which typifies the formation persists over most of its extent. However, a dolomite facies prevails over the Seminole uplift, along a north-southward trend through McIntosh and Pittsburg Counties, and in a few scattered localities in central Oklahoma.

The manner in which the dolomite pattern abuts the zero limit of the formation in northern Okfuskee County is substantial evidence for post-Corbin Ranch, pre-Fernvale erosion. In Cherokee and Adair Counties, the truncation resulted from pre-Chattanooga erosion.

There is no evidence regarding the exact nature of the formation's limits in the western part of the state other than being essentially depositional, although minor truncation may have occurred. Normal thinning northward in eastern Oklahoma suggests that the Corbin Ranch was not deposited originally much farther north than Tulsa or Delaware Counties.

The absence of Corbin Ranch strata in many of the Arbuckle outcrop sections and in at least one subsurface section in northern Jefferson County (where Viola beds rest directly upon Bromide strata) provides evidence that some movement occurred in Arbuckle and Wichita areas at the end of Simpson time.

CHAPTER IV

DISCUSSION OF LAP-OUT AND PALEOGEOLOGIC MAPS

General Statement

A lap-out map, commonly known as a "worm's eye" map, is a special method of paleogeologic expression where post-unconformity geologic relations are portrayed. Specified map patterns represent formations that lie directly upon the surface of unconformity, and it is generally desirable that these patterns depict not only the onlap of progressively younger strata, but also the areas over which interformational unconformities exist.

A paleogeologic map portrays the geology of a surface of unconformity as that geology existed at the time a designated rock unit had been eroded prior to further deposition. As Levorsen (1960, p. 3) has pointed out, a distinction exists in the strict application of the terms paleogeologic and subcrop. According to Levorsen, a subcrop mapping applies only to an area where the overlapping formation is yet present, whereas a paleogeologic map connects and projects subcropping formations to the positions they occupied originally below the overlapping formation, and before later erosion removed the cover.

Lap-out Map

Plate XIII illustrates the relationship of Simpson formations to the post-Arbuckle surface of unconformity. All Pennsylvanian tectonic elements in southern Oklahoma were deleted so that the postulated extent of the formations might be portrayed.

The map does not exhibit an ideal lap-out in northeastern Oklahoma insofar as the zero limit represents a truncated edge resulting from pre-Chattanooga uplift and erosion of Simpson and superjacent rocks from the Ozark dome (Chautauqua arch). Projection of both Burgen-Oil Creek sandstone and upper Oil Creek onlap limits northeastward suggests that the Oil Creek Formation was originally deposited no farther north than Mayes and Delaware Counties. The McLish Formation presumably formed a thin veneer over the entire area.

Bromide strata directly overlie the Arbuckle Group in a local area of southwestern Tillman County and a narrow belt of Corbin Ranch limestone (underlain unconformably by the McLish Formation) marks the southernmost depositional limit of Simpson rock in Oklahoma.

Paleogeologic Map

With the exception of northeastern Oklahoma, the paleogeology of the Simpson Group (Plate XIV) is a restoration of the Simpson surface of unconformity prior to the deposition of Viola sediments. The map reflects some episodes of epeirogenic uplift, truncation, and overlap, particularly the regional truncation of the Bromide Formation and overlap of the Corbin Ranch Formation upon beds as old as Oil Creek and Arbuckle. Most of the positive elements previously discussed in connection with the facies maps are not revealed on this map due to the masking effect of the Corbin Ranch Formation. Recession of the upper Bromide limit in Blaine County, on the other hand, does coincide with the axis of the Blaine arch and exhumation of Bromide strata (upper) in southern Oklahoma attests to minor positive movement in the Arbuckle and Wichita uplifts in pre-Viola time.

Prediction of pre-Viola paleogeology in northeastern Oklahoma proved ineffective and meaningless because pre-Chattanooga-post-Hunton tectonism of the Ozark uplift has removed all of the evidence on which a purposeful paleogeologic reconstruction might be based. Also, the Simpson of this area was purposely portrayed as it appears in subcrop beneath the Chattanooga Formation, so as to elucidate problematic stratigraphic relationships. Actually, the northeastern Oklahoma portion of the map may be visualized as an expression of pre-Chattanooga paleogeology.

The subcrop interpretation shown on the southeastern flank of the Ozark uplift and the classic example depicted by White (1926, pocket map) differ chiefly as a result of disparate correlations. Whereas White considered the Burgen sandstone as a continuous subcrop belt from Delaware County to northern Osage County, the writer believes that the Burgen sandstone pinches out by onlap eastward in Tulsa County (see Plate XIII), and that the so-called "Burgen" sandstones of the subsurface in Osage County are misnamed McLish sands.

This difference in correlation does not alter interpretation of events that occurred to bring about the subcrop pattern. Evidence retains and supports White's concept of a pre-early Mississippian episode during which time uplift of the Ozark region (Chautauqua arch) induced truncation of pre-Mississippian rocks progressively southwestward.

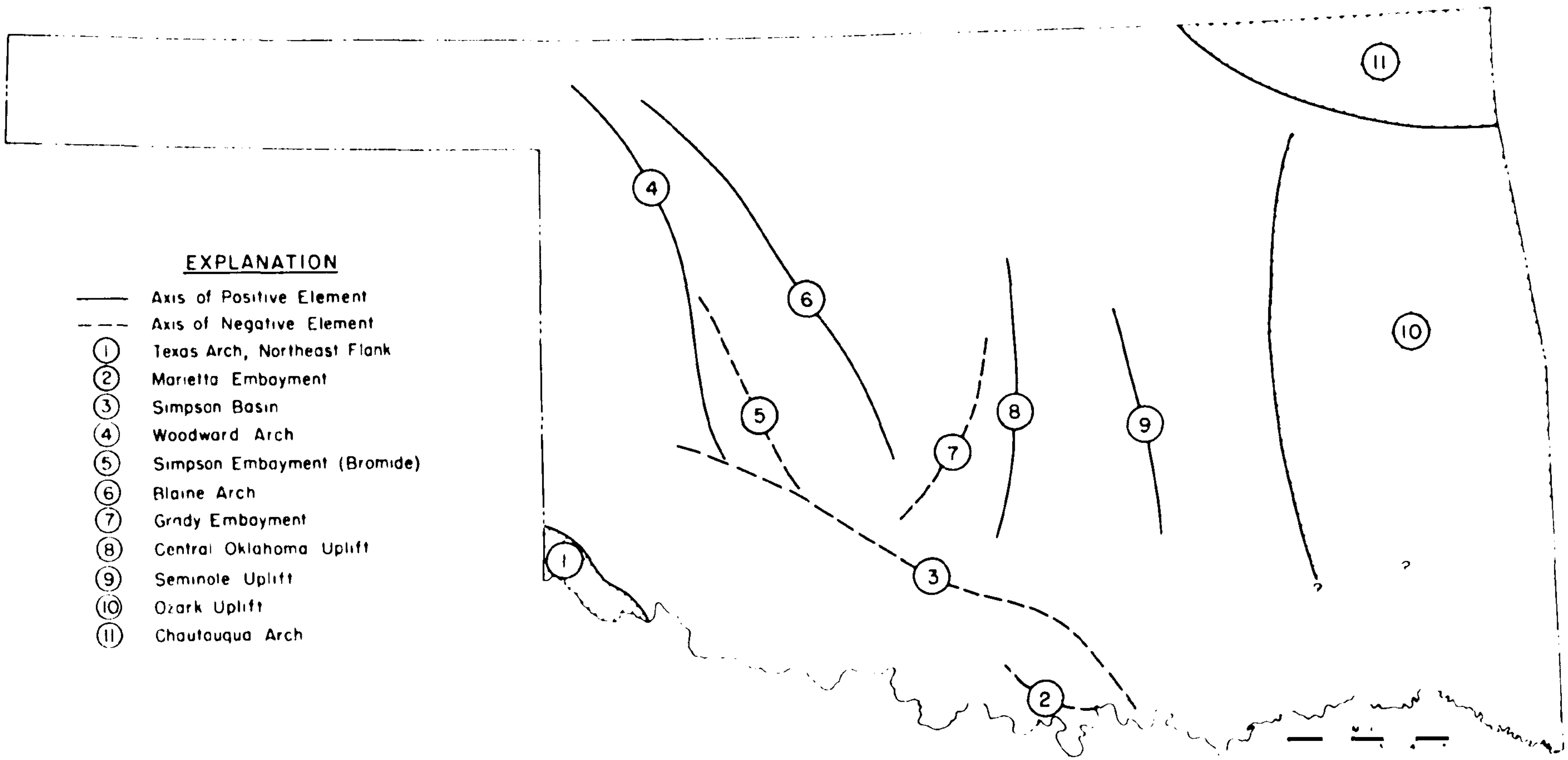
CHAPTER V

REGIONAL TECTONIC ASPECTS

Two general tectonic aspects of the Simpson Group have been revealed by means of lithofacies and paleogeologic analysis of formations comprising the group: (1) a basin and stable shelf with pronounced structural elements, which appear to be intrinsically related to the Precambrian complex, as manifested by isopach and gross lithologic associations, and (2) interformational unconformities and post-Simpson peneplanation, suggesting tectonic episodes during and following Simpson deposition.

The more outstanding tectonic features shown on Figure 3 have been discussed in conjunction with each of the facies maps. The positions of axes are representative of the group as a whole and are not intended to coincide directly with axes of individual Simpson formations.

Most of the elements are observable on maps of all the formations of the Simpson Group. Notably, on the other



MAJOR SIMPSON TECTONIC ELEMENTS IN OKLAHOMA

FIGURE 3

M W SCHRAMM, JR , PH D

MAY, 1963

hand, the Woodward and Blaine arches first appeared with the deposition of McLish sediments, the Blaine arch being more pronounced.

The Central Oklahoma uplift is a persistent feature which is considered ancestral to the pre-Atokan or late Mississippian Central Oklahoma arch (Lowman, 1933, p. 32).

The axial trend of the Seminole uplift differs from the northeast-southwestward trend shown by Huffman (1959, p. 2543). Nevertheless, the feature, although smaller than its Pennsylvanian counterpart, is considered to be the same.

The Simpson basin, of course, is the most outstanding tectonic feature. Conceivably a miogeosynclinal attenuation of the Ouachita geosyncline, the basin forms a narrow linear depositional trough which is asymmetrically disposed between the Texas arch to the southwest and the Chautauqua arch to the northeast. Composite thicknesses of Simpson rock indicate the depocenter to be in Marshall County and in the present vicinity of the Arbuckle Mountains. At least three subsidiary embayments extended from the basin, only one of which (Simpson embayment) is not reflected on maps of all the formations.

The Ozark uplift profoundly affected subsurface distribution of the Tulip Creek and Bromide Formations in eastern

Oklahoma. Further research will reveal what effect, if any, this tectonism reflected on equivalent rocks within the Ouachita geosyncline.

CHAPTER VI

GEOLOGIC HISTORY

The Simpson basin, which is often referred to as the Oklahoma basin or Arbuckle geosyncline, had its inception with downwarping of the basement complex to form a narrow, linear depositional belt in Late Cambrian time. Following deposition of the Reagan sandstone (Croixian) and approximately 7,000 feet of Arbuckle carbonates (Cambro-Ordovician), the latter of which thin abruptly shelfward, eustatic withdrawal of the Canadian sea produced a widespread irregular surface of unconformity throughout the entire Mid-Continent region.

Thus, a significant unconformity separates Arbuckle rocks from basal Simpson Joins sediments, which were deposited during rejuvenated subsidence of the basin in early Chazyan time. Depositional conditions differed little from those that existed during Arbuckle deposition. Abundant calcium carbonate was precipitated from the areally restricted sea, and clays were carried into the site of thickest accumulation. Dolomites were probably being formed penecontemporaneously around the peripheral shelf areas. Disjoined from the Simpson basin proper, younger Joins magnesian carbonates, diluted with an influx of coarse clastics (sands) from the northeast, were being deposited in east-central Oklahoma.

Further and more pronounced subsidence of the basin and a concomitant eustatic rise in sea level during late Chazyan permitted the advent of vast quantities of clastics into Oklahoma. Sands, constituting the basal sandstone of the Oil Creek Formation, were introduced from the east and became limited in distribution by marked dissipation and facies change to clays and calcareous sediments of the basin and by onlap northwestward upon Arbuckle strata. The sea transgressed laterally from the basin, redistributing some of the sand to conform to existing structural elements on the stable shelf. Later Oil Creek sedimentation on the shelf was characterized by deposition of fine detrital materials and erratic intercalations of coarser clastics. The supply of clay was sufficiently abundant to prevent appreciable accumulation of carbonates.

Neither the Texas arch nor the proximal craton contributed significant amounts of sand to the Simpson basin or shelf. As is true for the Simpson Group as a whole, sands entered Oklahoma from the east and northeast, having been derived ultimately from the Canadian Shield. Dake (1921) postulated the Canadian Shield as the source terrane for Simpson clastics, and Dapples (1955, p. 465) has hypothesized sand transporting currents to have emanated from that region.

Frequent references to an eolian origin for Simpson sands, based solely on the frosted appearance of individual "golfball" grains and as the only means by which the sands could be transported so far, are speculative. Mankin (personal communication, 1963) pointed out that petrographic analyses of Simpson sandstones, and other sandstones displaying frosted grains, revealed incipient quartz overgrowths to be the chief factor in inducing the "frosted" appearance. Thus, southwestward-moving longshore currents, although somewhat conjectural, do provide an alternate and more plausible explanation as to mode of transport of these Simpson sands. Regression of the Chazyan sea permitted removal of a relatively thin sequence of upper Oil Creek beds from the depositional periphery in northern Oklahoma and southern Kansas. There is little subsurface evidence to substantiate appreciable erosion of the entire Oil Creek Formation; deposition in the slowly subsiding Simpson basin was essentially continuous. A marked faunal hiatus observed by Harris (1957, p. 102) in the Arbuckle Mountains may attest to local ancestral tectonism in that area. Decker and Merritt (1931, p. 22) also presented evidence for erosional contact with overlying McLish.

Renewed transgression of the Simpson sea in early Black Riveran time and a fresh supply of sand directly from the east produced a depositional environment similar to that of the Chazyan sea. Sands were restricted at the northeastern rim of the basin, and conditions of onlap and normal convergence prevailed northward over the entire shelf. Positive movement of the Woodward arch in western Oklahoma induced thinning by differential compaction, and the Central Oklahoma arch acted as an obstruction which may have decreased the longshore current energy, thereby preventing sands from moving into the basin proper. Repetitive minor fluctuations in sea level caused the deposition of limestones, dolomites, and thin sandstones in varying proportions over the shelf.

Tulip Creek sediments were deposited in much the same fashion, although their areal distribution was limited by a diminishing, yet transgressing, sea. Positive movement of the Seminole uplift diverted the basal transgressive sand southward through Pontotoc County, where transporting power was sufficient to transport a wedge of sand into the southeastern part of the basin and to allow northward distribution upon the western flank of the uplift. Upper Tulip Creek shales then onlapped and covered the uplift.

While later stages of Tulip Creek deposition continued in the basin and over a major portion of the western shelf, a major pulsation of the Ozark uplift caused the entire sequence of Tulip Creek sediments to be eroded from eastern Oklahoma and to be redeposited in the Bromide sea.

With widespread inundation of almost the entire region in late Black Riveran time, vast quantities of sand were derived and compounded from the exposed McLish surface in northern Oklahoma, from the Tulip Creek strata of eastern Oklahoma, and undoubtedly from an elusive terrane in the north-central part of the United States, to form the thick, massive sandstones of the lower Bromide Formation. The sands spread essentially everywhere over the basin except the southeastern part and upon the southern shelf.

The Blaine arch became pronounced for the first time as a distinct element separating the Grady embayment from the newly formed Simpson embayment. A dolomite facies of lower Bromide sands formed at the conjunction of these arches in northwestern Oklahoma.

The last stages of Black Riveran deposition were characterized by slow regression of the sea, quiescence, and carbonate precipitation to form the limestones and dolomites of the upper Bromide Formation. Mild epeirogenic uplift accompanied by withdrawal of the sea into the deepest part of the basin or into the Ouachita geosyncline exposed the region to a brief interval of erosion and truncation. In eastern Oklahoma, either renewed activity of the Ozark uplift induced erosion of existent Bromide strata, or the area remained high, thus preventing their deposition.

The depositional environment under which the Corbin Ranch Formation was formed was radically different from that of older Simpson units. Whereas most of the older formations were cyclically deposited in relatively shallow waters under stable conditions (accompanied by oscillation on the shelf and by mild subsidence of the depositional trough), the early Trenton (Corbin Ranch) sediment was a microcrystalline calcareous ooze which probably was deposited rapidly as a result of biochemical or chemical precipitation in extremely quiet waters. The persistent lithographic characteristic so typical of the formation attests to a persistent depositional environment that prevailed throughout its extent.

A brief cessation of the Ozark uplift allowed the early Trenton sea to inundate the region. The Seminole uplift and an undefined area directly east of it, however, both were positive, causing thereon extensive thinning and dolomitization of the limestone. The total lack of dolomites surrounding the zero limit of the Corbin Ranch in the Arbuckle Mountain region or in the vicinity of northern Jefferson County is evidence that minor movement occurred in these areas after the carbonate sediments had been indurated.

CHAPTER VII

CONCLUSIONS

The Joins, Oil Creek, McLish, Tulip Creek, Bromide and Corbin Ranch Formations of the Simpson Group were correlated throughout the subsurface of Oklahoma in order to (1) establish formational equivalents between measured surface sections in the Arbuckle and southwestern Ozark Mountain regions, (2) determine erosional or depositional limits of each of the formations, (3) illustrate suspected existing interformational regional disconformities, and (4) provide basic operational units from which thickness and gross lithologic data could be derived quantitatively for construction of a series of isopach and facies maps.

A second, but no less important, purpose of this study was to advance a technique of lithofacies expression based on the distance-function method. Conceived by Pelto (1954) as a means of mapping multicomponent systems alternative to methods devised by Krumbein and Sloss (1951), the distance-function technique has not been utilized heretofore in practical application. Simplicity in map design, compared with corresponding composite maps based on percentages and ratios, and the provision of relative proportions of specific lithologic types justify recognition of this method as a usable mapping tool.

A total of 446 electric logs (226 supported by sample logs) and 11 measured outcrop sections were used as a basis of control for the maps and correlation diagram of this thesis. The writer personally examined samples and cores of several wells, reviewed numerous unpublished core analyses, and visited several outcrops in order to examine lithologic characteristics of the units. Data for the facies and isopach maps were derived quantitatively by calculating thicknesses and percentages of gross lithologic types for each formation. A vast amount of data necessitated the use of an electronic computer for calculations of classifying-functions and distance-functions.

Detailed subsurface correlation and faunal evidence substantiate the thesis that the thin lower Tyner-Burgen sequence cropping out on the southwestern flank of the Ozark uplift is equivalent to at least the lower part of the thick Oil Creek Formation of the Arbuckle region. The middle Tyner shale is considered by the writer to be McLish, and the upper Tyner dolomitic limestone and Fite limestone are herein correlated conjunctively with the Corbin Ranch Formation. A distinct break in sedimentation between the upper and middle Tyner beds represents a significant hiatus during which time Tulip Creek and Bromide strata were eroded from the Ozark area.

The Simpson Group contains many interformational unconformities and onlap pinchouts of both local and regional magnitude. Intraformational discontinuity on a lesser scale is suspected but not confirmed. The Joins and Tulip Creek Formations are limited essentially to the southern half of Oklahoma as a result of non-deposition. The Tulip Creek and superjacent Bromide Formation are absent from eastern Oklahoma due to erosion from the Ozark uplift in Black Riveran time. The absence of the Corbin Ranch Formation below Viola strata in the Arbuckle and eastern Wichita Mountains is evidence that minor incipient tectonism of these elements occurred in post-early Trenton time.

Information gained from correlations and computed data enabled construction of a series of isopach and lithofacies maps of Simpson formations covering the entire state. Analysis of the resultant maps revealed (1) the ingress of Simpson detritus (sand) into Oklahoma to be essentially from the east and northeast, (2) the presence of several negative and positive tectonic elements, heretofore unrecognized, representing incipient development of prominent Pennsylvanian features, (3) the existence of prominent Simpson structural elements, previously unmapped, as manifested by isopachs and lithologic associations within individual formations (the writer herein introduces the names Woodward arch, Blaine arch, Simpson embayment, and Grady embayment for Simpson elements revealed in the maps), and (4) evidence for obstructions which permitted southwestward dissipation of current energy and, hence, the restriction of coarse clastics essentially to northern and northeastern shelf environs.

In summary, the following contributions to a better understanding of Simpson stratigraphy evolved from this study:

1. More precise correlation between Simpson rocks of the Ozark and Arbuckle Mountains.

2. Subsurface correlation of Simpson formations throughout the state.

3. Limits of onlap and truncation of the individual Simpson formations.

4. Use of lithofacies maps for individual Simpson formations.

5. Application of the distance-function principle to lithofacies studies.

6. Determination of probable source areas for Simpson sediments.

7. Establishment of tectonic elements indigenous to the Simpson.

8. Evidence of ancestral activity of numerous prominent Pennsylvanian features.

Observation of tectonic elements and their relationship to facies, and an understanding of the regional geologic aspects in general, are of paramount importance to the petroleum geologist. Cursory examination of regional conditions under which petroleum accumulated in Simpson reservoirs indicates that similar environments elsewhere deserve attention. It is hoped that this study provides a background for further detailed exploration of Simpson rocks.

Perhaps even more important than the basic information found in this report is the fact that it might well stimulate interest in regional studies. Certainly it is hoped that similar studies be made for other economically important geologic units. The writer concludes that the combination of isopach and facies, utilized in conjunction with standard exploratory methods, application of distance-function to mapping procedure, and utilization of electronic computers to process vast amounts of data are valuable tools which the oil industry cannot afford to ignore.

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APPENDIX I

LIST OF MEASURED OUTCROP SECTIONS USED IN THIS STUDY

Section Name	Location Sec.	Twp.	Rge.	Reference
Carter County				
Highway 77, Arbuckle Anticline	25	2S	1E	Harris, 1957
Criner Hills, North	15	5S	1E	Decker, 1941
Cherokee County				
Qualls Dome	35	15N	21E	Huffman, et al., 1958
Illinois River (Tahlequah)	2	17N	22E	Cram, 1930
Johnston County				
Belton Anticline, Northeast	9, 10	2S	7E	Ham, 1955
Sycamore Creek	27	3S	4E	Ham, 1955
Mill Creek Reservoir	31, 32	3S	5E	Womack, 1956
Murray County				
Lake Classen	24	1S	1E	Dunham, 1951
West Spring Creek	6	2S	1W	Harris, 1957
Mill Creek Syncline	32	1S	2E	Ham, 1955
Pontotoc County				
Hunton Anticline, Northeast	12	1N	6E	Ham, 1955

APPENDIX II

LIST OF CONTROL WELLS USED IN THIS STUDY

Operator and Well	Location Sec.	Twp.	Rge.	Sample Control
Alfalfa County				
Amerada No. 1 Rexroat	14	23N	11W	X
Amerada No. 1 Kiner	11	23N	12W	X
Continental No. 1 Maltbie	8	28N	9W	X
Ohio No. 1 Parr	9	28N	10W	X
Huber Corp. No. 1 Maxwell	17	28N	12W	X
Huber Corp. No. 1 Smith	22	29N	10W	X
Continental No. 1 Hill	23	29N	11W	X
Atoka County				
Texas No. 1 Price	19	2S	9E	X
Texas Eastern & Anderson Prichard No. 1 Lewis	31	2S	11E	X
Amerada No. 1 Ridgeway	24	3S	9E	X
Beaver County				
Gulf No. 1 Ratzlaff	9	3N	21ECM	X
Phillips No. 1 Blakemore	36	4N	20ECM	
Sinclair No. 1 Barby	21	4N	26ECM	X
Pure No. 1 Albert	16	5N	26ECM	X
Beckham County				
E. L. Boyd No. 1 Bohannon	32	8N	21W	
Gulf No. 1 Lam Day	12	8N	22W	
Pure No. 1 Taute	34	10N	25W	X

Blaine County

Signal Oil No. 1 Norris	17	19N	10W	X

Bryan County

Honeyman-Nat'l. Coop. No. 1 Townsend	30	5S	8E	X

Caddo County

Texas No. 1 Yellow Fish	20	5N	11W	X
Mack Oil No. 1 Schurch	3	5N	12W	
W. C. Jackson No. 1 H. R. Bacek	28	5N	12W	X
Sinclair-Prairie Oil No. 1 German	1	6N	13W	X
Shell No. 1 Tofpi	34	7N	13W	X
Denver Prod. & Refining No. 1 School Land	16	10N	9W	X

Canadian County

Sinclair et al. No. 1 Hutchemon Unit	14	12N	7W	X
Cities Service No. 1 Porter "B"	5	12N	8W	X
Southern Union Gathering No. 1 Schumacher	22	13N	7W	

Carter County

Pure No. 1 Noble	35	3S	1E	X
Pure No. 1 Dillard	6	3S	2E	X
Fain-Porter Drlg. No. 1 Coleman	18	3S	2W	X
Frankfort Oil No. 1 Royal	9	5S	1E	X
T. H. McCasland No. 1 McClure	15	5S	1E	X
Texas No. 1 George	17	5S	1E	X
Frankfort Oil No. 1 Simmons	17	5S	2W	X
Sinclair-Prairie-Pasotex No. 1 R. S. Bond	33	5S	2W	X

Cherokee County

Shell No. 1 Owens	25	16N	19E	X

Cimarron County

Ohio No. 1 Perkins	24	1N	6ECM	X
Texas No. 1 Youtsler	23	1N	9ECM	X
Gulf No. 1 Cox	35	2N	8ECM	X
Shell No. 1 Moore	15	3N	3ECM	X
Cities Service No. 1-B Moore	22	4N	3ECM	X
Stanolind No. 1 Burton	28	3N	6ECM	
Texas No. 1 Pugh	34	3N	9ECM	
Shell No. 1 State	23	4N	2ECM	
Sun No. 1 State	33	5N	1ECM	
Ohio No. 1 School Land	33	5N	2ECM	X
Sun No. 1 State	24	6N	3ECM	X

Cleveland County

K. A. Ellison No. 1 Frontenier	12	7N	2W	
Brown et al. No. 3 Roberts	15	8N	1E	
Pan American No. 1 Stout	20	8N	1W	X
Petroleum, Inc. No. 1 Tullius	16	8N	2W	X
Anderson-Prichard No. 1 Allison Unit	27	8N	2W	X
C. B. Wrightsman No. 1 LeMaster	3	9N	1W	
J. D. Wrathers et al. No. 1 McCoy	13	9N	1W	
Sinclair No. 1 Rose	21	9N	3W	X
Parrish & Reynolds No. 1 Little	22	10N	1W	X
Lone Star Prod. Co. No. 1 Reynolds "A"	6	10N	2W	

Coal County

Rockhill Oil No. 1 Fanning	35	1N	8E	X
Anderson-Princhard No. 2 Cook	15	1N	11E	
Gibson No. 1 Thomas	10	1S	9E	X
Stanolind-Amerada No. B-1 Cushing Royalty	22	3N	9E	X
Atlantic Refining Co. No. 1 Cody	25	3N	9E	
Ohio No. 1 Jones	35	3N	11E	

Comanche County

Dixon Drlg. No. 1 Otippoby	17	3N	11W	
Tidewater No. 1 Myers	10	4N	11W	X
Texas No. 1 J. C. Roberts	30	4N	11W	X
D. H Bolen No. 1 Pfeiffer	12	4N	12W	

Cotton County

Johnson & Flesher Drlg. No. 1 McCullough	17	4S	13W	
Johnson & Russell No. 1 A. F. Holmes	20	2S	13W	X

Craig Coungy

E. A. North No. 1 Harris	15	24N	19E	
J. C. Starr No. 1 Hill	29	25N	20E	X
J. C. Starr No. 1 Cass	32	25N	21E	
Frankfort Oil No. 1 Van Ausdel	31	28N	20E	
City of Welch	29	28N	21E	
Empire Gas & Fuel No. 1 Siegel	34	29N	19E	

Creek County

Hoxsey Oil No. 5 Abraham	14	14N	8E	
Mid-Continent Petr. No. 1 Estates Land Co.	19	16N	7E	
Texas No. 1 Wickham	19	16N	8E	
Kewanee No. 1 Vaughn	4	16N	9E	
Sinclair Oil & Gas Co. No. 5 Fee 209	24	17N	7E	
P. B. Jackson No. 2 Carmen	25	17N	9E	
Central Commercial No. 3 Hay	10	17N	10E	X
Gulf No. 1 Berryhill	17	17N	12E	
Meissner & Sharp No. 1 Johnson	22	18N	9E	
Mikel Drlg. No. 1 Burgess	25	18N	10E	
Leader No. 1 Vernon	30	19N	8E	

Custer County

Magnolia No. 1 Miller	22	15N	16W	X

Delaware County

(Unknown) No. 1 Starr	28	25N	24E	
M & F Oil No. 1 Ransom	18	20N	22E	X

Ellis County

Sinclair No. 1 Berry	14	24N	25W	

Garfield County

Stephens Petroleum No. 1 Rieser	7	20N	3W	X
Frankfort & Inland Oil No. 1 Southwick	15	22N	4W	
Atlantic No. 1 Kruse	19	22N	4W	X
Amerada No. 1 Roberts	8	23N	3W	X
A. G. Oliphant No. 2 Hoover	2	24N	5W	

Garvin County

Pan American No. 1 Williams	17	1N	2W	X
Ohio No. 1 Burns	17	3N	2E	X
Cities Service No. 1 McCurley Unit	19	3N	1W	X
Phillips No. 1 Marvin "B"	22	3N	3W	
Kubit & Phillips No. 1 Newbern	14	4N	2E	
Champlin Refining & Bell Oil No. 1 Ray	31	4N	2E	
Carter & Mandel No. 1 Masters	23	4N	3E	
Cities Service No. 1 Weatherford	31	4N	2W	X
Texas No. 1 Tessy Lindsay	6	4N	3W	
California No. 2 Roller	36	4N	3W	
Phillips No. 2 Martin Ranch	2	4N	4W	

Grady County

Magnolia No. 1 Dougherty & Welch	1	4N	5W	

Stanolind No. 1 Briscoe Unit	4	4N	5W	X
Cleary Petroleum Inc. No. 1 Hilltop	16	8N	5W	X

Grant County

L. J. Horwitz No. 3 Bowling	31	26N	5W	
Sunray No. 1 Kent	21	26N	8W	X
Cities Service No. 2 Pratt	6	28N	3W	X
Cities Service No. 1 Lehring	19	28N	3W	X
Trigg Drlg. No. 1 Boyer	34	28N	5W	
Gulf No. 1 Rixse	9	28N	7W	X
Continental No. 1 Connery	32	28N	8W	X
Texas No. 1 Shepherd	29	29N	4W	
Atlantic No. 1 Shoffner	34	29N	6W	X
Sinclair No. 1 Hendrixson	17	29N	8W	

Greer County

Bridwell Oil No. 1 Meadows	5	3N	22W	
T.X.L. No. 1 Herron	23	4N	24W	X

Harmon County

California No. 1 Wade	23	1N	25W	X
Bolin Oil No. 1 Cummins	23	2N	26W	
Continental No. 1 Durham	27	2N	26W	X
Amerada No. 1 Moore	8	3N	25W	X
Continental No. 1 Denton	27	3N	25W	X

Harper County

Continental No. 1 Benton	2	25N	22W	
Sunray No. 1 Klinger	12	25N	26W	
Phillips No. 1 Seevers	6	27N	20W	X
Continental No. 1 Howard	15	27N	21W	X
Hamilton Bros. No. 1-32 Bennett	32	27N	21W	X
Sinclair No. 1 Holcomb	7	28N	22W	X
Gulf No. 1 White & Wood	24	28N	23W	X
Deep Rock No. 1 Lamunyon	21	28N	24W	X
Sinclair No. 1 Browning	26	29N	22W	X

Haskell County

Superior Oil No. 73-18 Allred	18	8N	20E	X
Phillips No. 1 Abbie	31	9N	20E	X
I. T. I. O. No. 1 Blake	3	10N	21E	X

Hughes County

Stanolind No. 1 Hamilton	33	4N	9E	X
Pan American & R. G. Scott No. 1 Calvin	8	5N	10E	X
Fleet & Stanolind No. 1 Skinner	21	5N	11E	X
Seaboard Oil No. 1 Gamble Estate	18	6N	9E	
Phillips No. 1 Mandler	1	6N	10E	X
Pure No. 1 Rogers et al.	18	8N	12E	X
Manahan Oil No. 5 McGirt	1	9N	8E	
Amerada No. 1 Adams Estate	31	9N	9E	
F. Thomas et al. No. 1 W. Johnson	1	9N	11E	

Jackson County

Mid-Continent Petroleum No. 1 Moon	31	1N	19W	X
Gulf No. 1 Fowler	9	1N	20W	
Sun No. 1 Hickman	19	1S	22W	
Oil Service No. 1 Russell	2	2N	21W	X
Sohio No. 1 Grider	13	2N	21W	
Stanolind No. 1 Murray "A"	33	2N	22W	X
Sun No. 1 Perryman	21	3N	22W	X
Tidewater Assoc. No. 1 Johnson	19	3N	23W	X

Jefferson County

Phillips No. 1 Price	21	3S	7W	X
Gulf No. 1 Robinson	9	4S	6W	X
L. O. Pulliam No. 1 Stone	21	4S	7W	
W. H. Peckham et al. No. 1 Sanders	10	4S	8W	X
Davon Oil & Atlantic No. 1 Payne	3	5S	6W	
Lario Oil & Gas No. 1 Seay	34	5S	6W	
L. O. Pulliam No. 1 Stone	6	5S	7W	
Goff & Leeper No. 1 Howard	23	5S	7W	X
Texas No. 1 Howard	14	6S	4W	X

Sun Drlg. & Kingery No. 1 Dennis	10	6S	5W	X
Mack Oil No. 1 Ollen	4	6S	6W	X
Beach & Talbot No. 1 Richeson	6	6S	7W	X
Sun Drlg. & Gilmer Oil No. 1 Dilley	15	6S	7W	
Cities Service No. 1 Linton	7	7S	6W	X
Texas No. 1 Smart	14	7S	6W	X
J. A. Maurer No. 1 McGinnis	31	7S	6W	X
Gulf No. 1 Greiser	28	7S	7W	X

Johnston County

Jones, Shelburne & Pellum Oil No. 1 Harris	15	2S	8E	
Continental Oil No. 1 Rutherford	30	4S	6E	X
Sunray No. 1 Rawson	28	4S	4E	X

Kay County

Phillips No. 1 Farris	5	25N	1E	
Continental No. 1 Brett "A"	8	25N	2E	
Jones & Shelburne No. 1 Snodgrass	4	26N	3E	
Cyclone Drlg. No. 1 Moxan	1	27N	1E	
Vaughn No. 1 Constant	6	27N	1W	
Siler No. 1 Whetmore	15	27N	2E	
Texas No. 1 Lee	21	27N	2W	
Kantor Oil No. 8 Lawrence	5	28N	1W	
Magnolia No. 1 Correll	5	28N	2E	X
B. B. Blair No. 1 Clevier	25	28N	3E	
K. A. Ellison No. 1 Bain	4	28N	4E	
Service Drlg. No. 1 Boles	28	28N	5E	
Pure No. 1 Lutz	14	29N	2W	X
Union Oil No. 1 Stalnaker	20	29N	2E	
F. D. Strickler No. 1 Treat	20	29N	3E	X
Ben Chadwell et al. No. 1 Stewart	15	29N	4E	

Kingfisher County

Phillips No. 1 Grape	30	18N	5W	X
Pure No. 1 Pollard	34	19N	5W	X

Kiowa County

Wally Diety No. 1 Troub	15	6N	14W	
W. F. Collins No. 1 Fraizer	1	6N	15W	
F. W. Burger No. 1 Dudgeon	31	6N	16W	
Barton & Underwood No. 1 Brown	8	6N	17W	
Stanolind No. 1 State School Land	24	6N	17W	X
Carter Oil No. 1 McDonald	16	7N	14W	X
Carter Oil No. 1 Burson	30	7N	14W	
Wegener Drlg. No. 1 Britch	5	7N	18W	X
Gibralter Oil No. 1 Wattenbarger	6	7N	19W	X
Dore & Rolls No. 1 Mitchell	9	7N	20W	

Lincoln County

Texas No. 1 Linan	20	13N	3E	X
McElreath & Biffle No. 3 Roberson	3	14N	6E	
Wilcox Oil No. 1 Potter	24	16N	2E	
Deep Rock No. 1 Argo	4	16N	5E	X
Big Bend Petroleum No. 1 Cook	3	16N	6E	

Logan County

United Transport, Inc. No. 1 Cornsforth	17	15N	3W	
Ryan et al. No. 1 Camp	23	15N	3W	
Blackwood & Nichols No. 1 Krout	14	15N	4W	X
Davon Oil No. 1 Graff	11	17N	3W	
Sunray No. 3-B Haynes	27	17N	1E	

Love County

Sinclair No. 1 Ewing	9	6S	1E	X
Frankfort Oil No. 1 Gardner	34	6S	2E	X
George E. Cameron No. 1 Haynes	7	7S	3E	X

Major County

Continental No. 1 Kimball	34	20N	16W	X
Woodward & Co. No. 1 Walker	34	22N	13W	X
Sinclair No. 1 Spafford	33	23N	16W	X

Marshall County

Texas No. 1 Chapman	35	4S	4E	
Magnolia No. 1 Ward-Rains "C"	13	6S	6E	X

Mayes County

J. L. Dixon No. 1 Drew	8	20N	19E	

McClain County

Anson Petroleum No. 1 Smith	27	5N	1E	
A. A. Cameron No. 1 Haney	22	5N	2W	
Max Pray et al. No. 1 Goddard	35	5N	2W	X
Cities Service No. 1 Jones "C"	32	5N	4W	X
Carter Oil No. 1 Atchley	27	6N	2W	X
Carter Oil No. 1 Neal	23	6N	3W	
Pasotex Petroleum No. 1 Hubbard Welch	26	7N	2W	X
Woodward & Mendota Oil No. 1 Conner	11	7N	3W	
Carter Oil No. 3 Johnson Unit	30	8N	2W	X
Jay Simmons No. 1 Wilson	14	8N	4W	X

McIntosh County

Carter Oil No. 1 Follansbee	18	9N	15E	X
Phillips No. 1 Ruby	30	10N	16E	X
W. E. Steelman No. 1 Stechell	5	11N	14E	
Bell Oil & Gas No. 1 Young Estate	11	11N	18E	
Oklahoma Natural Gas No. 1 Covey	14	12N	16E	X

Murray County

Continental No. 1 Springer	31	1N	2E	
K. A. Ellison No. 1 Healey	34	1S	2E	X
Alladin Petroleum No. 1 DeFratus	26	1S	3E	X

Muskogee County

Mid-Continent Oil No. 1 Dunagan	31	11N	19E	X

Phillips No. 1 Hatcher	36	11N	19E	X
U.S.S.R.A.M. Exploration Co. No. 1 Marshall	23	13N	19E	X
Grant No. 1 Bartholet	8	14N	17E	

Noble County

Shell No. 1 Magney	17	20N	2W	X
Gypsy Oil No. 1 Bergstrom	28	22N	1W	X
Texas No. 1 Hudson	11	23N	1E	X
R. L. Owen No. 1 Wentz	12	24N	3E	

Nowata County

Pure No. 2 Parrish	8	25N	17E	X
Whitehill & Hayden No. 1 Petit	2	26N	14E	
Wilkinson No. 1 Janzen	14	26N	15E	
Riverland Company No. 1 Nicholson	14	27N	15E	
Ludowici-Celadon Co. No. 12 Taylor	16	28N	16E	

Okfuskee County

Amerada No. 1 Canard	16	10N	10E	
Champlin Refining No. 4 Lewis	15	11N	11E	

Oklahoma County

Cities Service No. 5 Farley	19	11N	2W	X
British-American No. 1 Brady-Tellier	23	12N	3W	
Petroleum Corp., Inc. No. 1 Ruble	1	13N	2W	X
R. M. Jordan No. 1 Marcel	23	14N	1W	
Mohawk Drlg. No. 1 Emerald "A"	13	14N	4W	

Okmulgee County

Snee & Eberly No. 1 Miller	25	11N	13E	
Hamon & Cox No. 19 Reynolds	26	12N	13E	X
Honestake Producing Co. No. 1 Stanley	9	13N	11E	

W. H. Pine No. 1 Clew	2	13N	12E	
Mid-Continent Petroleum No. 9 Daniels	12	13N	13E	
Robinson Oil No S-1 McMurray	1	13N	14E	
Texas No. 19 Fee-NCT No. 2	11	14N	11E	X
Honestake Producing Co. No. 1 Whittaker	3	14N	13E	
Sohio No. S-1 Milner	35	14N	14E	
Four States Oil & Gas No. 1 Smith	26	16N	13E	X
Wood Oil No. 1 Bluford Miller	32	16N	14E	

Osage County

Morris Myer No. 1-A Mazel	6	20N	10E	
Dillard & Kennedy No. 1 Osage	8	20N	11E	
Sunray No. S-2 Osage	4	20N	12E	
Dietrich & Elliot No. 23 Osage	2	21N	9E	
Burton Oil & Gross Drlg. No. 1-A Osage	11	21N	10E	
O. A. Shaw No. 1 Hopper	21	21N	11E	
Mid-Continent Petroleum No. 1 Osage Tr 184	11	22N	7E	
J. A. Kornfeld No 2 Daniels	15	22N	8E	
D R. Lauck No. 1 Drummond	2	22N	9E	
Norbla Oil No 1 Millsap	19	22N	10E	
W. R. Dillard No. 1-A Lambert	14	22N	11E	
V. Greenwood No. 1 Osage	19	22N	12E	
C R Colpitt et al. No. 1 Romerman	21	23N	6E	
Texas No. 2 Little Soldier	11	23N	7E	X
Bradley Producing No. 1 Osage	26	23N	8E	
Sunray No 1 Pratt	15	23N	9E	
Jakcson Drlg. No. 2 Edgington	15	23N	10E	
Cities Service No. S-1 S. W. Avant Unit	14	23N	11E	X
V. Greenwood No. 1 Osage	31	23N	12E	
Sunray No. 1 Osage	10	24N	4E	X
Sands Oil No. 1 Gray	25	24N	5E	
W. Broadhurst No. 1 Colvert	11	24N	7E	
F. H. Lindsay No. 2-1 Post Oak	8	24N	9E	
Sunray No. 10 Osage	23	24N	10E	
Cities Service SWD No. 1, Lot 292	8	24N	11E	X
L. B. Stableford No. 1 Brandon	17	24N	12E	

Marland Oil No. 1 Alexander	11	25N	3E	X
Kewanee Oil No. 1 Silas	22	25N	4E	
W. P. Ballard No. 1 Osage	16	25N	5E	
Phillips No. 2 Jennie "A"	26	25N	6E	
Cities Service No. 1 Kennedy "C"	9	25N	7E	X
Palmer-Nat'l. Assoc. Petr. No. 1 Coldsprings	21	25N	8E	
C. E. Ramsey No. 1 Osage	8	25N	10E	
C. T. Matthews No. 1 Soldani	22	26N	4E	
Producers Pipe & Supply No. 1 Vaden	12	26N	6E	
Tennessee Gas Trans. No. 1 Osage "A"	15	26N	7E	
Bert Wheeler No. 1 Osage	8	26N	8E	
F. H. Lindsay No. 2-1 Sand Creek	23	26N	9E	
Sooner Oil No. 1 Remington	10	26N	10E	
Sunray No. 1 Osage	10	27N	6E	
Sooner Oil No. 1 Barnard	17	27N	9E	
I. T. I O. No. 414 Osage	26	27N	11E	X
Sunray No. 1 Osage	5	27N	12E	
Phillips No. 1 Barton "A"	21	28N	7E	
Amerada No. 1 Osage-Trumbly	14	28N	9E	
Texas No. 1 Osage	23	29N	5E	
Shamrock No. 1 Chapman	34	29N	9E	
L. E. Cox No. 2 Osage	31	29N	11E	

Ottawa County

Thrall No. 2 Davis	13	27N	23E	
City of Miami No. 3 Goodrich	24	28N	22E	X
Commerce Mining & Royalty No. 159 Beaver	19	29N	23E	X

Pawnee County

Selby Oil & Gas No. 1 Lauderdale	1	20N	7E	X
Trigg Drlg. No. 2 Peeler	21	20N	8E	
Waggoner & Co., et al. No. 1 Brodell	9	20N	9E	
W. B. Moran No. 1 Voorhees	26	21N	6E	
Harris & Suppes Exploration No. 1 Speed	22	21N	7E	
Malernee No. 1 Lucas	28	21N	8E	X

Continental No. 1 Myerdirk	10	22N	5E	X
Taylor No. 1 Garrett	20	22N	6E	X
D. Gibson No. 1 Dawes	32	22N	7E	
Porter Oil & Gas No. 1 Taulman	15	23N	4E	
H. Schafer et al. No. 1 Rowe	14	23N	5E	

Payne County

Wood Oil No. 1 Chief	33	19N	5E	X
Loffland Bros. No. 2 State	16	20N	2E	
Harper-Turner Oil No. 2 White	23	20N	4E	

Pittsburg County

Magnolia No. 1 Manshrick	28	6N	16E	X
Superior No. 1 Lytle	12	7N	14E	X

Pontotoc County

E. P. Halliburton No. 1 Bumpers	3	3N	4E	
Carter Oil No. 1 Gassoway	9	3N	4E	X
Gilmer Oil No. 1 Hollow	2	3N	5E	X
Oil Capitol Corp. No. 1 Whisenhunt	22	3N	8E	
Oil Capitol Corp. No. 1 Moshier	27	3N	8E	X
Deep Rock No. 1 Bond	23	4N	4E	
Texas No. 1 Gray	18	4N	5E	
W. H. Pine No. 1 Busby	12	4N	8E	X
Fleet Drlg. No. 1 Sinclair-Swell	14	4N	8E	
Rock Hill Oil No. 1 Newbern Estate "A"	31	5N	4E	

Pottawatomie County

General American Oil No. 2 DeJarnette	17	6N	3E	
Algord Oil No. 1 Petty	19	6N	4E	
Continental No. 2 Klinglesmith "A"	23	8N	2E	
Woodward & Co. No. 1 Pensoneau	36	10N	3E	
Atlantic No. 2 Washington	24	11N	4E	

Rogers County

Reed No. 1 Koenig	27	19N	17E	X
Wolfe Drlg. No. 1 Patrick	14	20N	14E	
E. N. Brockman No. 1 Nichols	31	22N	15E	X
Ambassador Oil No. 1 Dawson	13	23N	15E	
Campbell No. 1 Compton	6	23N	17E	
L. E. Reames No. 1 Marr	31	24N	15E	

Sequoyah County

Diamond Drlg. No. 1 Mullen	5	11N	23E	X
Leonard No. 1 Smith	23	12N	21E	
M. E. Cook No. 1 Fee	8	12N	24E	X

Seminole County

Rixleben No. 1 Bailey	34	6N	5E	
Stanolind No. 4 Palmer	36	6N	7E	X
Atmar Drlg. No. 1 Roberson	6	8N	6E	
Cities Service No 13 Livingston	15	8N	6E	X
Texas No. 9 Little	3	10N	8E	
Humble No. C-28 Riddle No. 6	35	11N	6E	

Stephens County

Phillips No. 1 Oakman	2	1N	4W	X
Eason Oil No. 1 Pinson	30	1N	7W	X
Jake Hamon No. 1 Bloydes	26	1S	7W	
British-American No. 1 S. Krieger	3	2N	5W	X
Carter Oil No. 1 Everett et al.	24	2N	9W	
Dobbins No. 1 Price	19	2S	5W	X
Ambassador Oil No. 1 McPhail	7	2S	6W	
W. H. Atkinson No. 1-A Mann	28	2S	6W	
Ashland Oil No. 1 A. M. Harley	3	2S	7W	
T. H. McCasland et al. No. 1 Pitts	3	2S	8W	
T. H. McCasland No. 1 Hildebrand	1	3S	7W	X

Texas County

Phillips No. 2 Pearl	16	1N	15ECM	
Cities Service No. 1 Hale	25	2N	12ECM	X

Tillman County

H. R. Theck No. 1 Cox	8	1S	16W	
S. D. Johnson No. 1 Tallant	8	1S	17W	X
Carter Oil No. 1 Anna Kurz	25	1S	17W	X
Lincoln & Moore No. 1 Rollins	8	1S	18W	
Texas No. 1 Reese	23	1S	18W	
Gulf Oil-Kadane No. 1 Copeland	31	1S	18W	X
Bridwell No. 1 Petty	8	1S	19W	
Homestake Producing No. 1 Stretesky	23	1S	19W	X
Mack Oil No. 1 Po-Ah-Wy	17	2S	15W	X
Continental No. 1 Smith	6	2S	16W	X
Aries Oil No. 1 Plott	16	2S	17W	
Continental No. 2 Kirby	34	2S	17W	X
I. T. I. O. No. 1 Fillmore	36	2S	19W	X
Pure No. 1 Sims	10	3S	14W	X
Magnolia No. 1 Amyx	17	3S	16W	X
Union Oil No. 1 Emenheiser	23	3S	17W	X
Sunray No. 1 Cassiday	1	3S	18W	
Magnolia No. 1 Ida Brown	21	3S	18W	X
Phillips-Falcon Seaboard No. 1 Robey	35	3S	18W	X
Johnson No. 1 McGuire	3	3S	19W	
Union Oil No. 1 Medlock	32	4S	15W	X
Pyramid Oil & Gas No. 1 Polk	13	4S	16W	X
Phillips No. 1 Wright	18	4S	17W	X
Sunray No. 1 Suiter	3	5S	15W	X

Tulsa County

Jersey Production Research Test Hole No. 1	35	17N	14E	
Bradley Producing No. 1 Ispocogee	34	18N	12E	
Parker No. 1 Hardcastle	22	19N	11E	
Gypsy Oil No. 15 Payne	19	20N	13E	X
Dowell No. 1 Fee	31	20N	13E	X
Superior No. 1 Blakemore	26	21N	13E	X
Phillips & Kenner Oil No. 1 Cookley	33	22N	13E	X

Wagoner County

Mid-Continent No. WS-1 N. Tecumseh	5	16N	15E	

Washington County

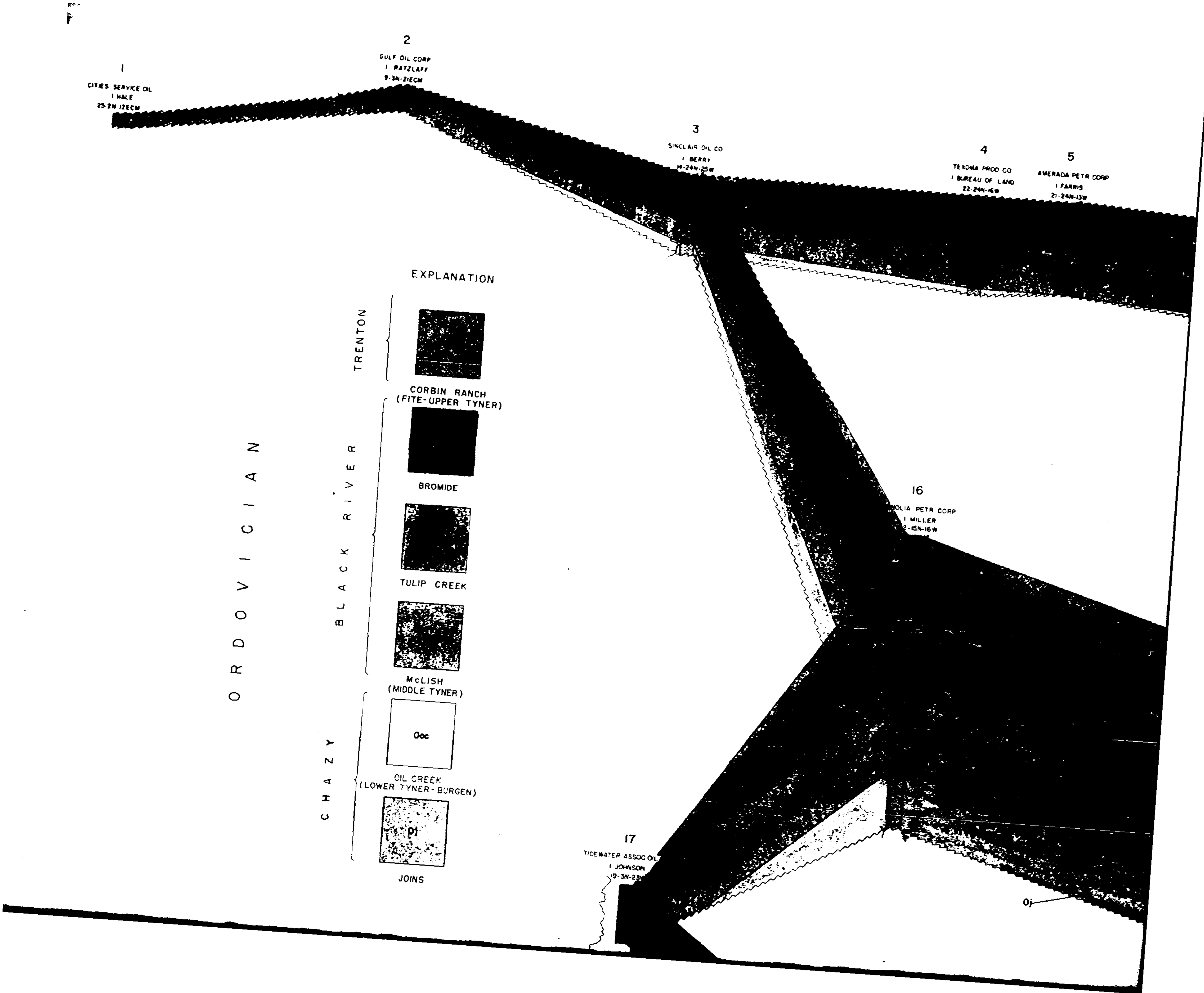
Carney & Phillips No. 1 Haddock nee Gifford	32	23N	13E	
Wolverine Oil No. 1 White	35	24N	12E	
Reinhardt & Donovan No. 1 Abel	27	24N	13E	
Empire Gas & Fuel No. 3 McElmore	25	25N	12E	
J. C. Bixler No. 1 Sears	10	25N	13E	X
Carter Oil No. 1 Anderson	7	25N	14E	
Link Oil No. 1 Whiteturkey	17	26N	13E	X
Ohio No. S-1 Stile	4	27N	13E	
Keener Oil & Gas No. A-1 Sheets	11	28N	13E	

Woods County

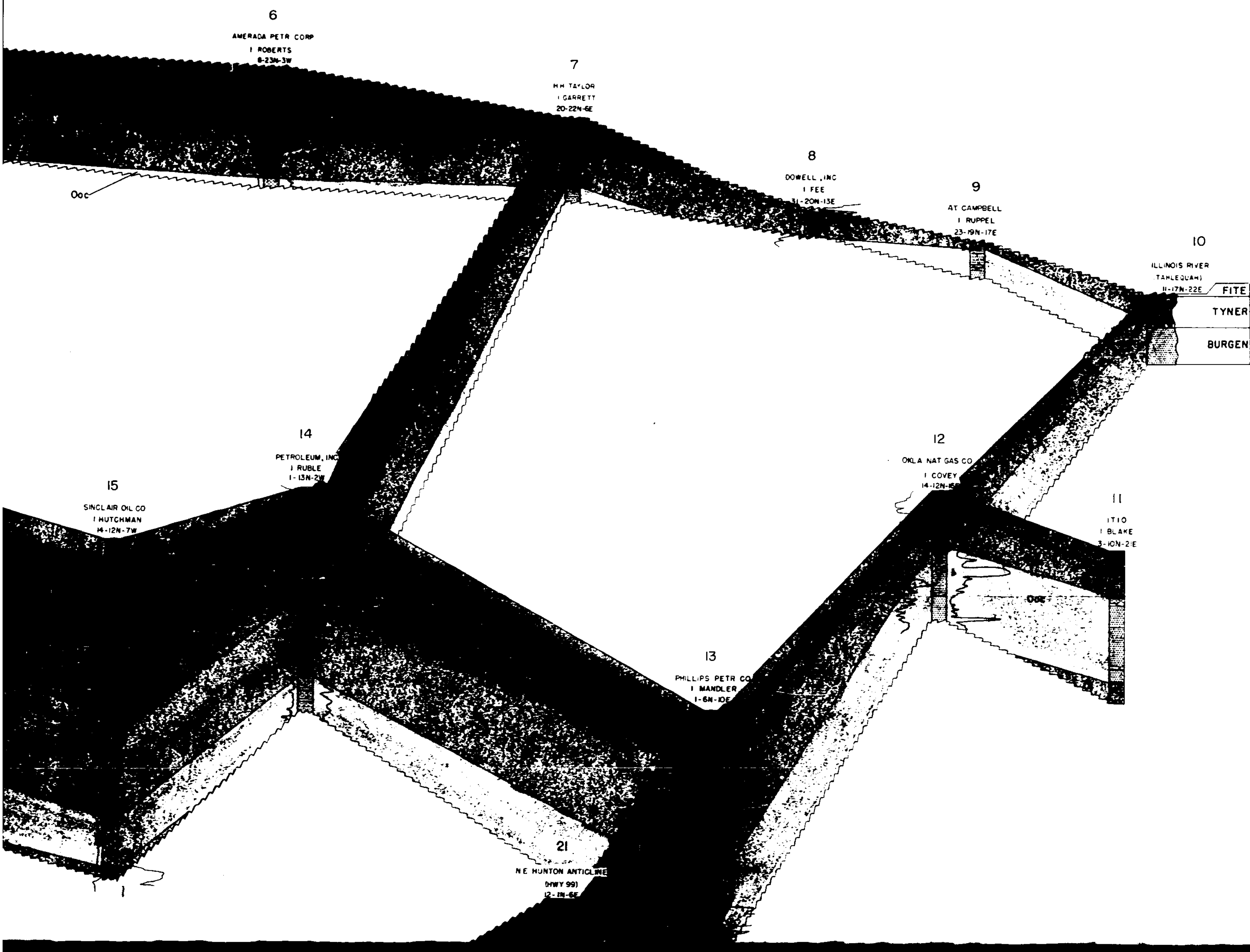
Amerada No. 1 Farris	21	24N	13W	X
Texhoma Prod. No. 1 Bureau of Land Mgt.	22	24N	16W	X
Altus Drlg. (Hunt-Tharpe) No. 1 Smith	17	25N	13W	X
Amerada No. 1 Krob	24	25N	13W	X
Gulf No. 1 Shade	31	25N	14W	X
Texas No. 1 McAntire	20	25N	15W	X
Phillips et al. No. 1 Avard	9	25N	15W	X
Deep Rock No. 1 Phillips	4	25N	17W	
Beach & Talbot No. 1 Thornberry	21	27N	14W	X
J. R. McDermott No. 1 Murrow	19	27N	16W	X
Gulf Oil No. 1 Zimmerman	12	28N	18W	X
Champlin Oil No. 1 Scribner	14	28N	19W	X
C. W. Scott No. 1 Uhl	29	28N	19W	X
Calvert et al. No. 1 Dodson	9	28N	20W	X
Rock Hill Oil No. 1 Williams	31	29N	15W	
Republic Nat. Gas & Alladin Petr. No. 1 McNet	18	29N	16W	X
Champlin Oil No. 1 Diamond Dyer	17	29N	17W	X
Texas No. 1 State Land	17	29N	19W	X

Woodward County

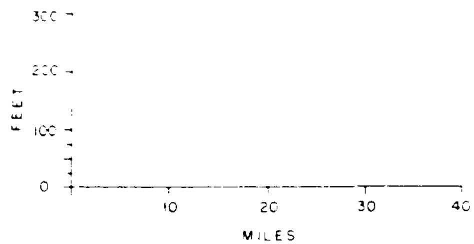
Magnolia et al. No. 1-A Borden	22	20N	20W	X
Union Oil No. 1 Sherman	13	22N	20W	X
Sinclair No. 1 Morrow	6	23N	19W	X
Pan American No. 1 Cooper Unit "E"	12	24N	22W	X
Pure No. 1 Henderson	17	25N	18W	X



F
1
CITIES SERVICE OIL
1 HALE
25-2N-12ECM
2
GULF OIL CORP
1 RATZLAFF
9-3N-21ECM
3
SINCLAIR OIL CO
1 BERRY
14-24N-25W
4
TEXOMA PROD CO
1 BUREAU OF LAND
22-24N-16W
5
AMERADA PETR CORP
1 FARRIS
21-24N-13W
16
OLIA PETR CORP
1 MILLER
2-15N-16W
17
TIDEWATER ASSOC OIL
1 JOHNSON
19-3N-23
EXPLANATION
ORDOVICIAN
TRENTON
BLACK RIVER
CHAZY
CORBIN RANCH (FITE-UPPER TYNER)
BROMIDE
TULIP CREEK
McLISH (MIDDLE TYNER)
Ooc
OIL CREEK (LOWER TYNER-BURGEN)
Oj
JOINS
Oj


6
AMERADA PETR CORP
1 ROBERTS
8-23N-3W
7
H H TAYLOR
1 GARRETT
20-22N-6E
Ooc
8
DOWELL, INC
1 FEE
31-20N-13E
9
AT CAMPBELL
1 RUPPEL
23-19N-17E
10
ILLINOIS RIVER
(TAHLEQUAH)
11-17N-22E
FITE
TYNER
BURGEN
14
PETROLEUM, INC
1 RUBLE
1-13N-2W
15
SINCLAIR OIL CO
1 HUTCHMAN
14-12N-7W
12
OKLA NAT GAS CO
1 COVEY
11
ITIO
1 BLAKE
3-10N-21E
13
PHILLIPS PETR CO
1 MANDLER
1-6N-10E
21
N E HUNTON ANTICLINE
(HWY 99)

JOINS



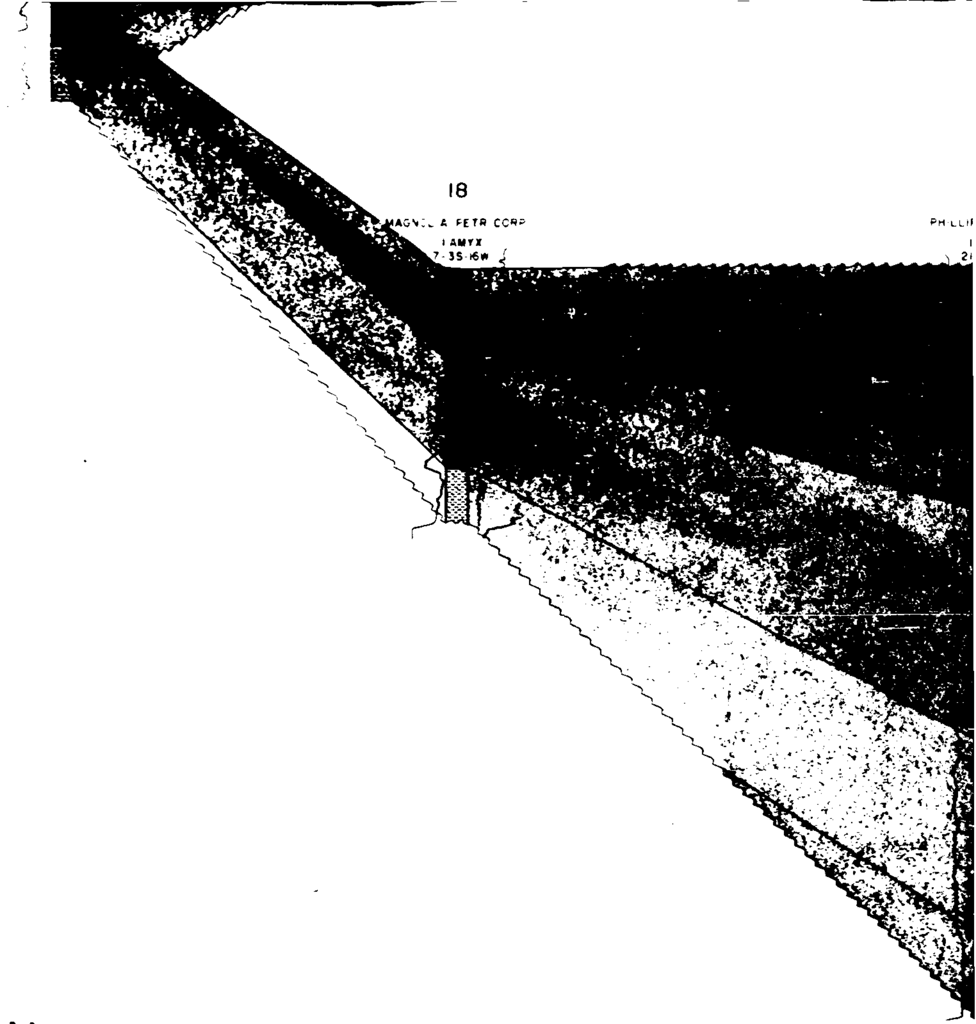


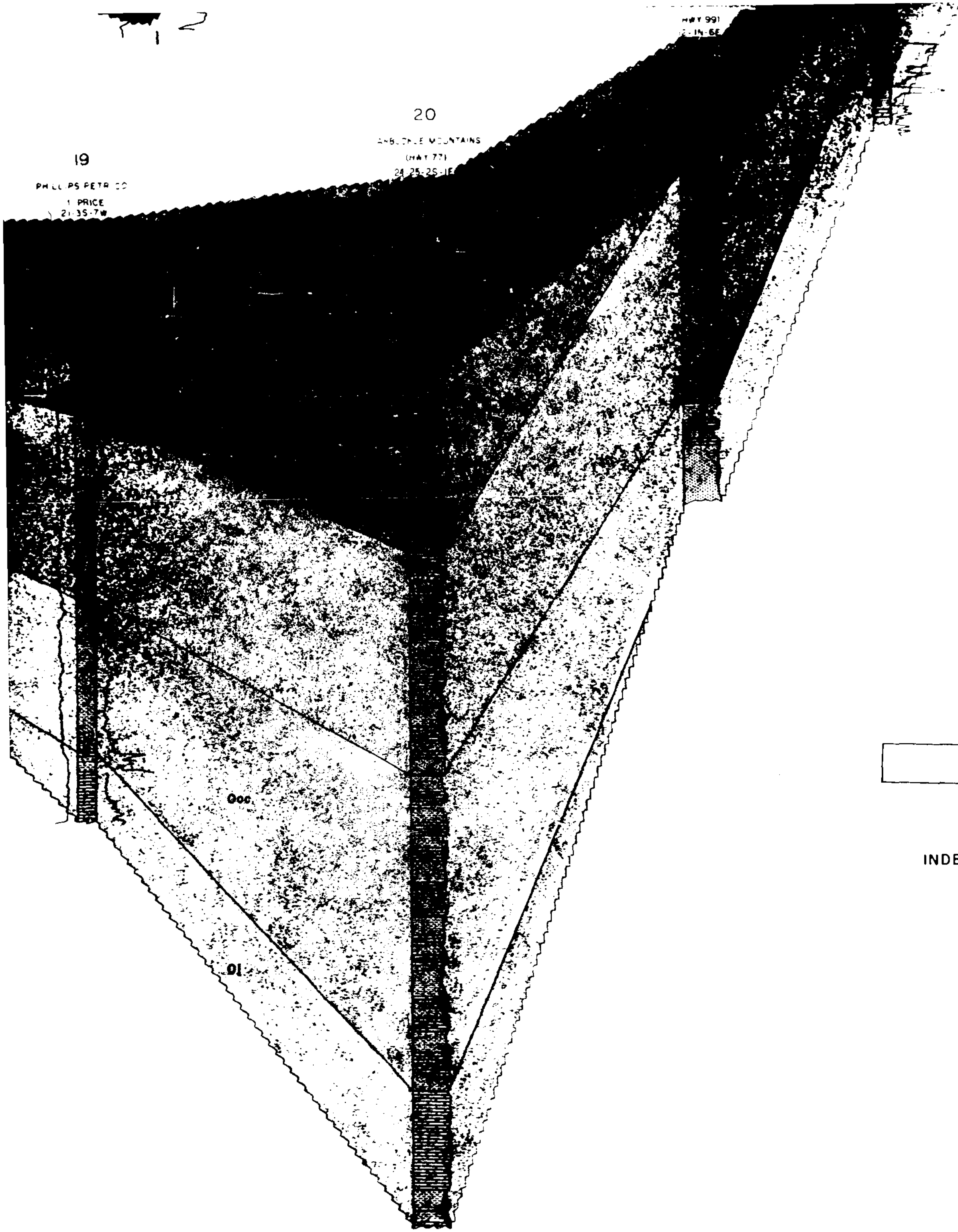
PLATE I

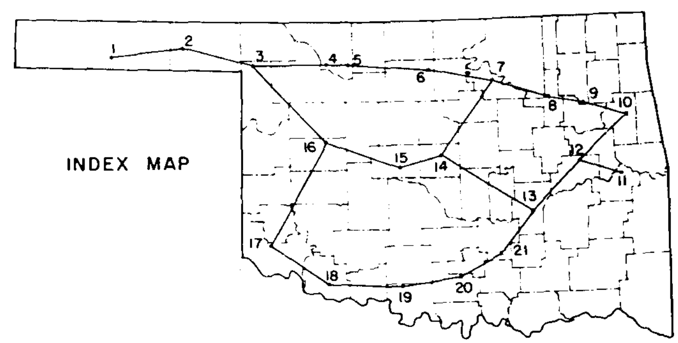
FENCE DIAGRAM

ILLUSTRATING STRATIGRAPHIC VARIATION IN THE SIMPSON GROUP, OKLAHOMA

M.W. SCHRAMM, JR., PH.D.

MAY, 1963


19
1 PRICE
21-3S-7W
20
(HWY 77)
24-25-2S-1E
Ooc


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21

INDEX MAP

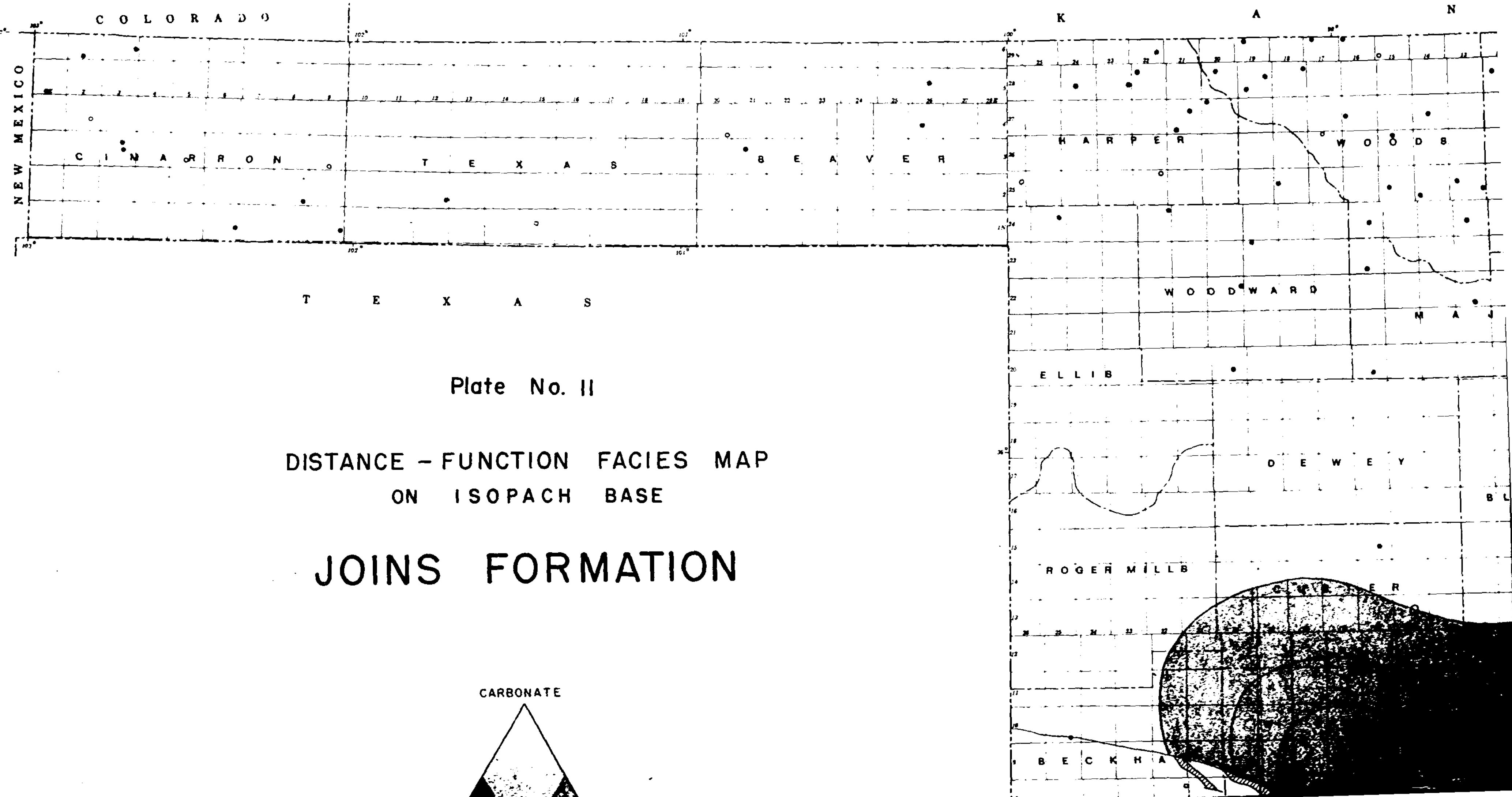
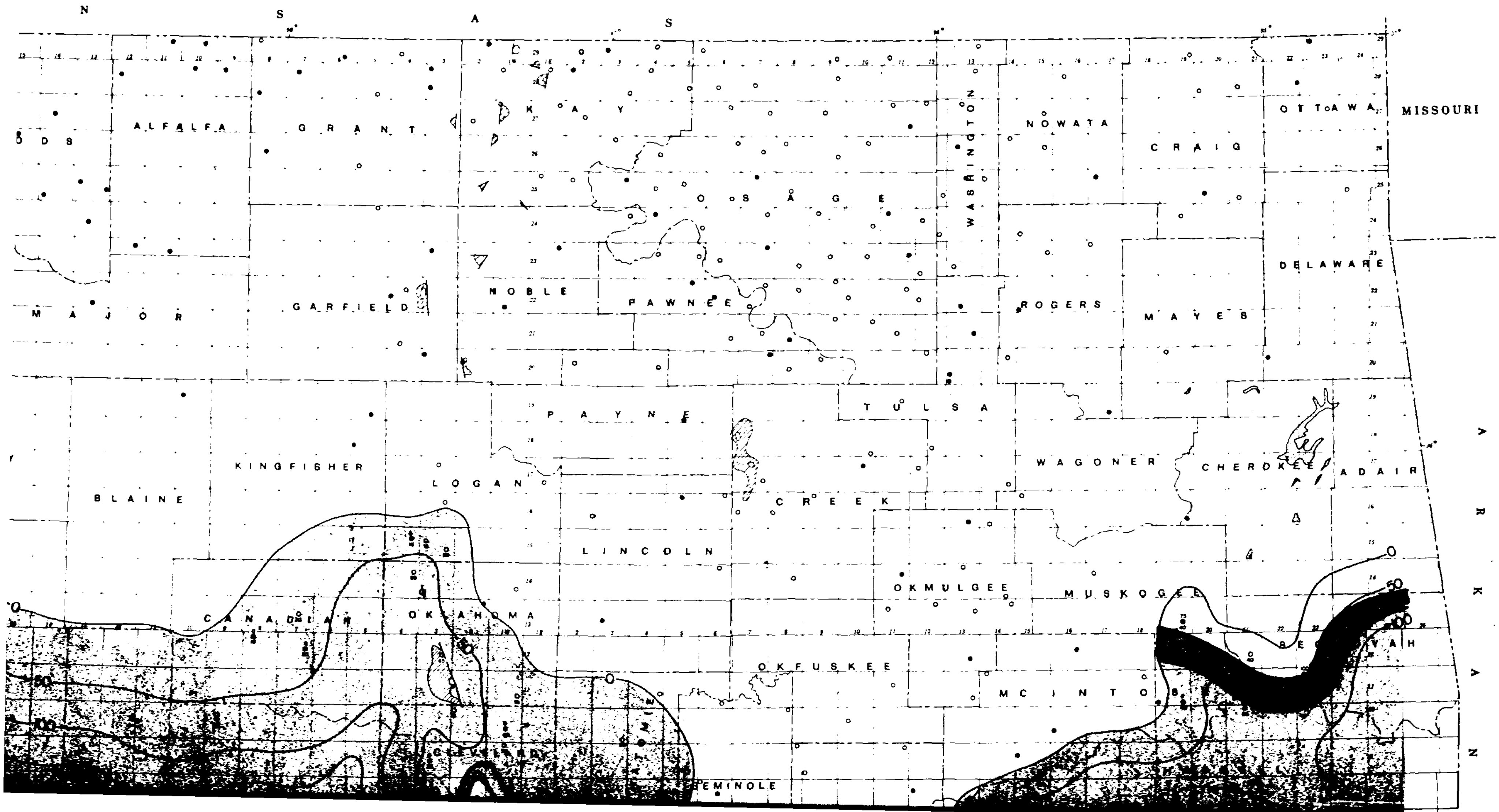


Plate No. II

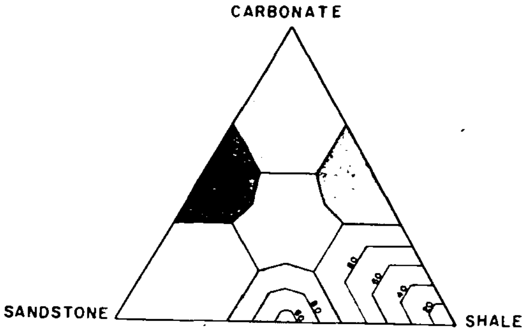
DISTANCE – FUNCTION FACIES MAP
ON ISOPACH BASE

JOINS FORMATION

CARBONATE

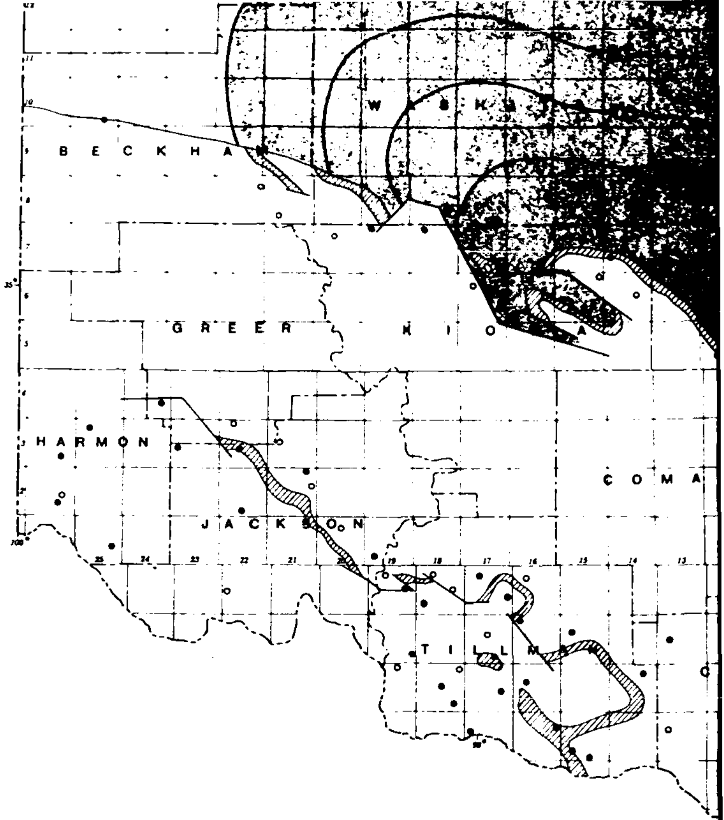


KANSAS
MISSOURI
ARKANSAS
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DELAWARE
KINGFISHER
LOGAN
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
BLAINE
LINCOLN
CREEK
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
OKFUSKEE
McINTOSH
SEQUOYAH
CLEVELAND
SEMINOLE
0
50
100



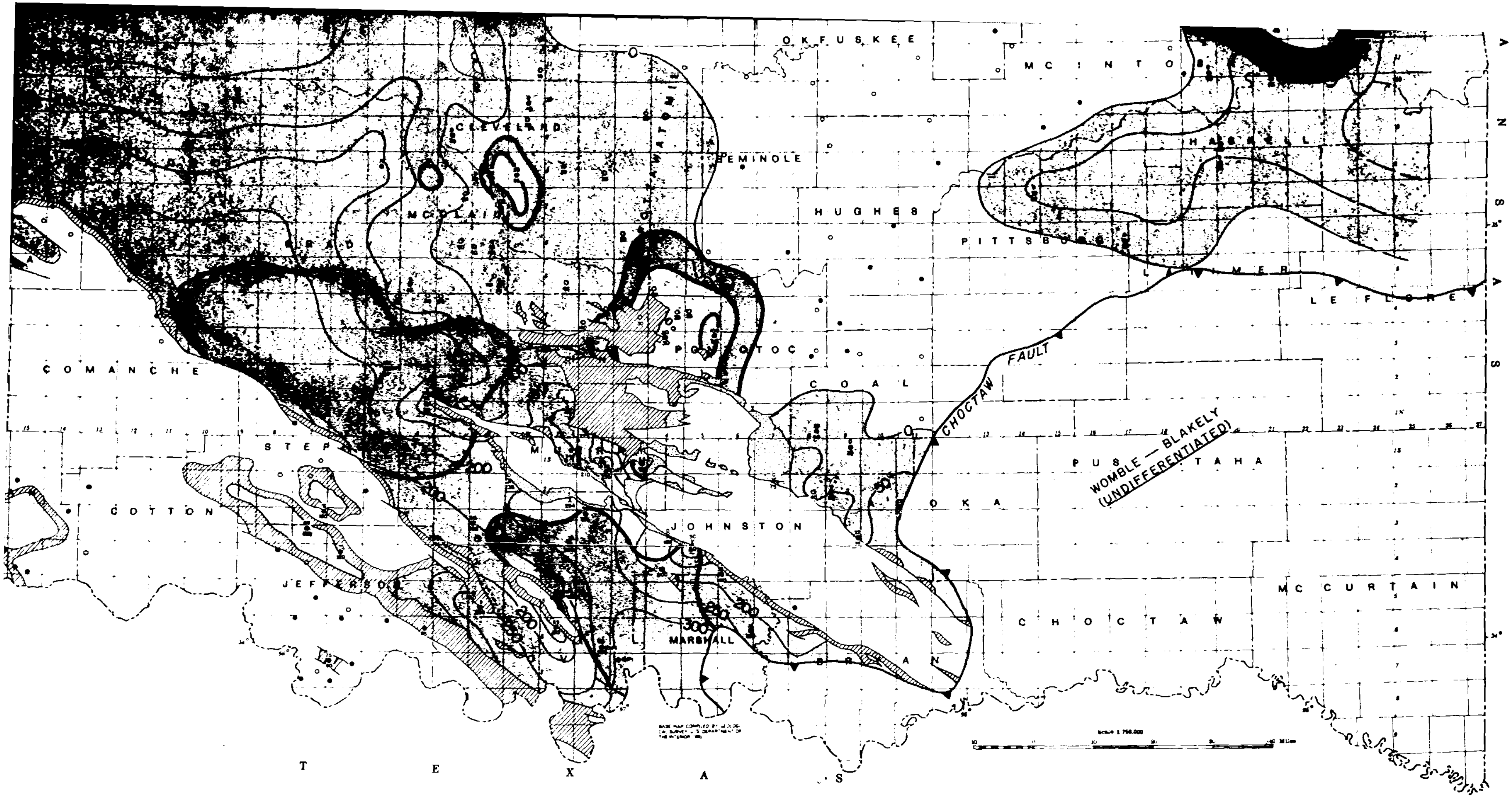
EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Distance Function Value / Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ Isopach (C.I. = 50')



M. W. SCHRAMM, JR., PH. D.

MAY, 1963



OKFUSKEE
MC INTOSH
HASKELL
CLEVELAND
SEMINOLE
HUGHES
PITTSBURG
LATIMER
LE FLORE
McCLAIN
GRADY
POTTAWATOMIE
PONTOTOC
COAL
CHOCTAW FAULT
COMANCHE
STEPHENS
MURRAY
PUSHMATAHA
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
ATOKA
COTTON
JOHNSTON
JEFFERSON
CARTER
MARSHALL
BRYAN
CHOCTAW
MC CURTAIN
200
300
T E X A S
K A N S A S
Scale 1:750,000

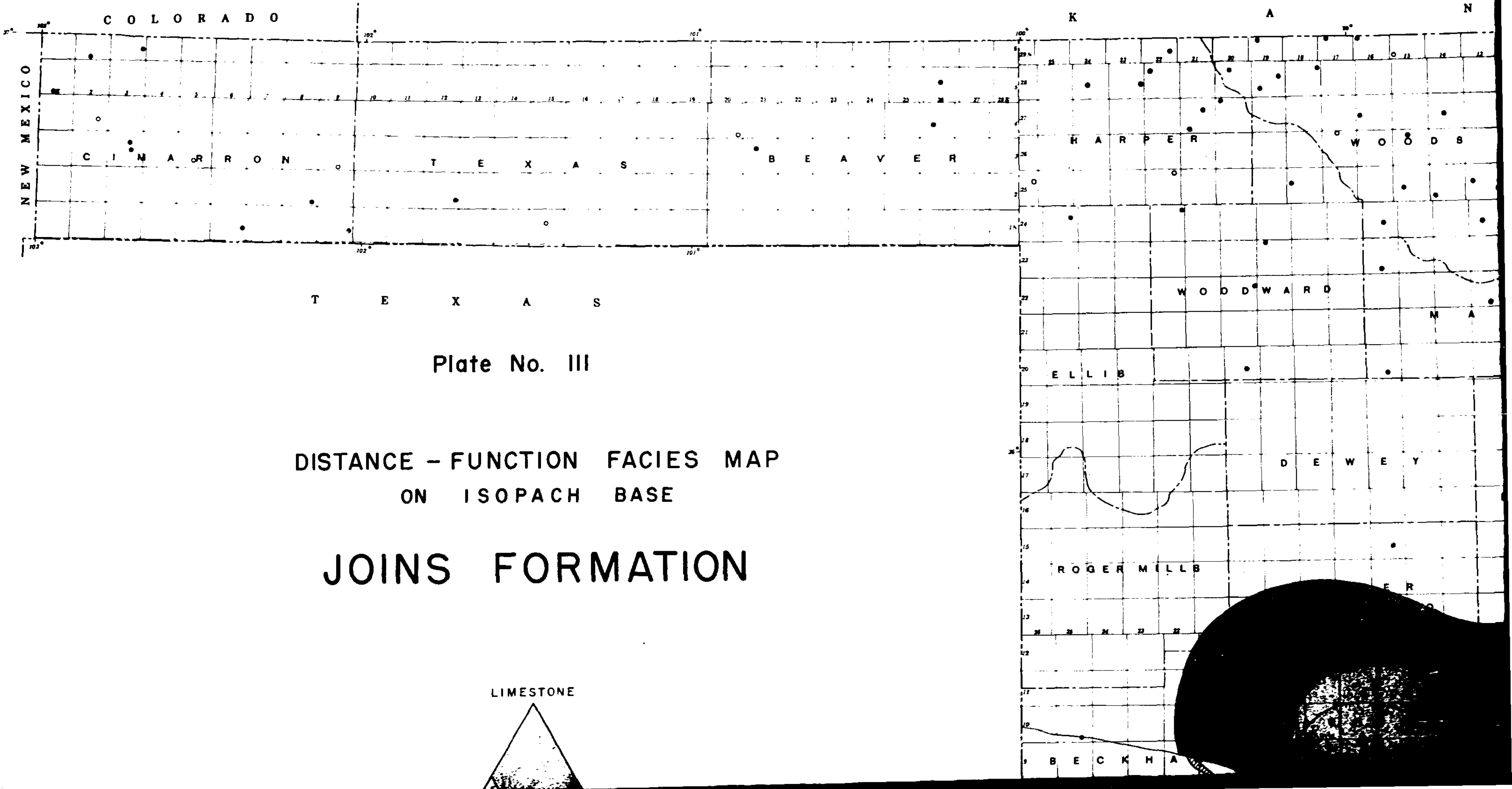
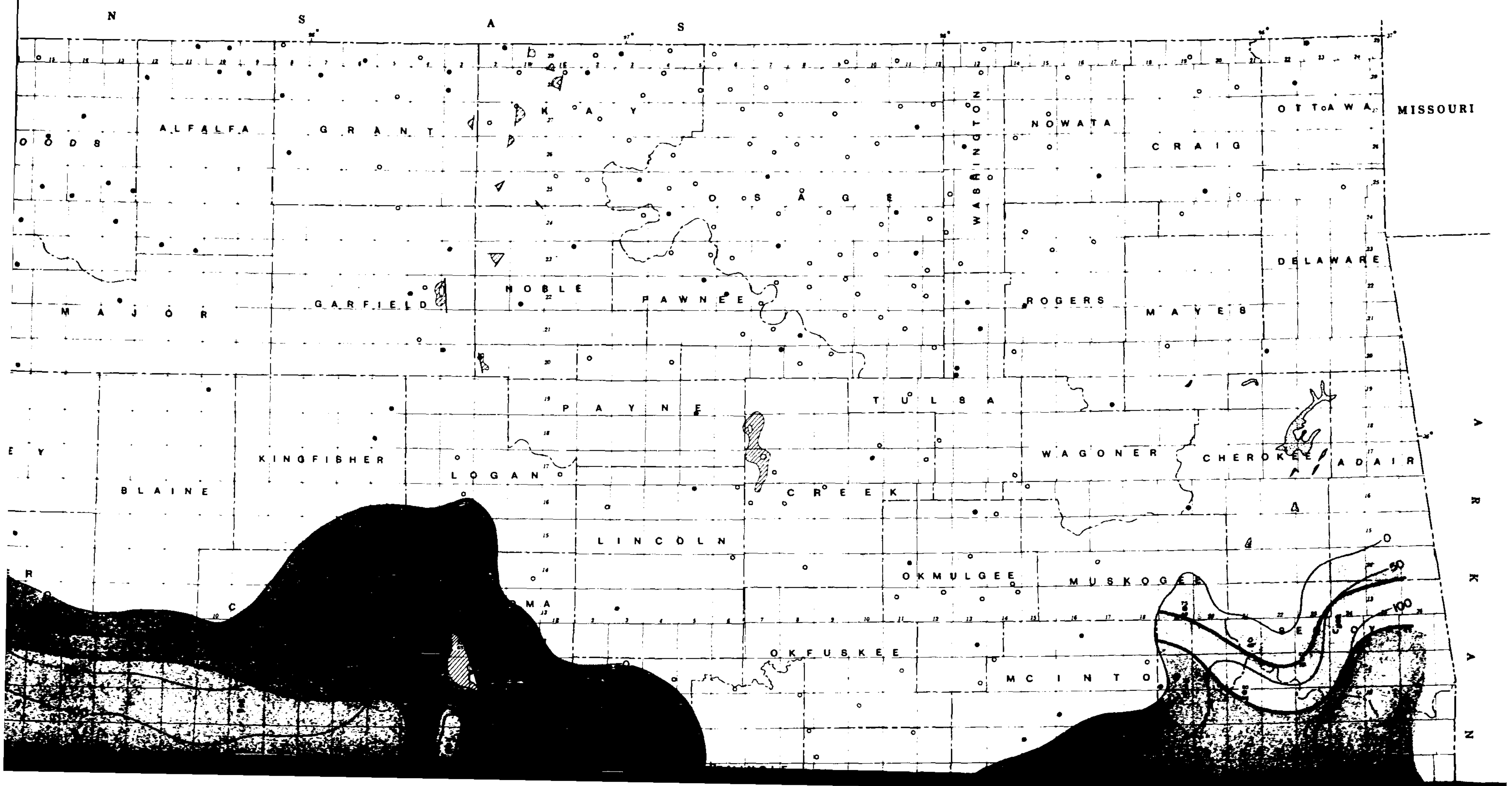


Plate No. III

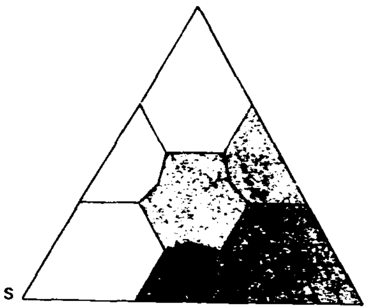
DISTANCE - FUNCTION FACIES MAP ON ISOPACH BASE

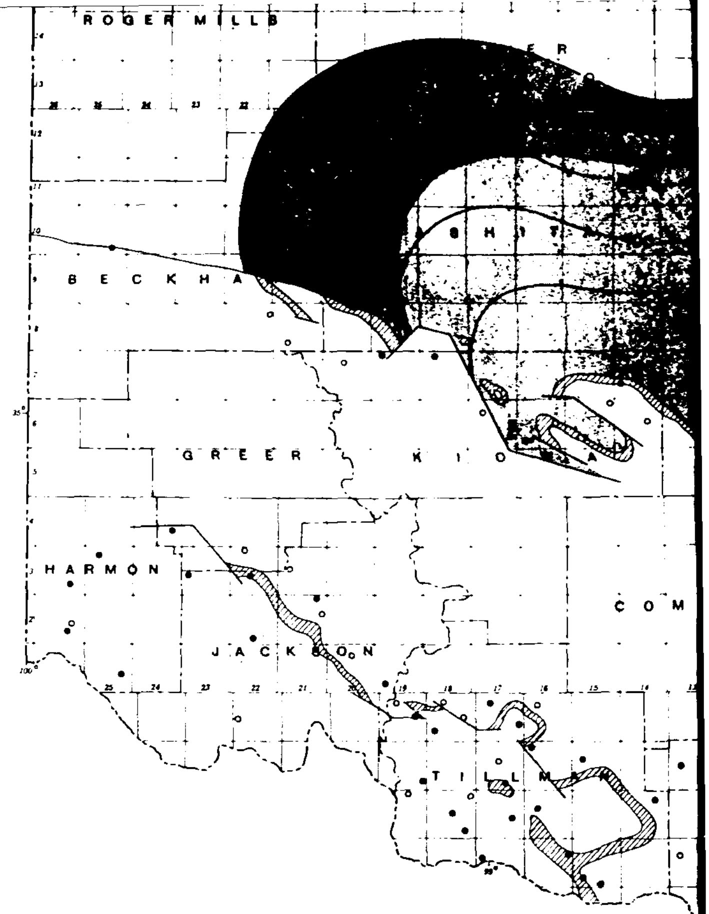
JOINS FORMATION

LIMESTONE



K A N S A S
MISSOURI
A R K A N
ALFALFA
GRANT
KAY
OSAGE
NOWATA
CRAIG
OTTAWA
WASHINGTON
DELAWARE
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
PAYNE
TULSA
KINGFISHER
LOGAN
BLAINE
CREEK
WAGONER
CHEROKEE
ADAIR
LINCOLN
OKMULGEE
MUSKOGEE
OKFUSKEE
MCINTO
0
50
100



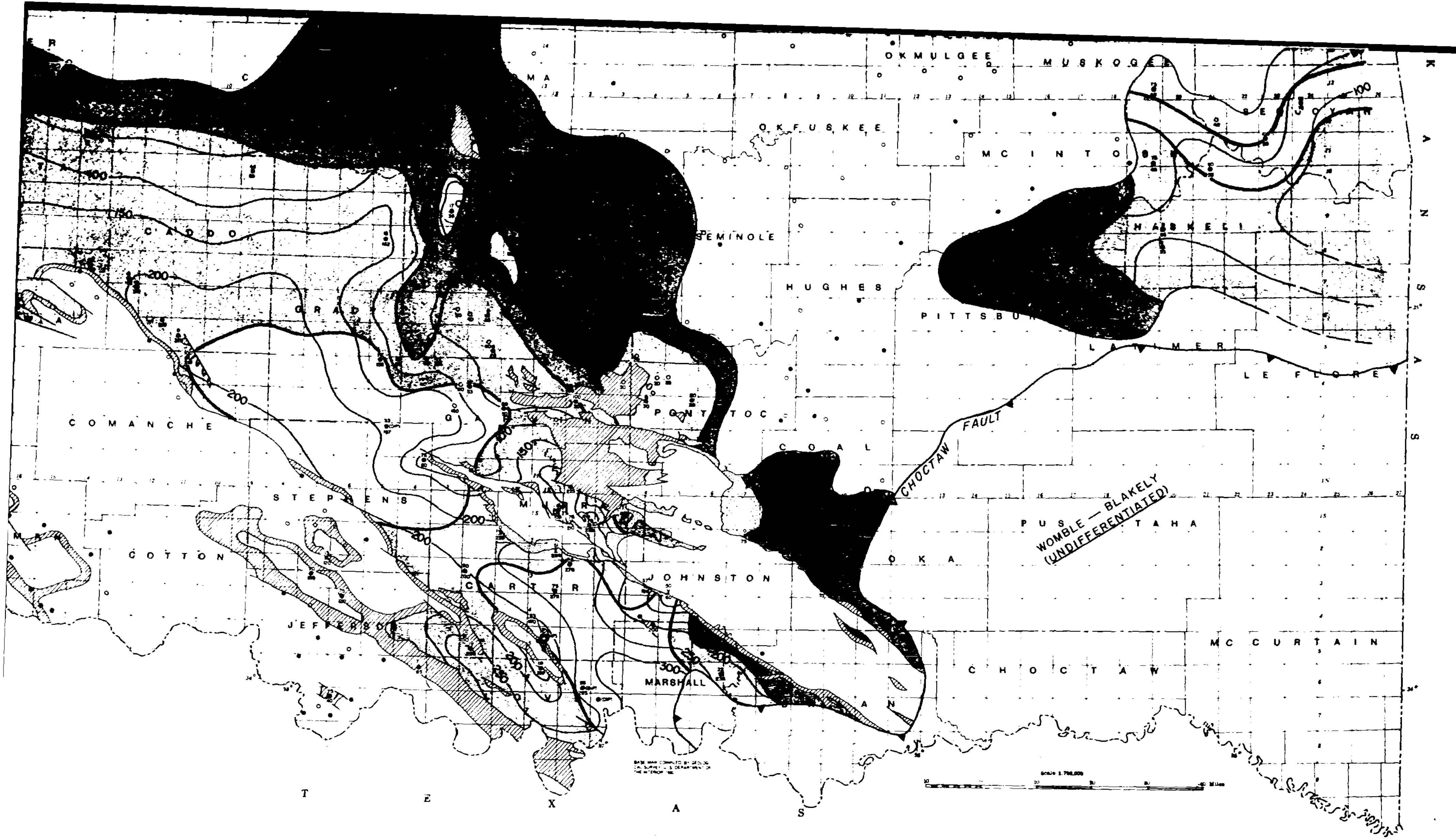


EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Distance Function Value / Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ Isopach (C.I.=50')

M. W. SCHRAMM, JR., PH. D.

MAY, 1963



OKMULGEE
OKFUSKEE
SEMINOLE
HUGHES
HASKELL
LATIMER
LE FLORE
COAL
CADDO
COMANCHE
COTTON
CARTER
JOHNSTON
MARSHALL
MC CURTAIN
CHOCTAW
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
100
150
200
300
T E X A S

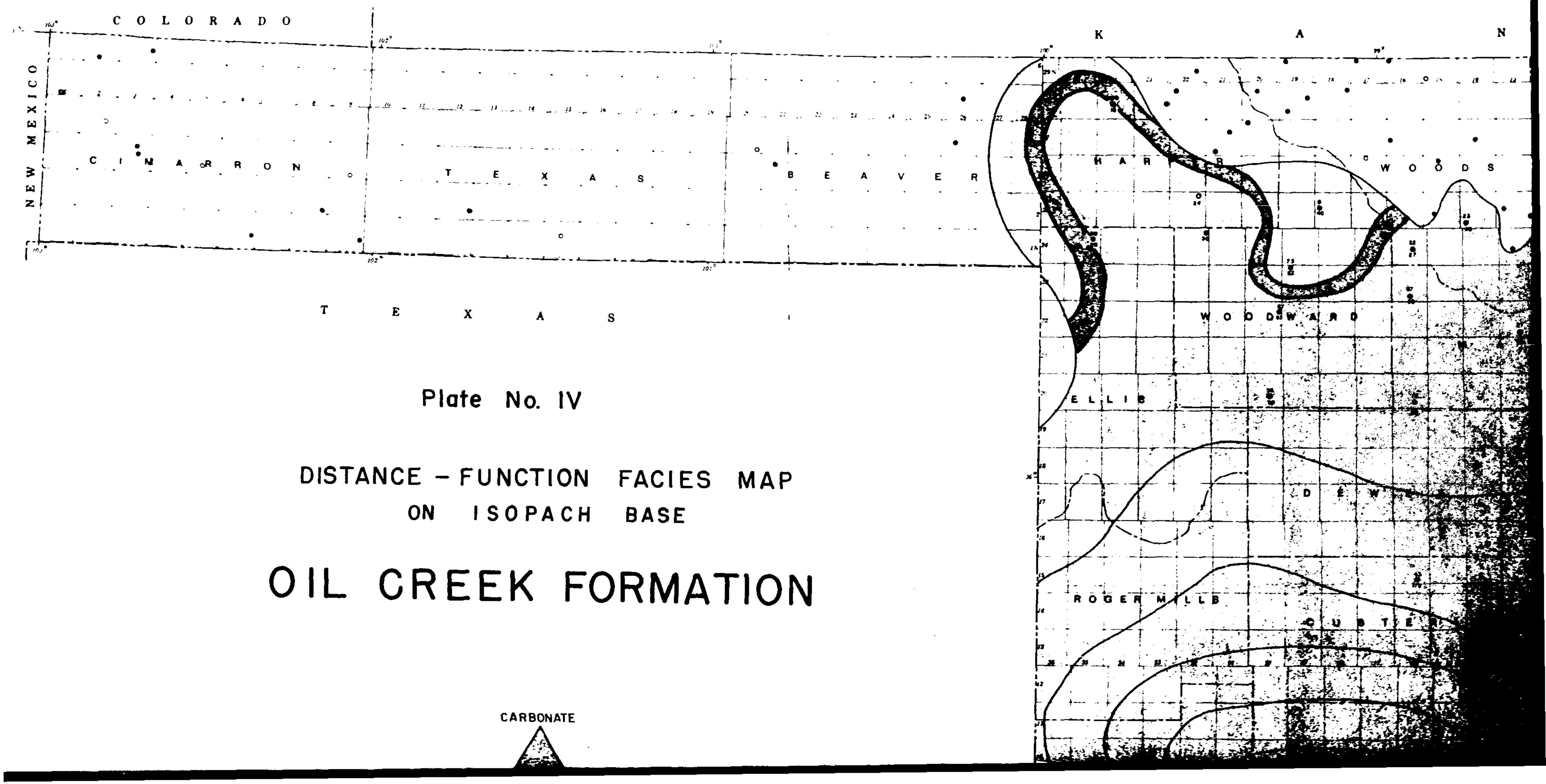
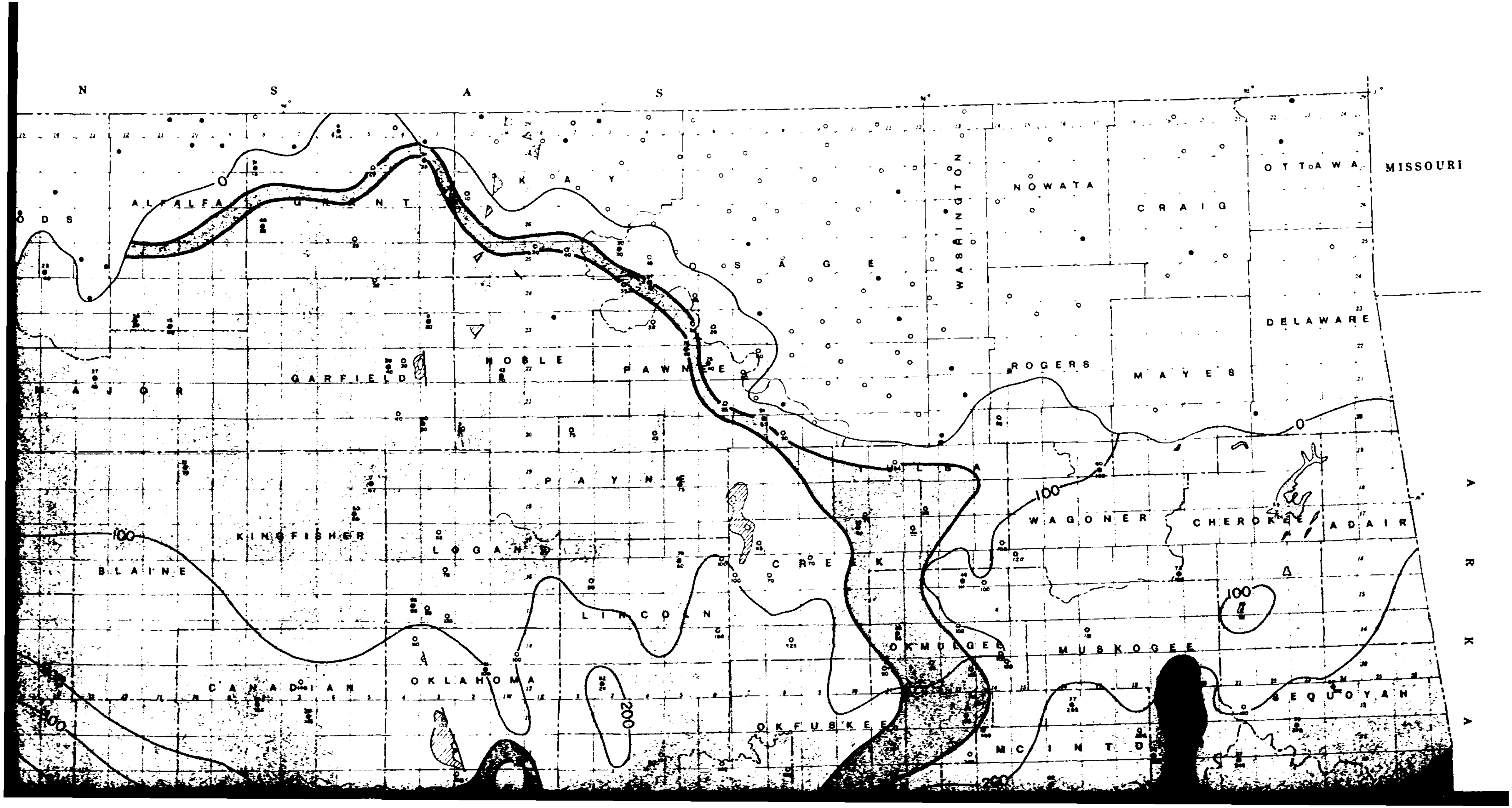


Plate No. IV

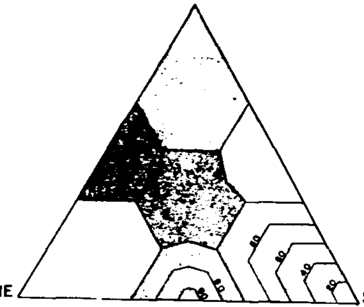
DISTANCE - FUNCTION FACIES MAP
ON ISOPACH BASE

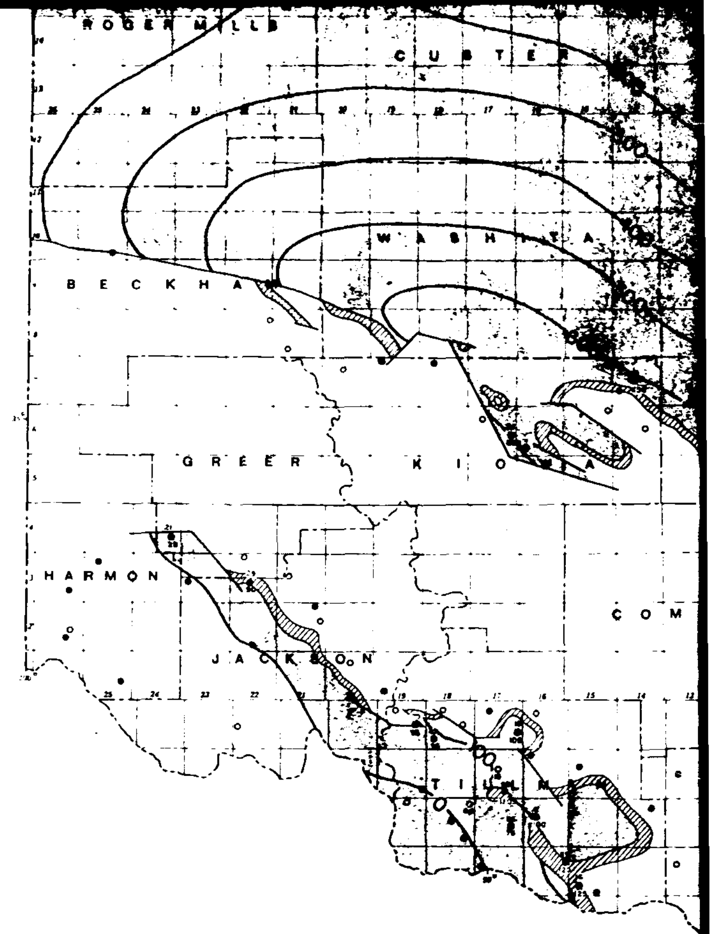
OIL CREEK FORMATION



KANSAS
MISSOURI
ARKANSAS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
DELAWARE
MAYES
ROGERS
PAWNEE
NOBLE
GARFIELD
MAJOR
KINGFISHER
LOGAN
PAYNE
CREEK
TULSA
WAGONER
CHEROKEE
ADAIR
MUSKOGEE
SEQUOYAH
MCINTOSH
OKMULGEE
OKFUSKEE
LINCOLN
OKLAHOMA
CANADIAN
BLAINE
0
100
200

OIL CREEK FORMATION



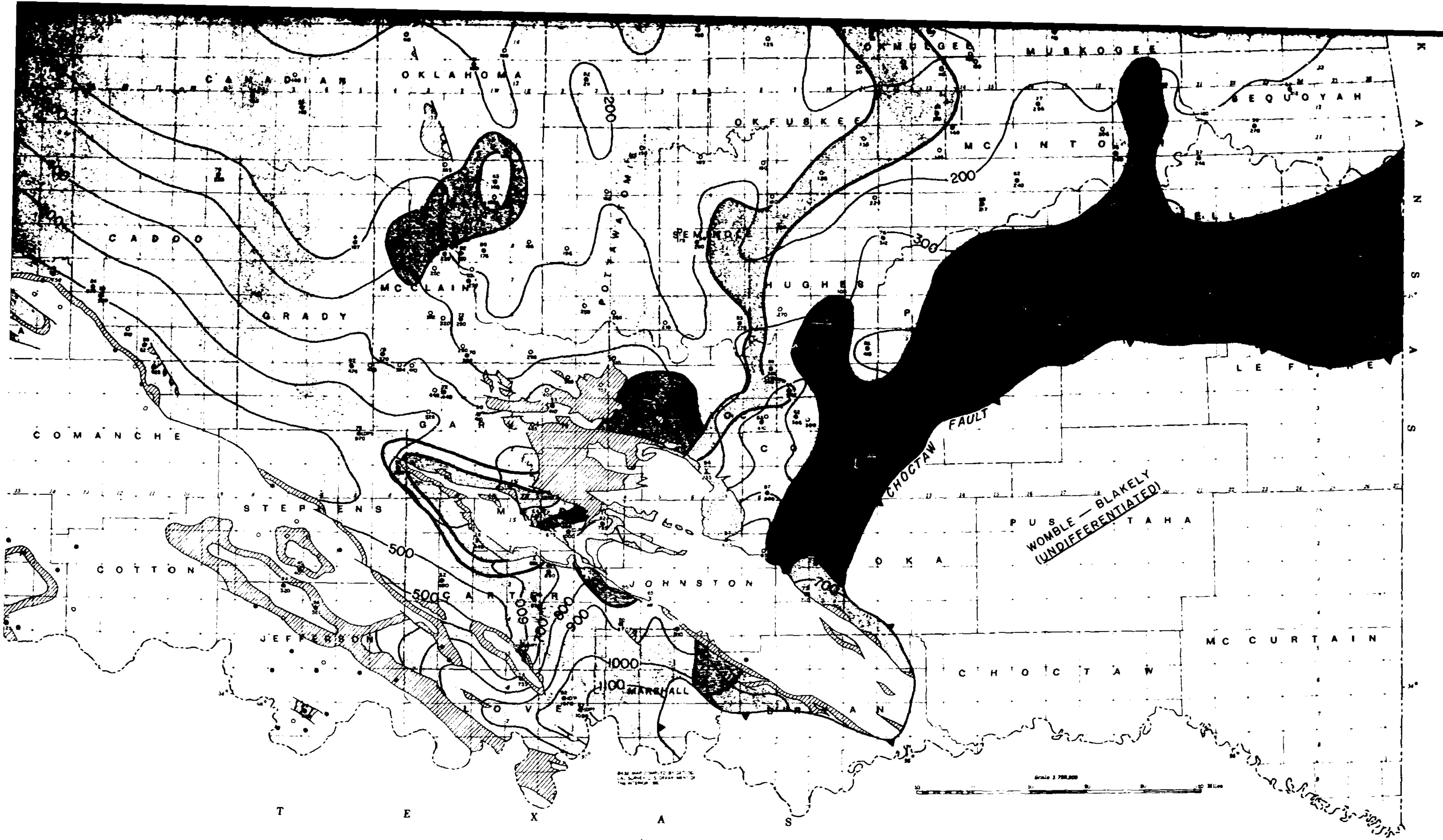


EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Distance Function Value / Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ Isopach (C.I. = 100')

M. W. SCHRAMM, JR., PH. D.

MAY, 1963


KANSAS
TEXAS
MUSKOGEE
SEQUOYAH
OKMULGEE
OKFUSKEE
MCINTOSH
CANADIAN
OKLAHOMA
CADDO
GRADY
MCCLAIN
POTTAWATOMIE
SEMINOLE
HUGHES
LE FLORE
COMANCHE
STEPHENS
GARVIN
COTTON
JEFFERSON
CARTER
JOHNSTON
MARSHALL
LOVE
PUSHMATAHA
ATOKA
CHOCTAW
MC CURTAIN
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
200
200
300
500
500
600
700
800
900
1000
1100
700

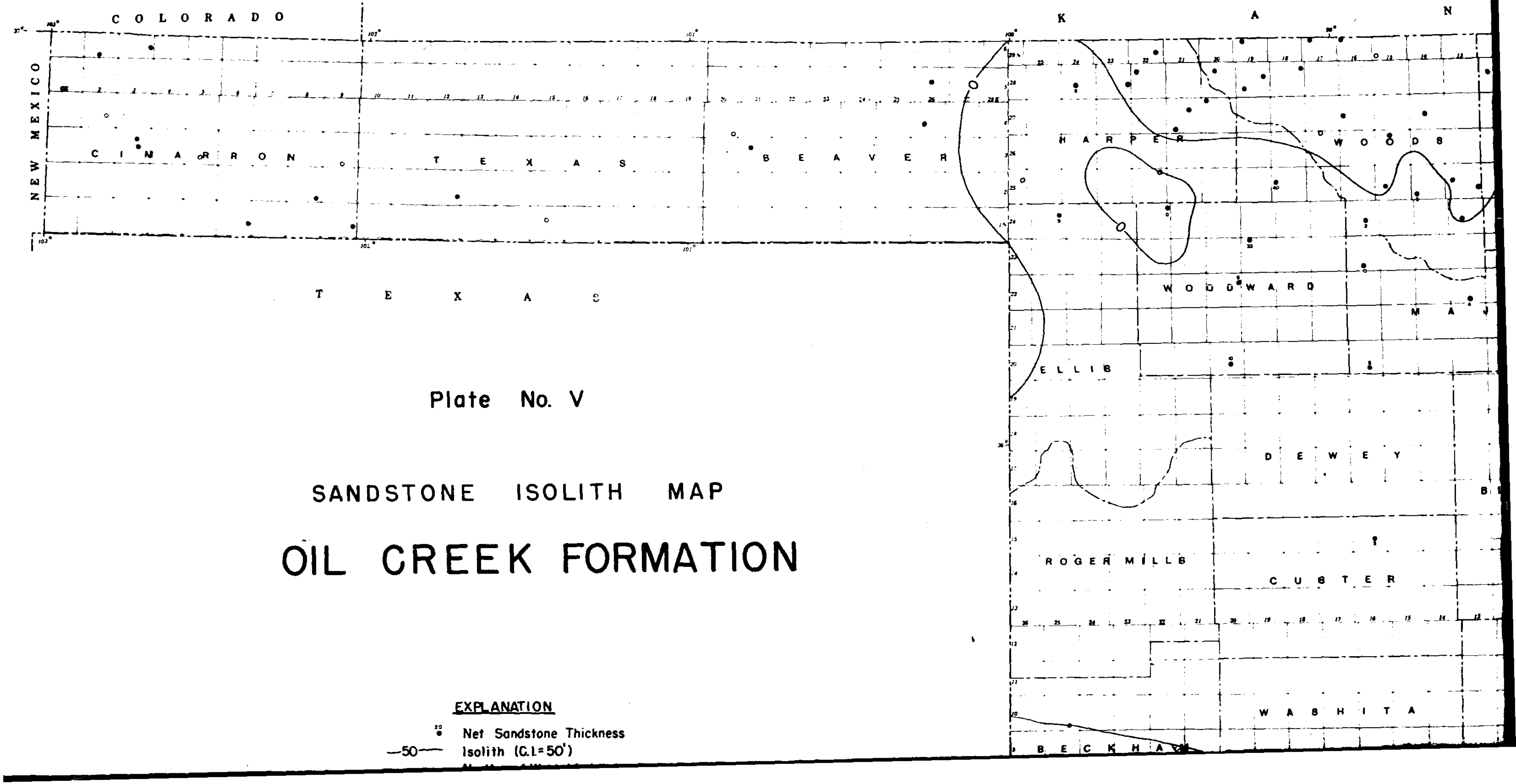


Plate No. V

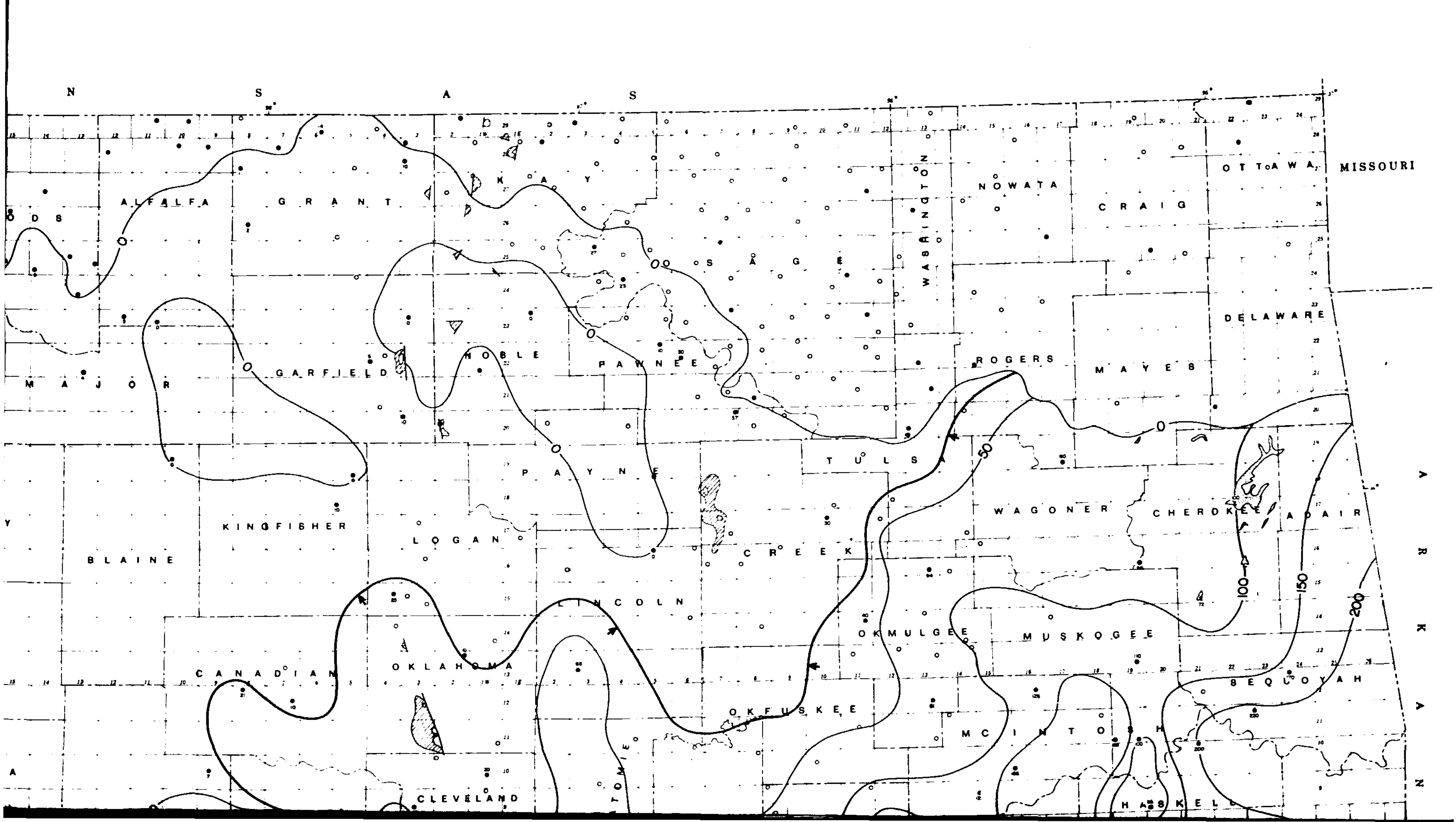
SANDSTONE ISOLITH MAP

OIL CREEK FORMATION

EXPLANATION

Net Sandstone Thickness

—50— Isolith (C.I.=50')

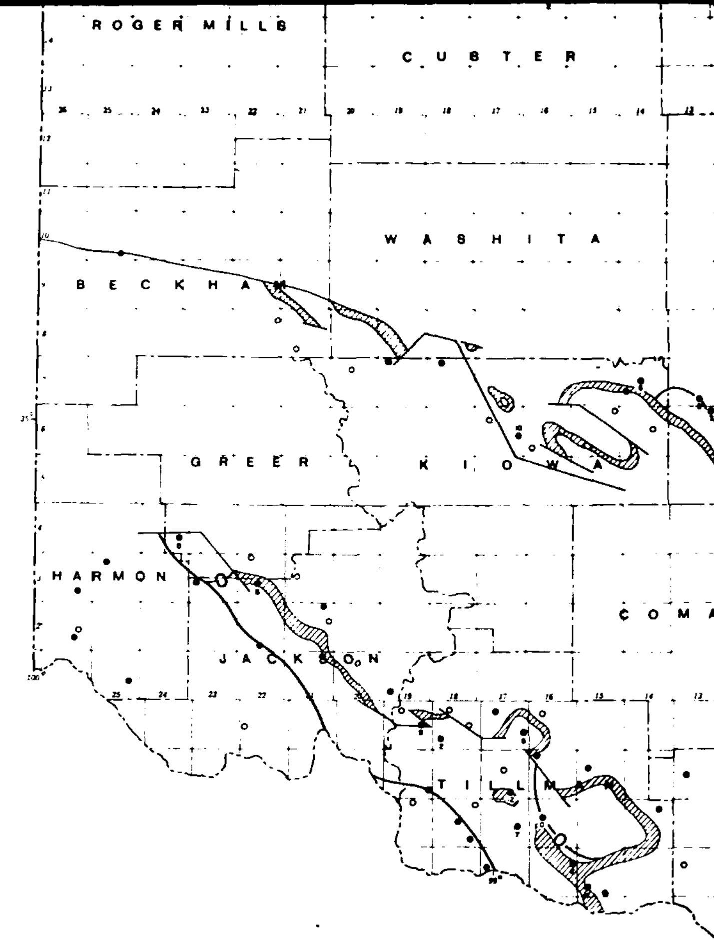


N S A S
MISSOURI
ARKANSAS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
DELAWARE
MAYES
ROGERS
PAWNEE
NOBLE
GARFIELD
MAJOR
TULSA
PAYNE
WAGONER
CHEROKEE
ADAIR
KINGFISHER
LOGAN
BLAINE
CREEK
LINCOLN
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
SEQUOYAH
OKFUSKEE
MCINTOSH
CLEVELAND
HASKELL
0
50
100
150
200

OIL CREEK FORMATION

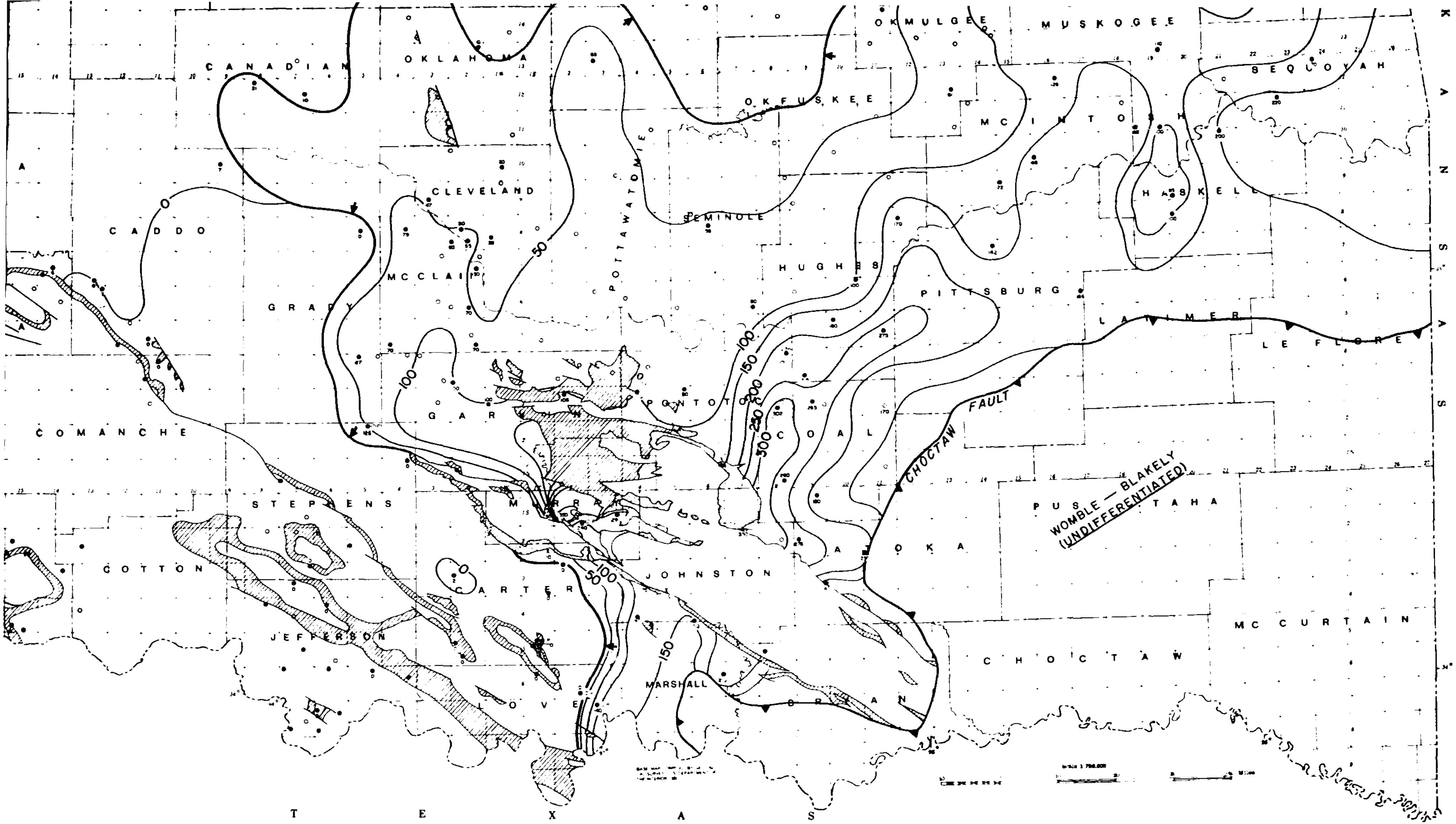
EXPLANATION

- Net Sandstone Thickness
- —50— Isolith (C.I.=50')
- North and West Limit of Basal Oil Creek-Burgen Sandstone
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)



M. W. SCHRAMM, JR., PH. D.

MAY, 1963



CANADIAN
OKLAHOMA
OKMULGEE
MUSKOGEE
SEQUOYAH
OKFUSKEE
McINTOSH
HASKELL
CLEVELAND
CADDO
SEMINOLE
POTTAWATOMIE
HUGHES
McCLAIN
GRADY
PITTSBURG
LATIMER
LE FLORE
PONTOTOC
GARVIN
COAL
COMANCHE
CHOCTAW FAULT
WOMBLE — BLAKELY (UNDIFFERENTIATED)
PUSHMATAHA
STEPHENS
MURRAY
ATOKA
COTTON
CARTER
JOHNSTON
JEFFERSON
McCURTAIN
CHOCTAW
MARSHALL
LOVE
BRYAN
ARKANSAS
TEXAS
0
50
100
150
200
250
300

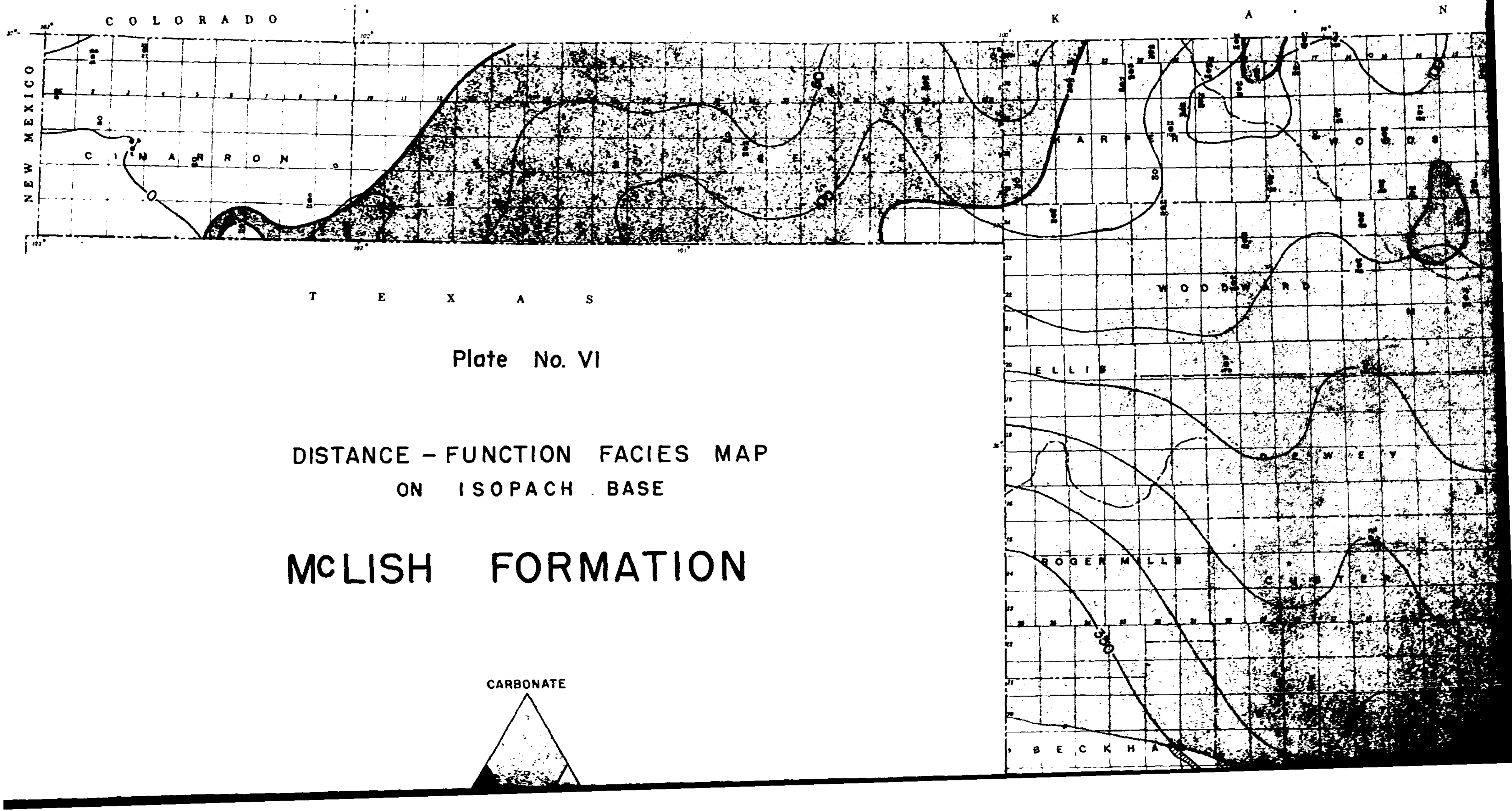
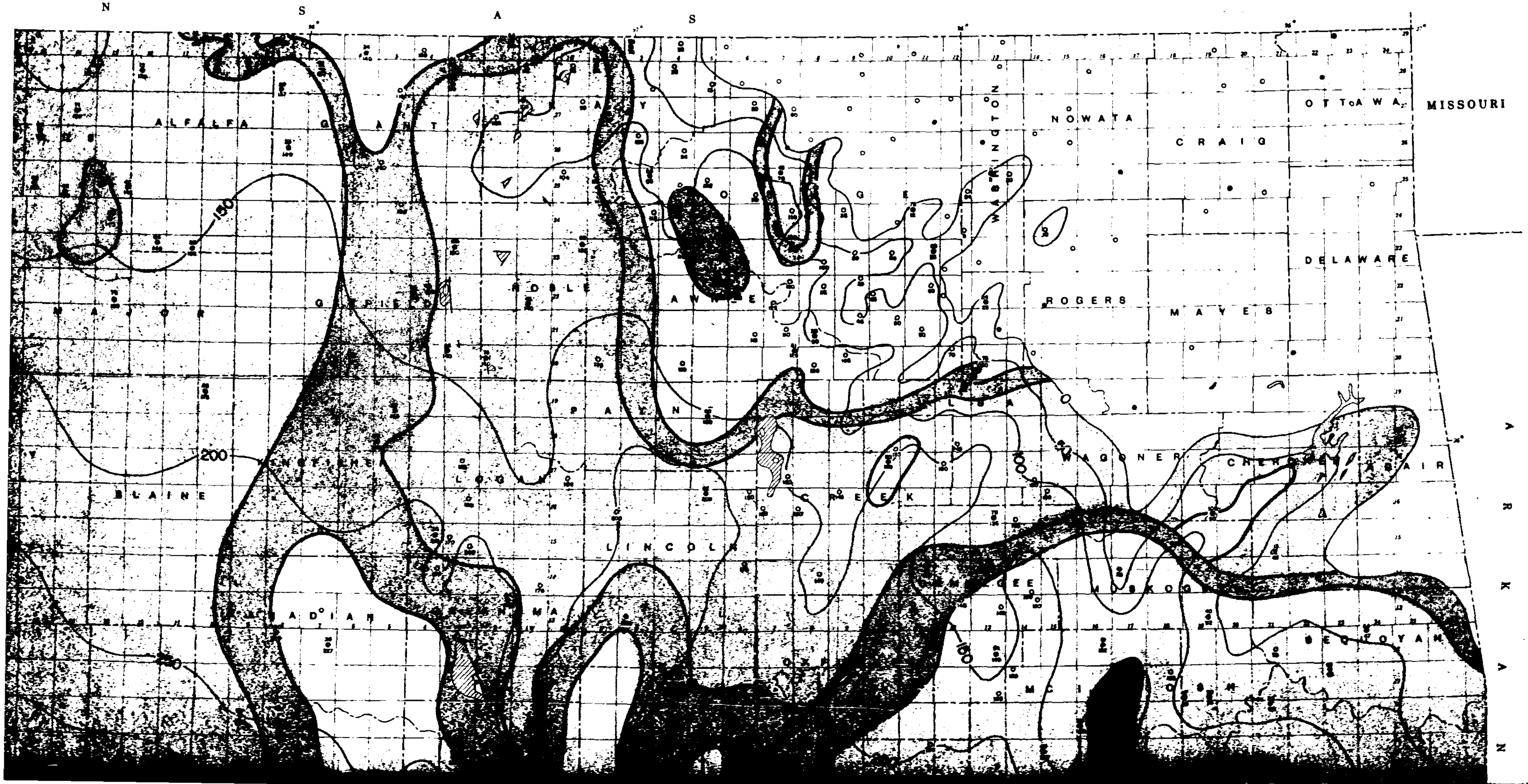


Plate No. VI

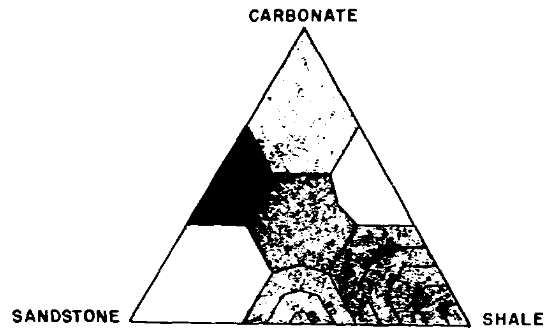
DISTANCE – FUNCTION FACIES MAP
ON ISOPACH BASE

McLISH FORMATION



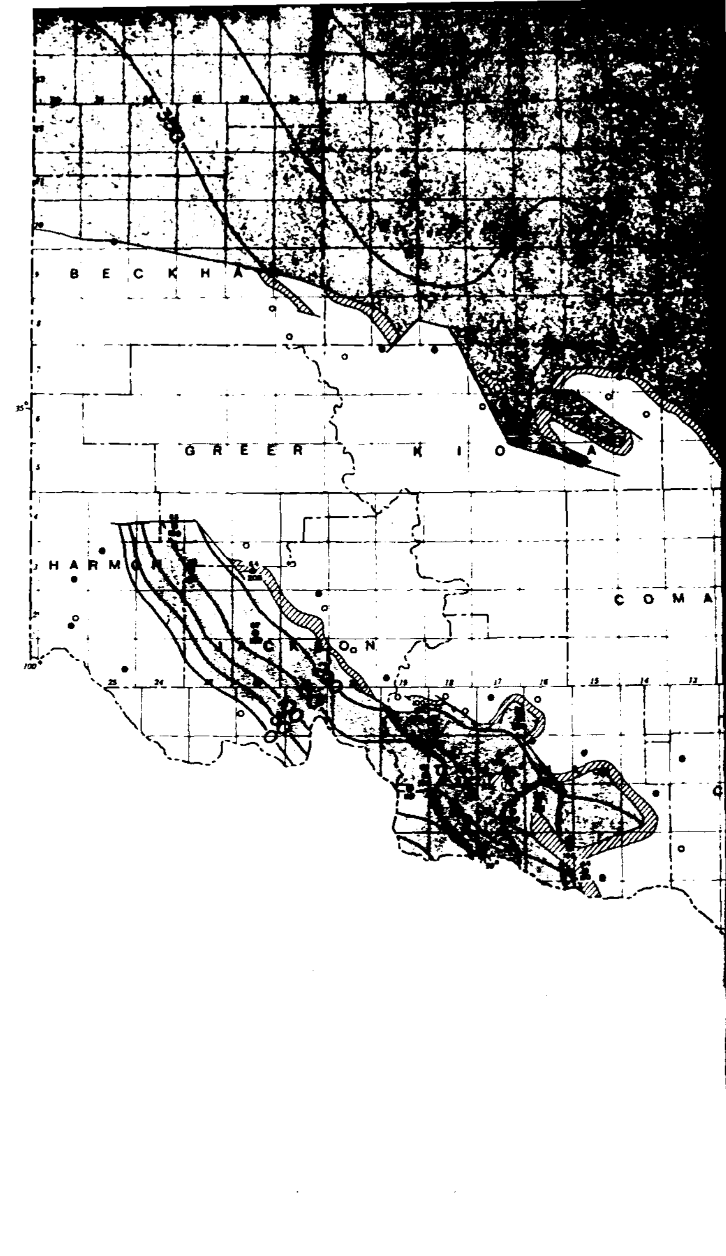
K A N S A S
MISSOURI
A R K A N S A S
ALFALFA
MAJOR
BLAINE
NOBLE
LOGAN
LINCOLN
CREEK
NOWATA
CRAIG
OTTAWA
DELAWARE
ROGERS
MAYES
WAGONER
ADAIR
150
200
100

McLISH FORMATION



EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Distance Function Value / Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ Isopach (C.I.=50')



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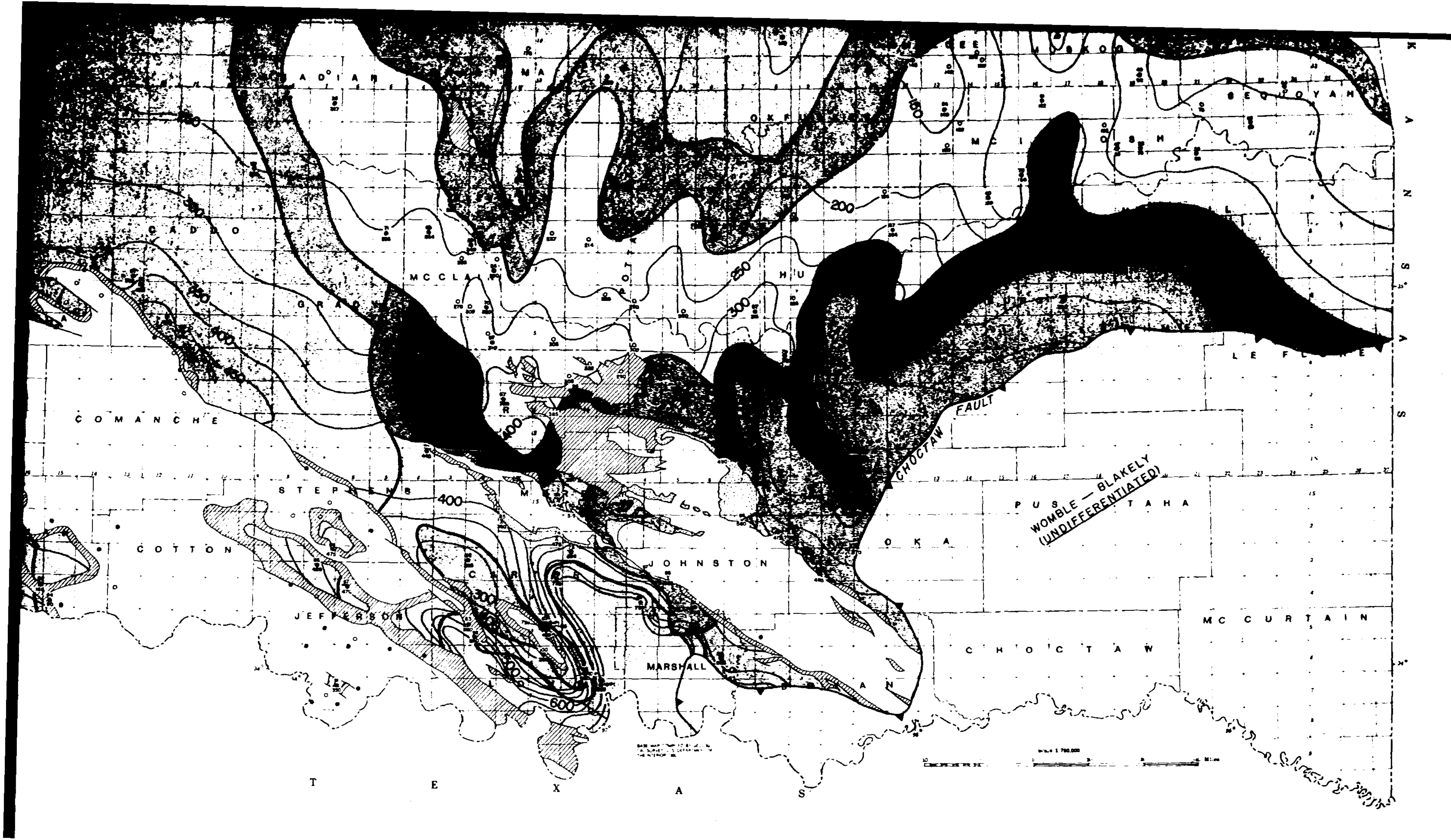
MAY, 1963


KANSAS
TEXAS
SEQUOYAH
CADDO
COMANCHE
STEPHENS
COTTON
JEFFERSON
JOHNSTON
MARSHALL
MCCLAIN
CHOCTAW
MC CURTAIN
CHOCTAW FAULT
PUSHMATAHA
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
150
200
250
300
400
600

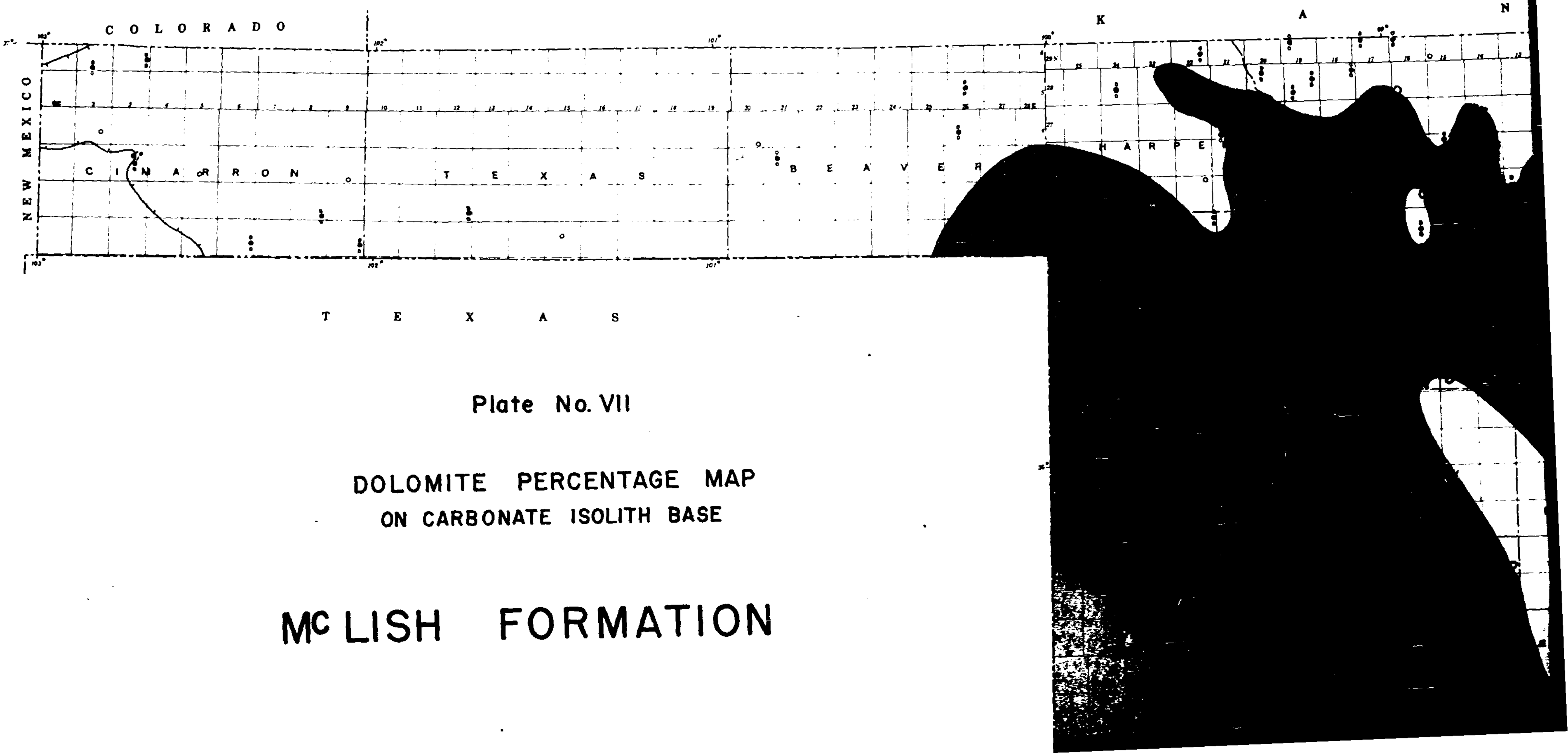
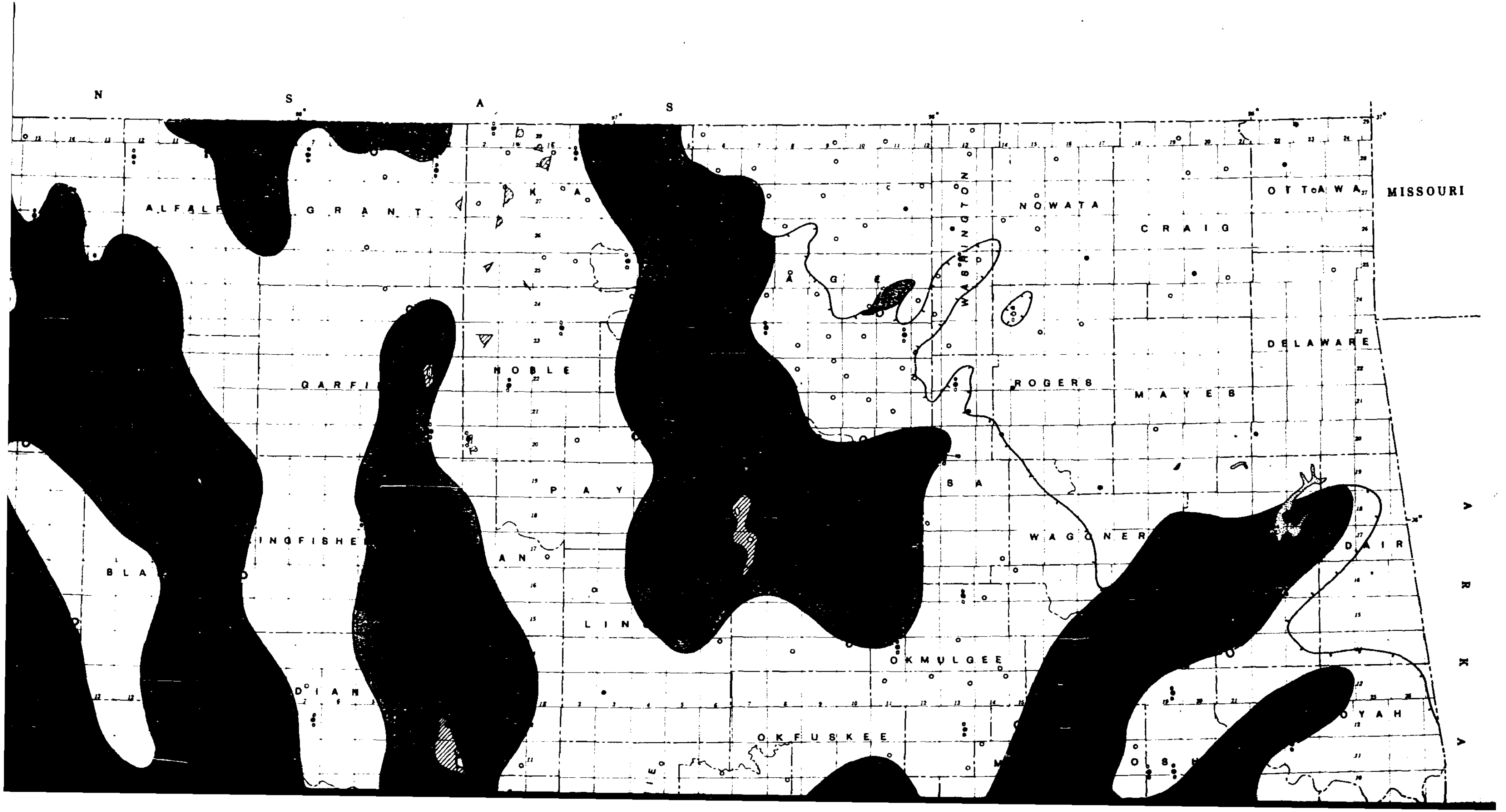


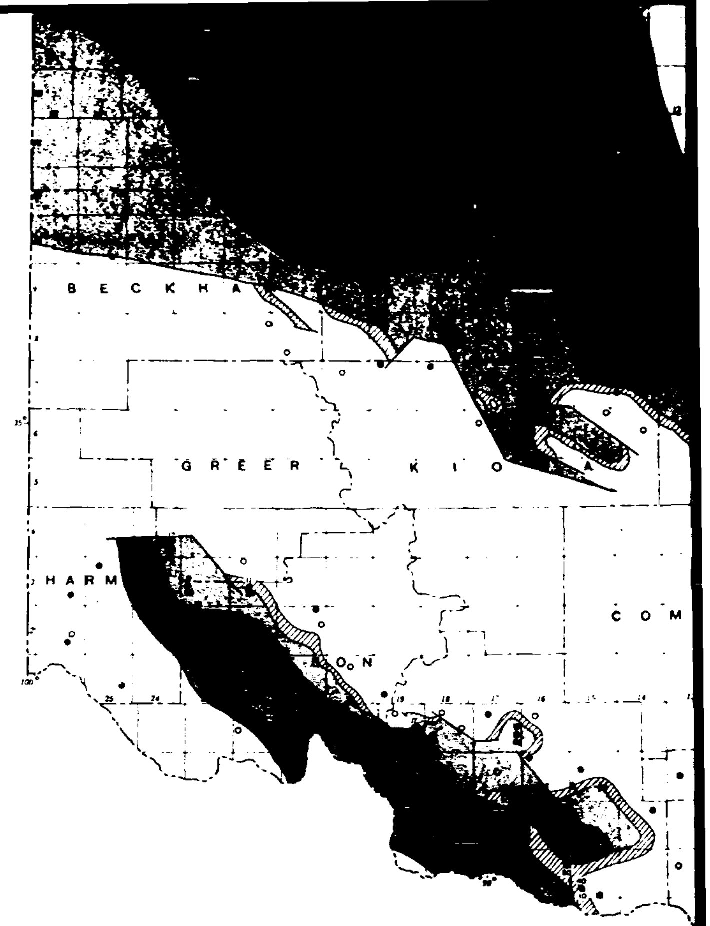
Plate No. VII

DOLOMITE PERCENTAGE MAP
ON CARBONATE ISOLITH BASE

McLISH FORMATION


MISSOURI
GRANT
NOBLE
NOWATA
OTTAWA
CRAIG
DELAWARE
ROGERS
MAYES
WAGONER
OKMULGEE
OKFUSKEE

McLISH FORMATION



EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Dolomite Percentage / Net Carbonate Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- 100 ISOLITH (C.I. = 50')
- Limit of McLish

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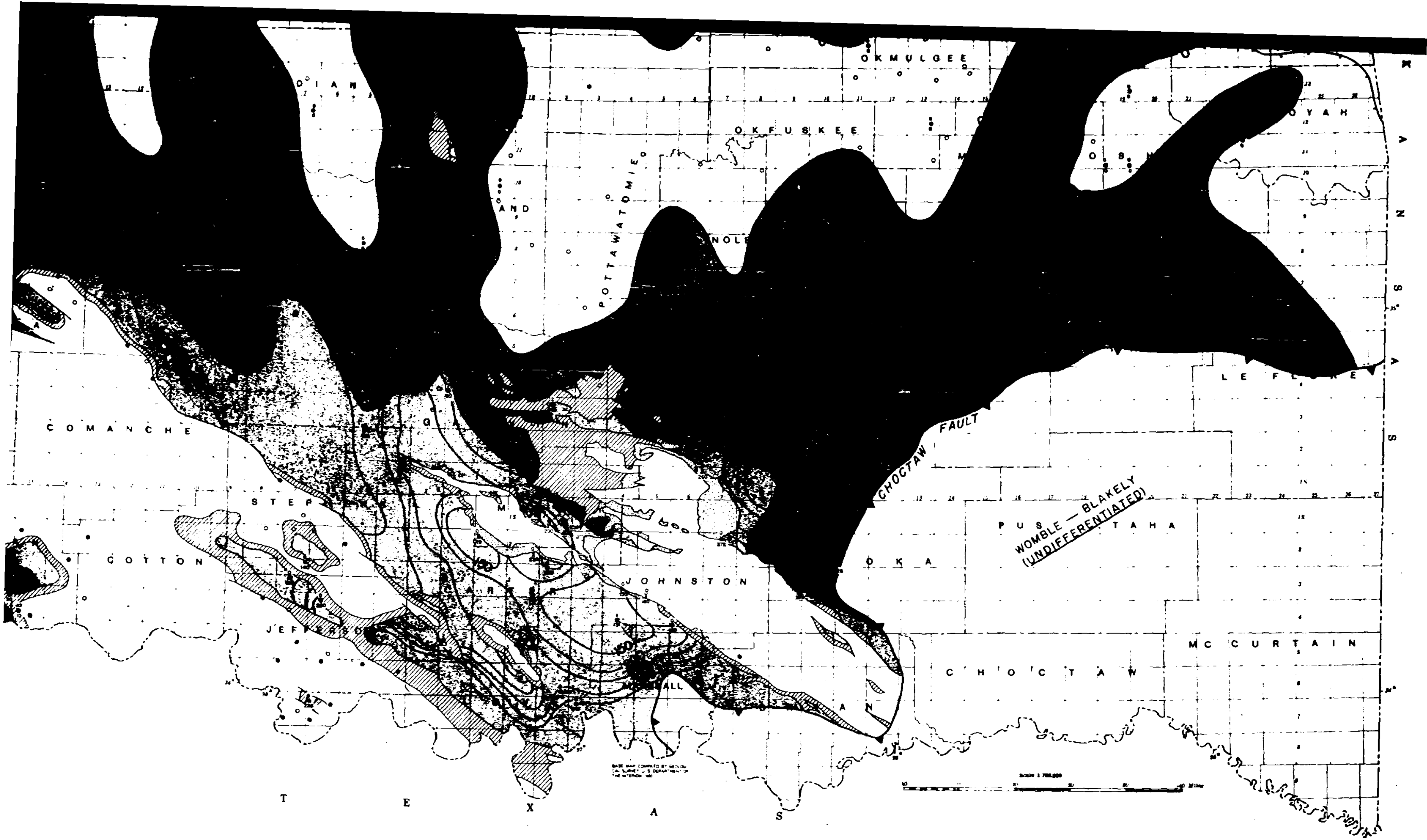

OKMULGEE
OKFUSKEE
POTTAWATOMIE
COMANCHE
COTTON
JOHNSTON
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
CHOCTAW
MC CURTAIN
T E X A S

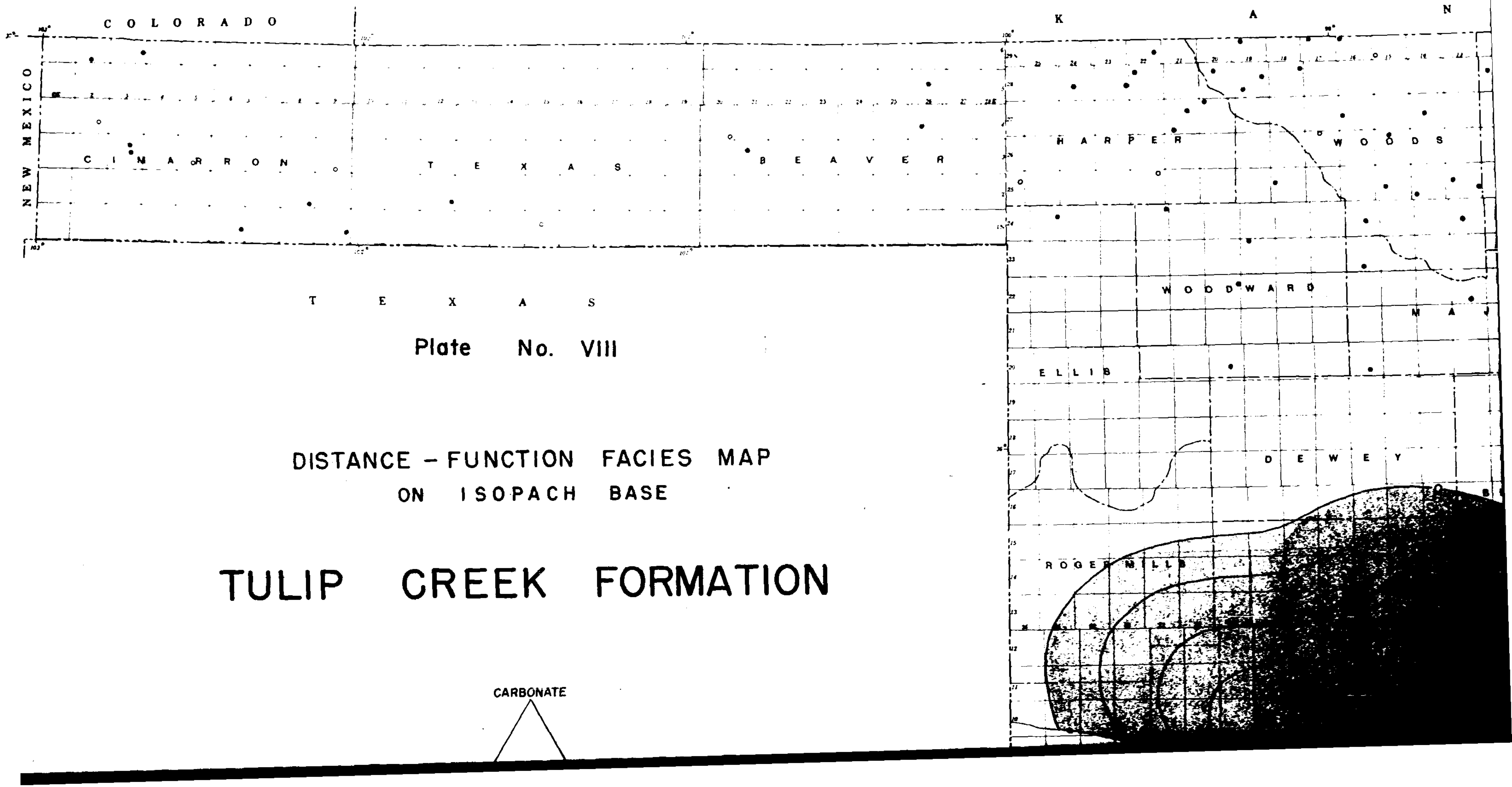
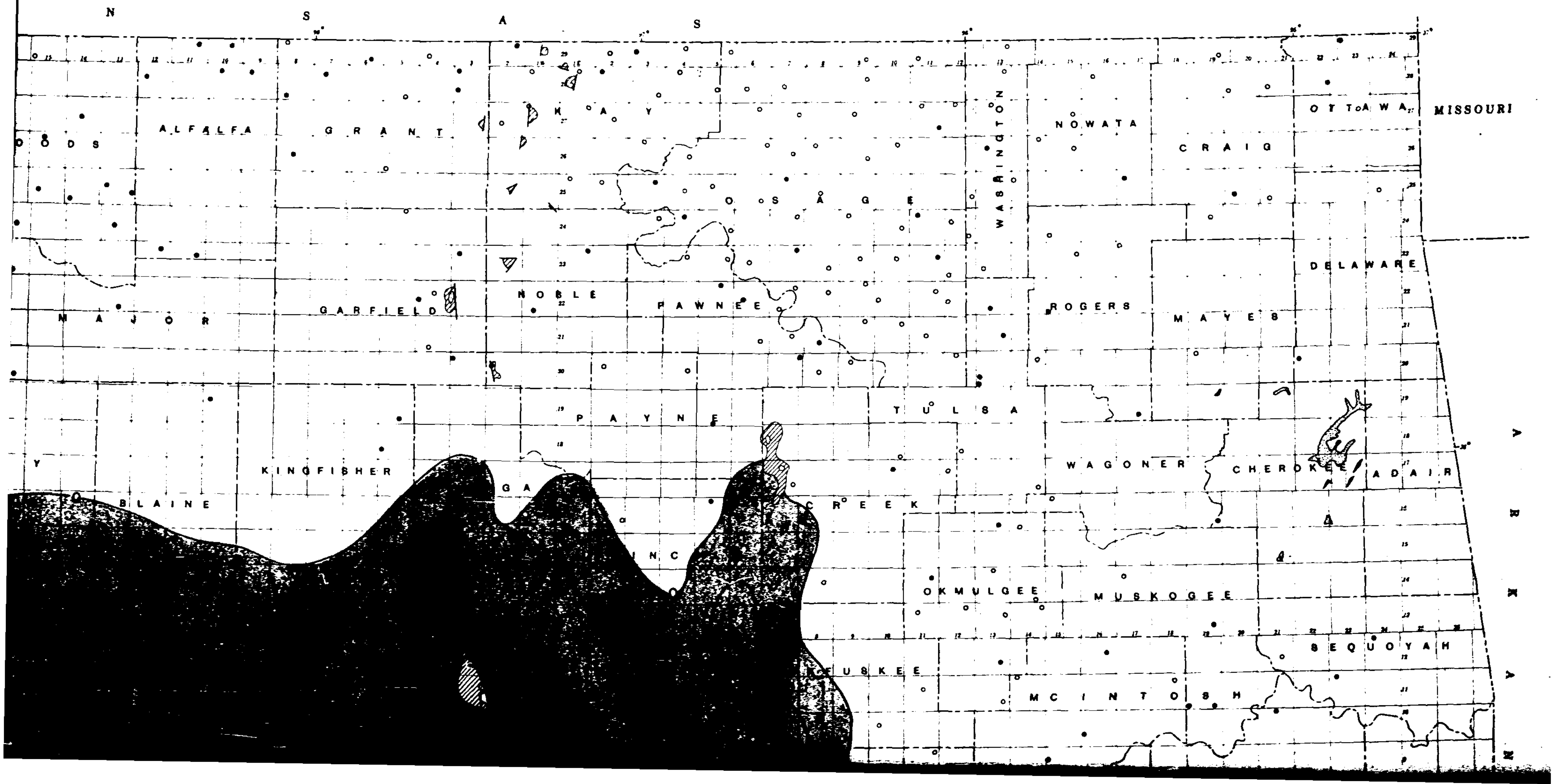


Plate No. VIII

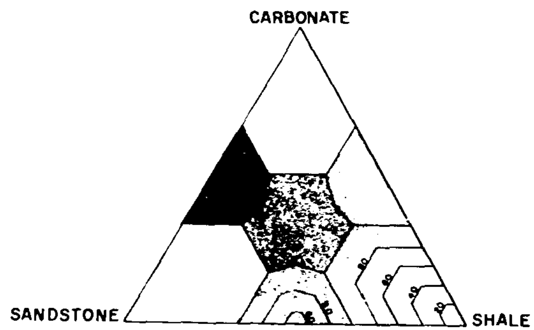
DISTANCE - FUNCTION FACIES MAP
ON ISOPACH BASE

TULIP CREEK FORMATION



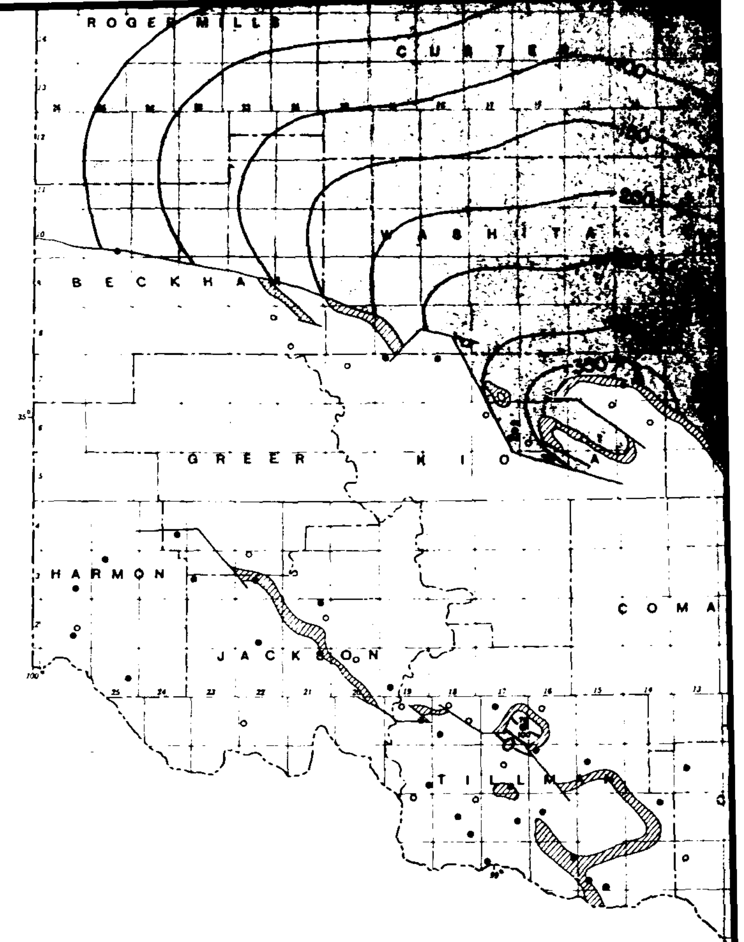
N S A S
MISSOURI
ODS
ALFALFA
GRANT
K A Y
O S A G E
WASHINGTON
NOWATA
CRAIG
OTTAWA
MAJOR
GARFIELD
NOBLE
PAWNEE
ROGERS
MAYES
DELAWARE
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
KINGFISHER
BLAINE
CREEK
OKMULGEE
MUSKOGEE
SEQUOYAH
MCINTOSH

TULIP CREEK FORMATION



EXPLANATION

- ◦ Control Point (Well)
- • Sample Control
- Distance Function Value
- Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ Isopach (C.I. = 50')



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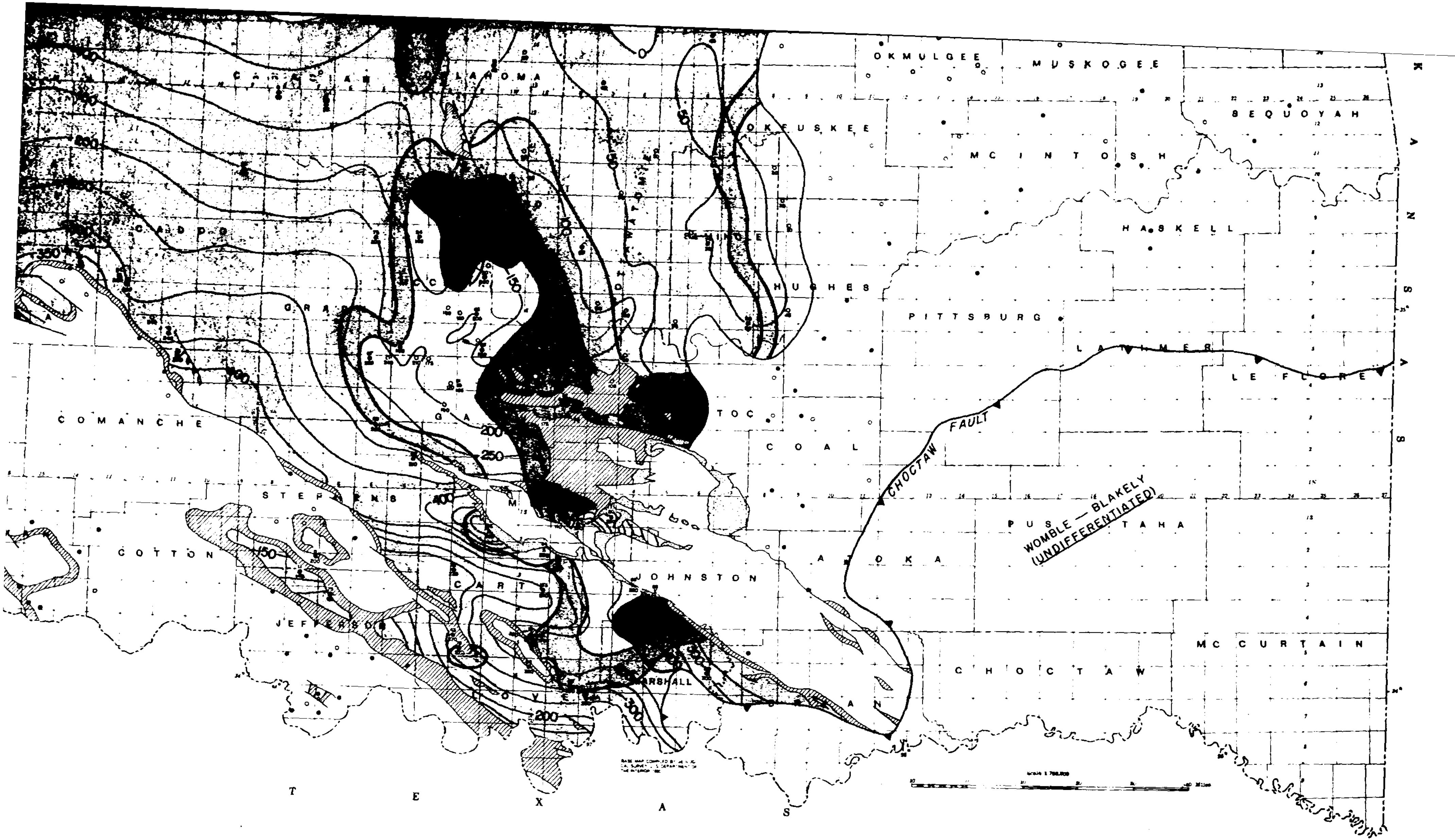
MAY, 1963



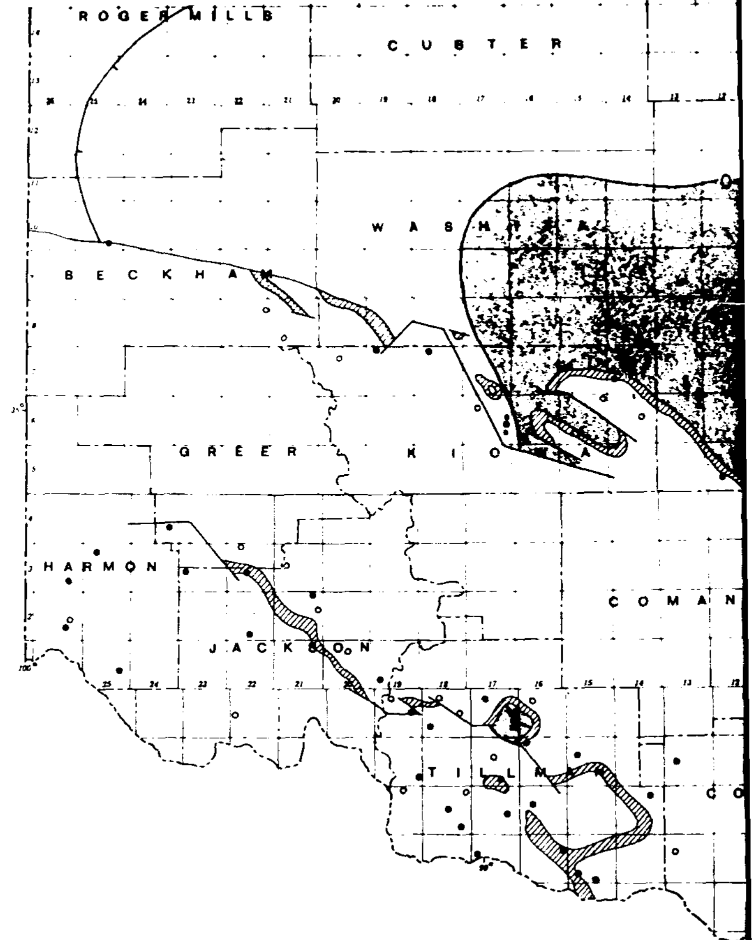
OKMULGEE
MUSKOGEE
SEQUOYAH
OKFUSKEE
MC INTOSH
HASKELL
HUGHES
PITTSBURG
LATIMER
LE FLORE
CADDO
COMANCHE
COAL
STEPHENS
COTTON
JOHNSTON
CARTER
JEFFERSON
MARSHALL
ATOKA
PUSHMATAHA
CHOCTAW
MC CURTAIN
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
TEXAS
ARKANSAS

TULIP CREEK FORMATION

0% 50% 100%

EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Dolomite Percentage
- Net Carbonate Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ ISOLITH (C.I.=25')
- Limit of Tulip Creek



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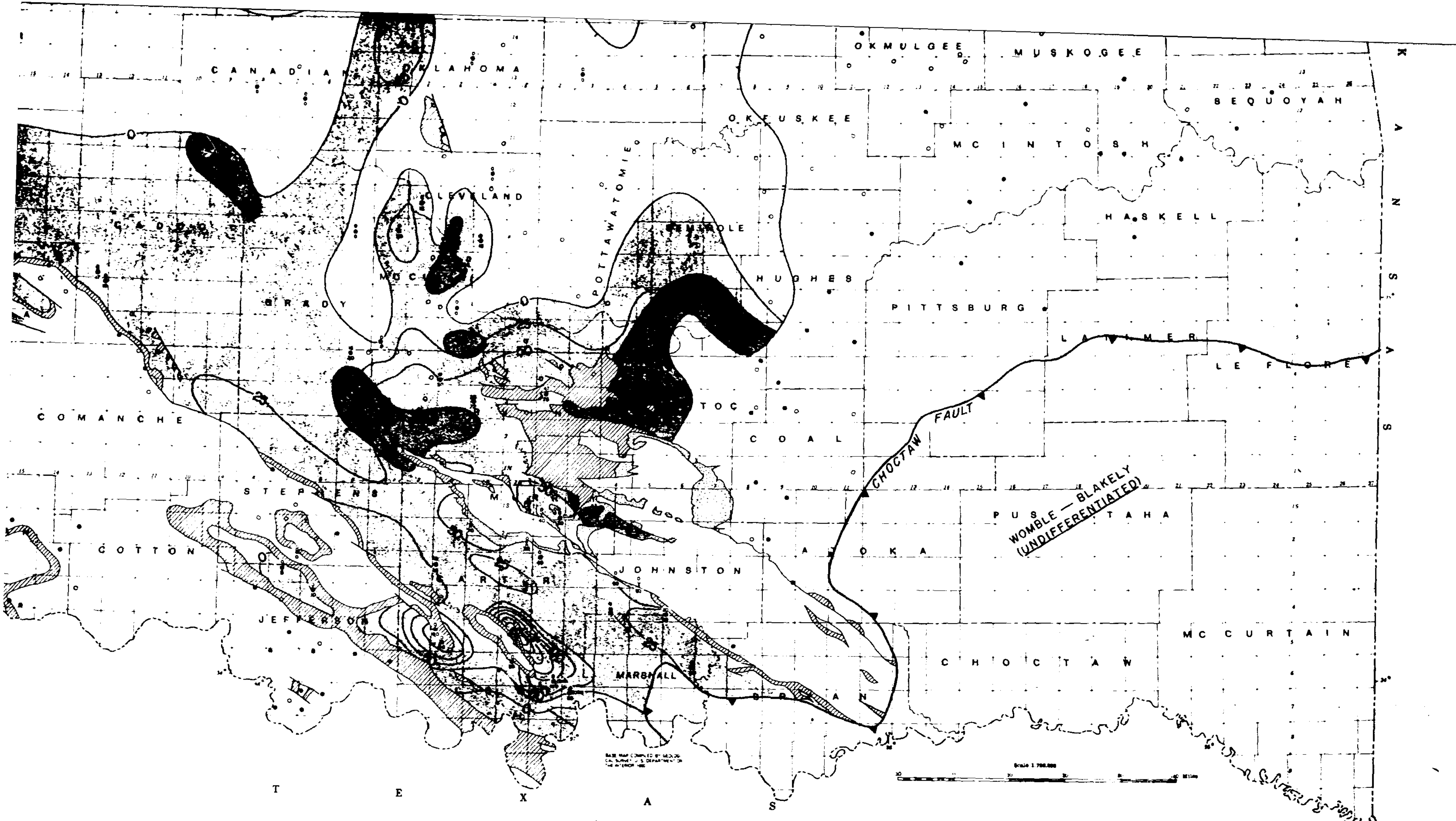
MAY, 1963


CANADIAN
OKLAHOMA
OKMULGEE
MUSKOGEE
SEQUOYAH
OKFUSKEE
MCINTOSH
CLEVELAND
POTTAWATOMIE
CADDO
SEMINOLE
HASKELL
HUGHES
GRADY
PITTSBURG
LATIMER
LE FLORE
COMANCHE
COAL
CHOCTAW FAULT
STEPHENS
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
PUSHMATAHA
COTTON
ATOKA
JOHNSTON
JEFFERSON
MC CURTAIN
CHOCTAW
MARSHALL
T E X A S
ARKANSAS

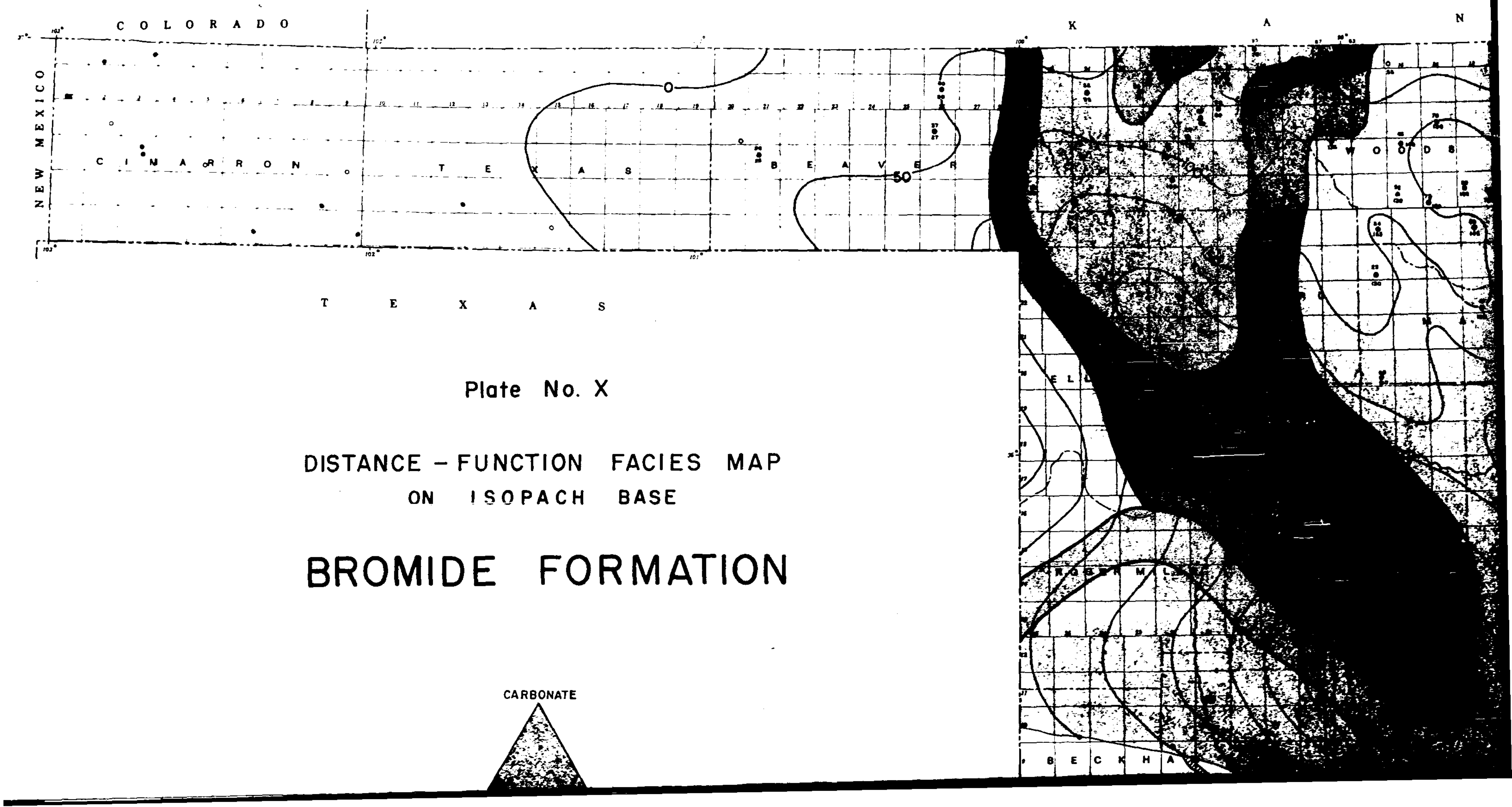
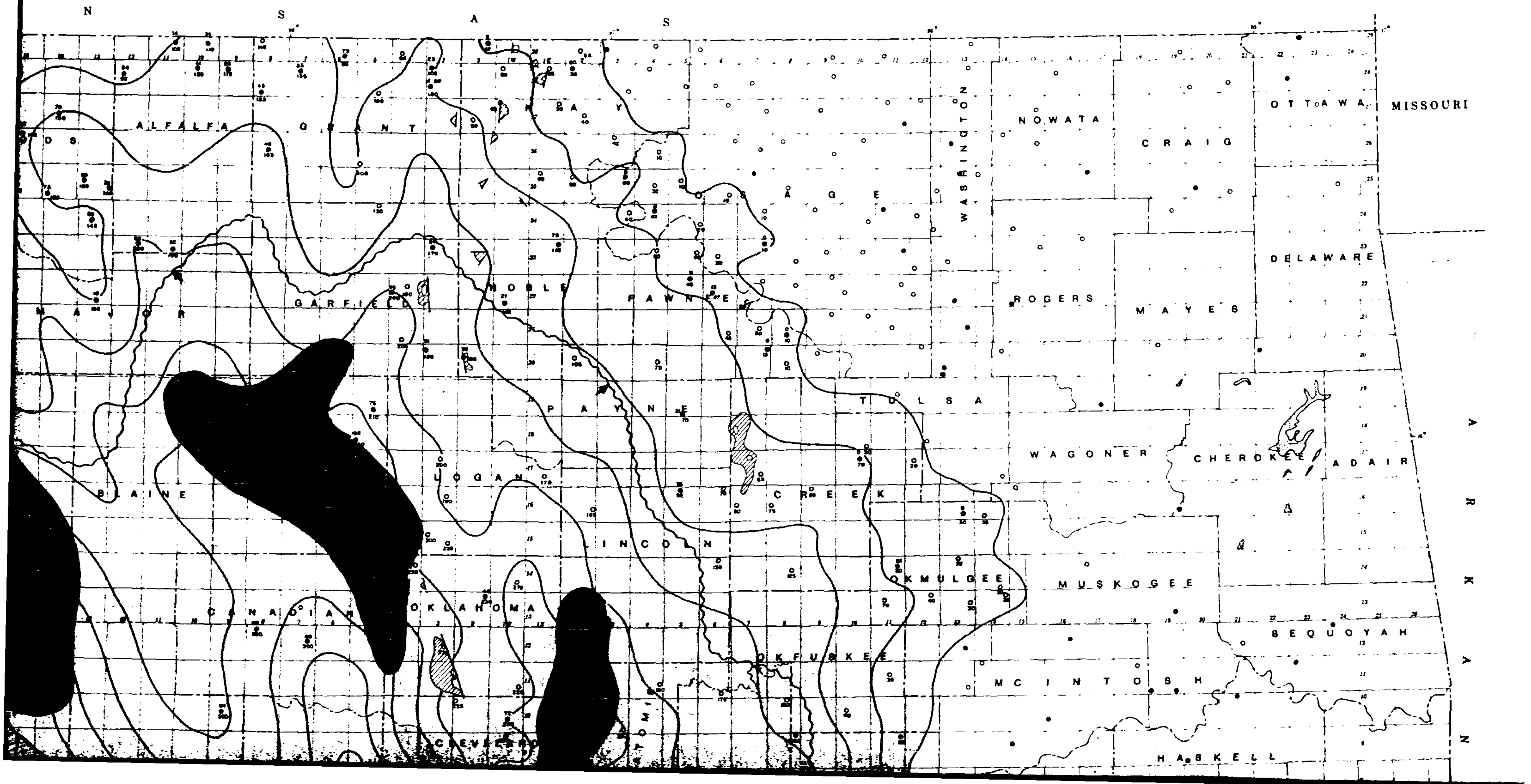


Plate No. X

DISTANCE – FUNCTION FACIES MAP
ON ISOPACH BASE

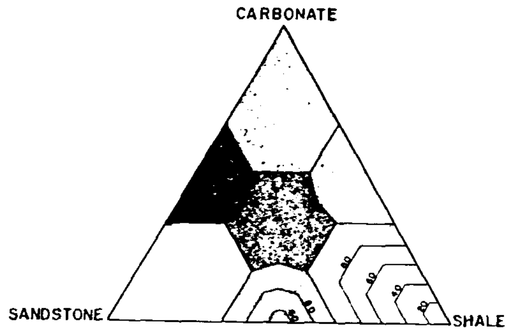
BROMIDE FORMATION

CARBONATE



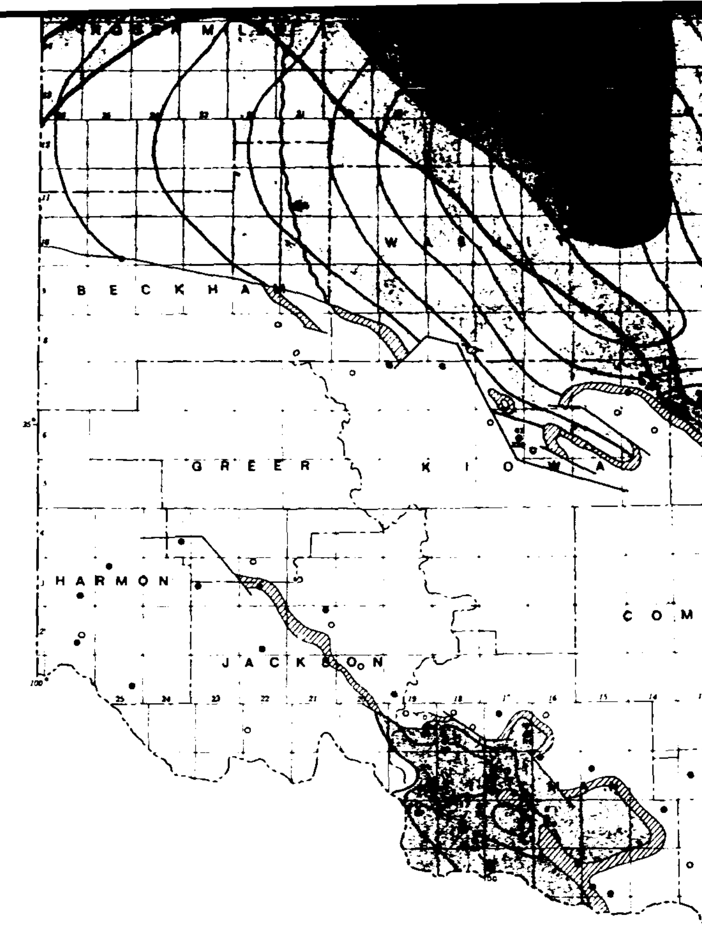
ALFALFA
GRANT
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
MISSOURI
DELAWARE
ROGERS
MAYES
GARFIELD
NOBLE
PAWNEE
MAJOR
PAYNE
TULSA
WAGONER
CHEROKEE
ADAIR
BLAINE
LOGAN
CREEK
OKMULGEE
MUSKOGEE
OKLAHOMA
OKFUSKEE
MC INTOSH
SEQUOYAH
HASKELL

BROMIDE FORMATION



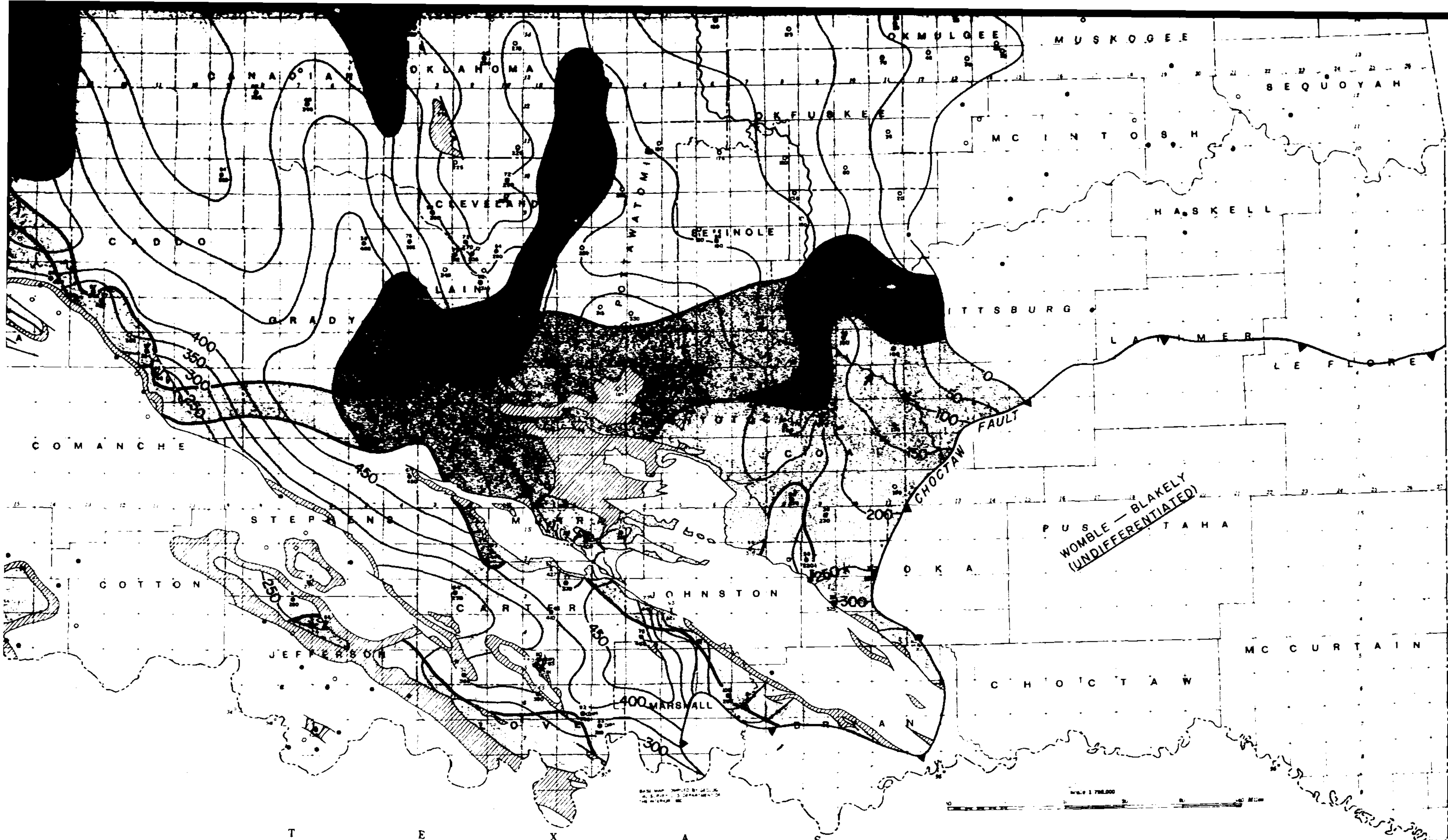
EXPLANATION

- ○ Control Point (Well)
- ● Sample Control
- Distance Function Value
- Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- 100 Isopach (C.I. = 50')
- Approximate limit Upper Bromide



M. W. SCHRAMM, JR., PH. D.

MAY, 1963


KANSAS
MUSKOGEE
SEQUOYAH
OKMULGEE
MC INTOSH
HASKELL
OKFUSKEE
CANADIAN
OKLAHOMA
CLEVELAND
SEMINOLE
CADDO
GRADY
PITTSBURG
LATIMER
LE FLORE
COMANCHE
STEPHENS
COTTON
JEFFERSON
CARTER
JOHNSTON
COAL
ATOKA
PUSHMATAHA
MC CURTAIN
CHOCTAW
MARSHALL
LOVE
BRYAN
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
TEXAS
0
50
100
150
200
250
300
350
400
450

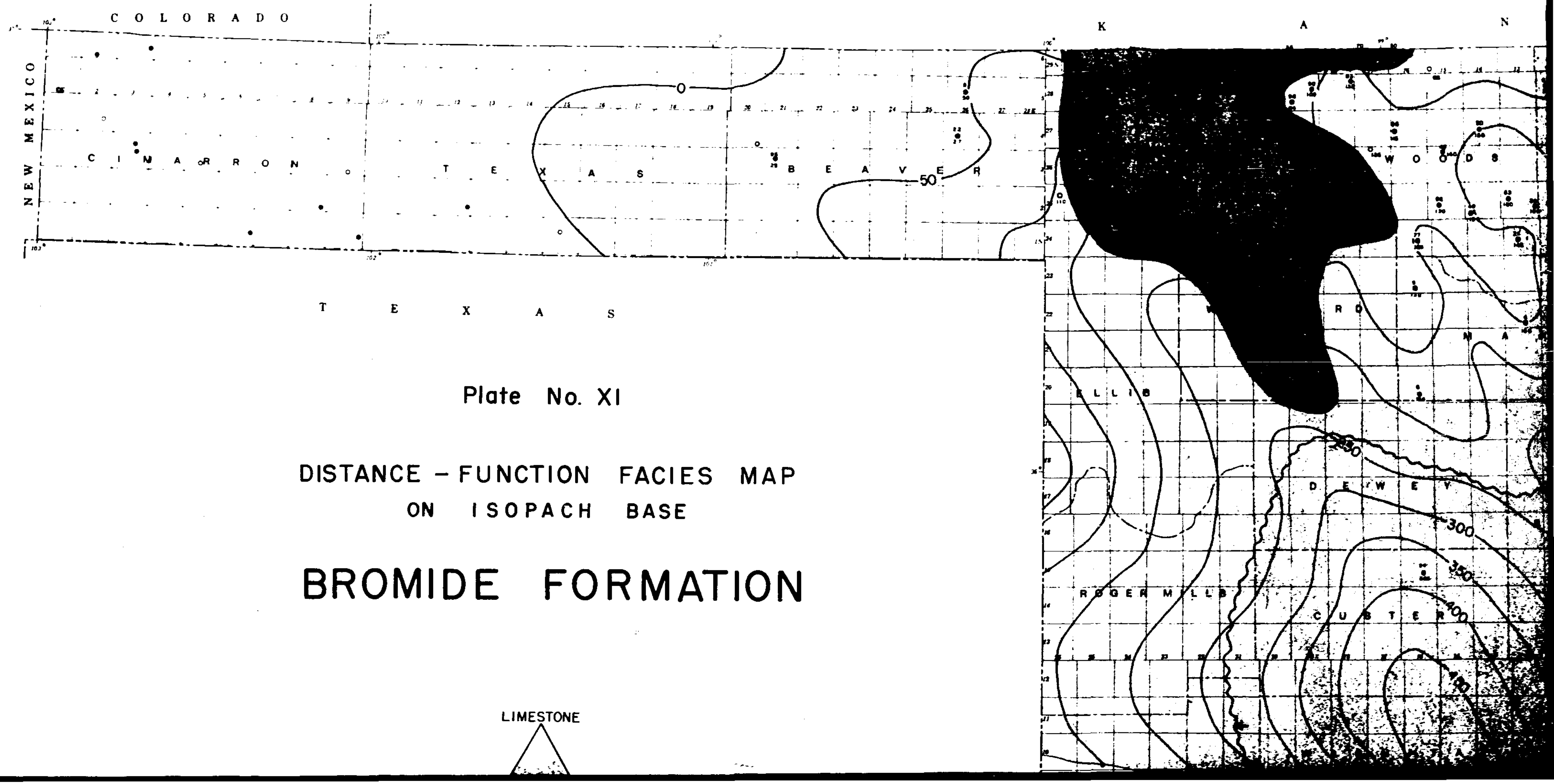
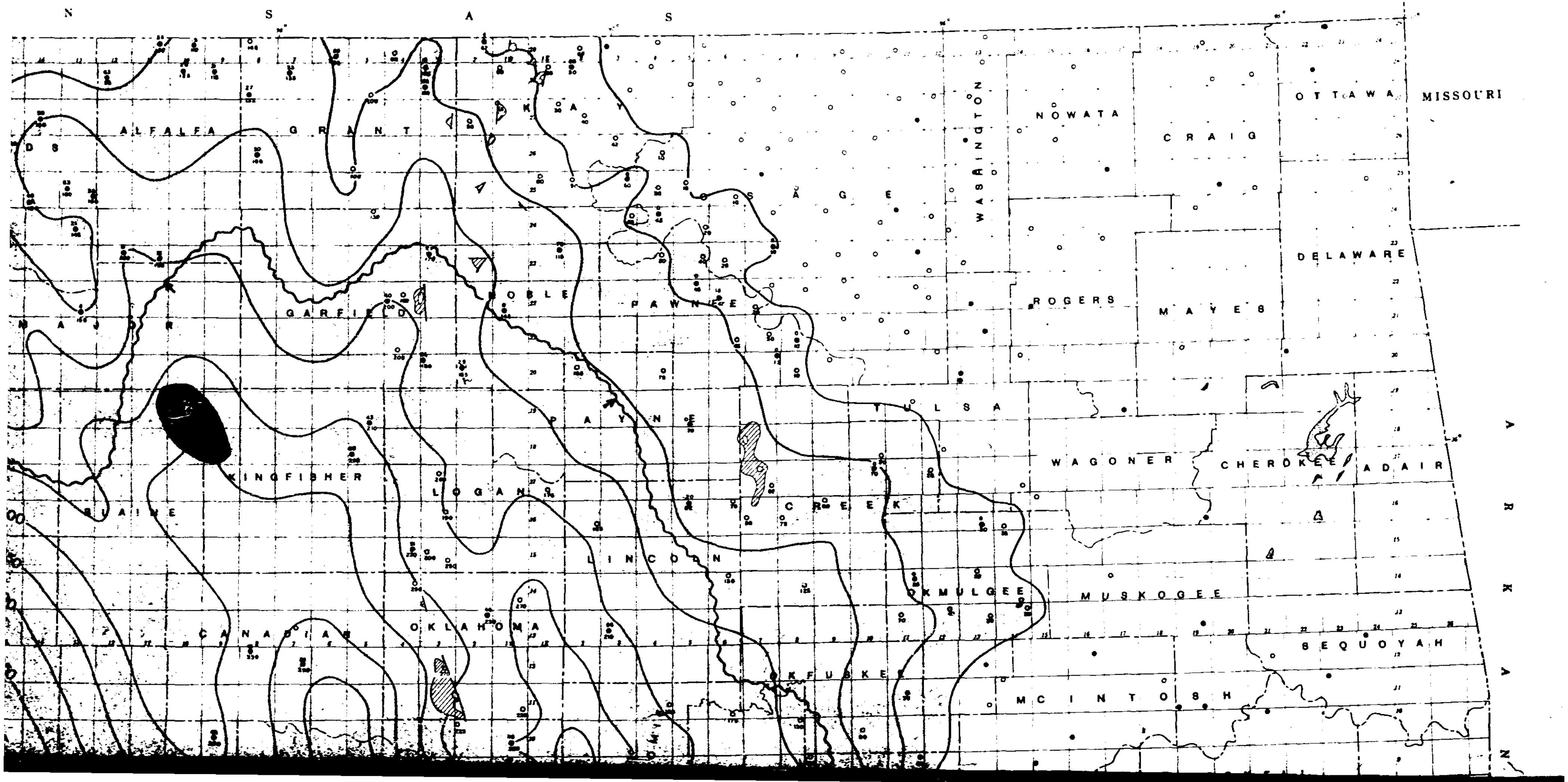


Plate No. XI

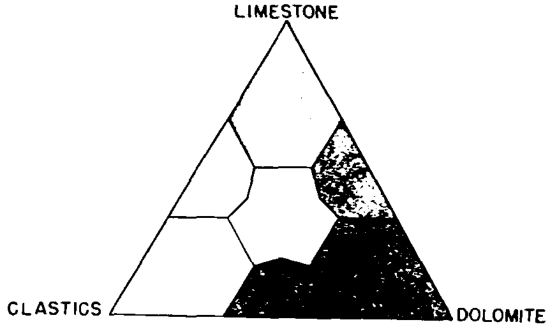
DISTANCE – FUNCTION FACIES MAP ON ISOPACH BASE

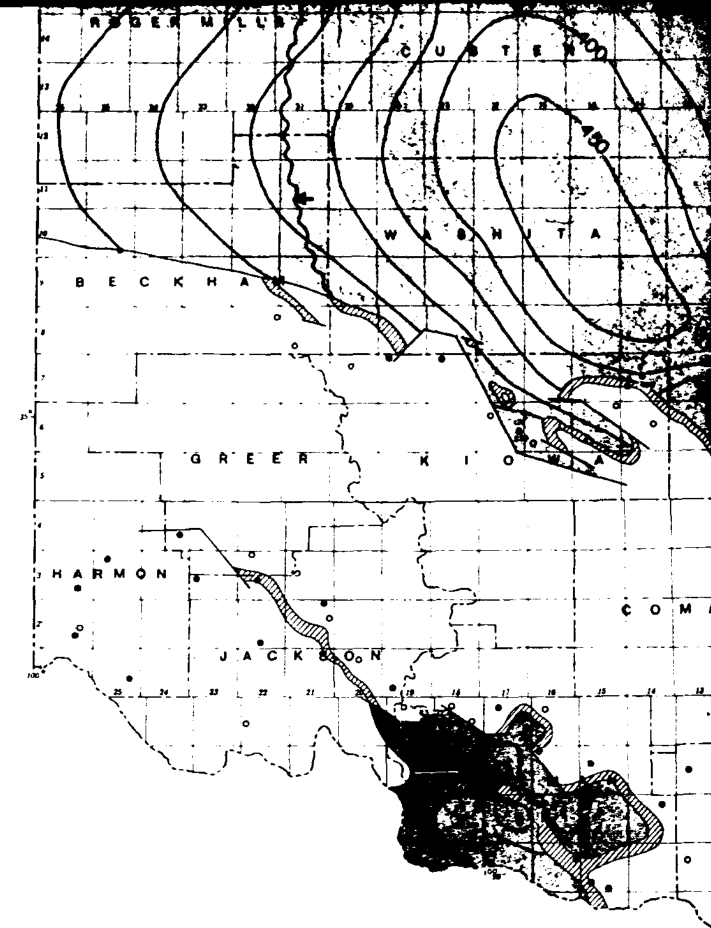
BROMIDE FORMATION



N S A S
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
MISSOURI
DELAWARE
ROGERS
MAYES
MAJOR
GARFIELD
NOBLE
PAWNEE
TULSA
PAYNE
KINGFISHER
LOGAN
WAGONER
CHEROKEE
ADAIR
BLAINE
CREEK
LINCOLN
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
SEQUOYAH
OKFUSKEE
MCINTOSH

BROMIDE FORMATION



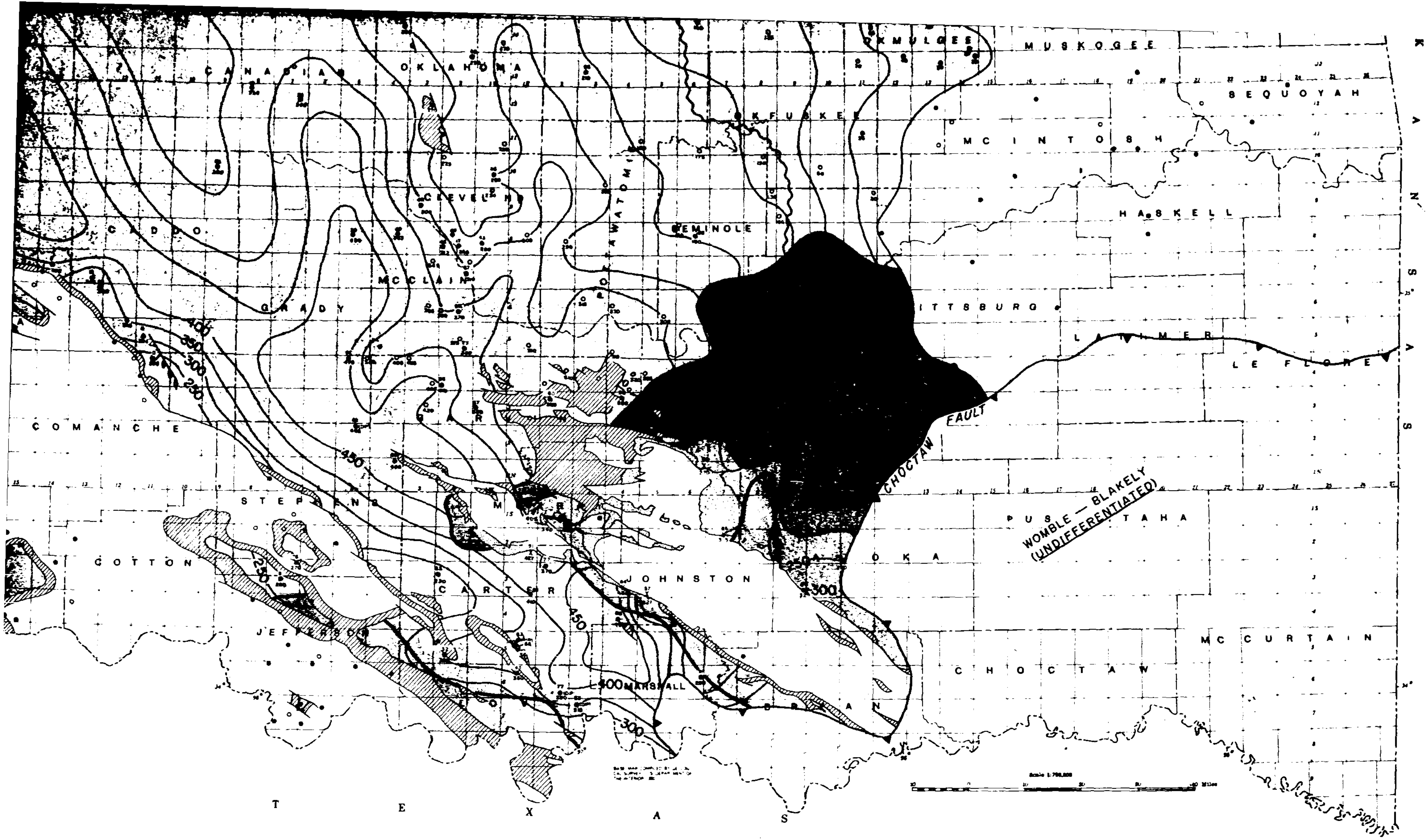


EXPLANATION

- Control Point (Well)
- Sample Control
- Distance Function Value
- Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- 100 Isopach (C.I. = 50')
- Approximate limit Upper Bromide

M. W. SCHRAMM, JR., PH. D.

MAY, 1963



KANSAS
TEXAS
MUSKOGEE
SEQUOYAH
OKMULGEE
OKFUSKEE
MCINTOSH
HASKELL
CANADIAN
OKLAHOMA
CLEVELAND
POTTAWATOMIE
SEMINOLE
CADDO
MCCLAIN
GRADY
PITTSBURG
LATIMER
LE FLORE
COMANCHE
STEPHENS
COTTON
CARTER
JOHNSTON
JEFFERSON
MARSHALL
BRYAN
ATOKA
PUSHMATAHA
MC CURTAIN
CHOCTAW
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
400
350
300
250
450

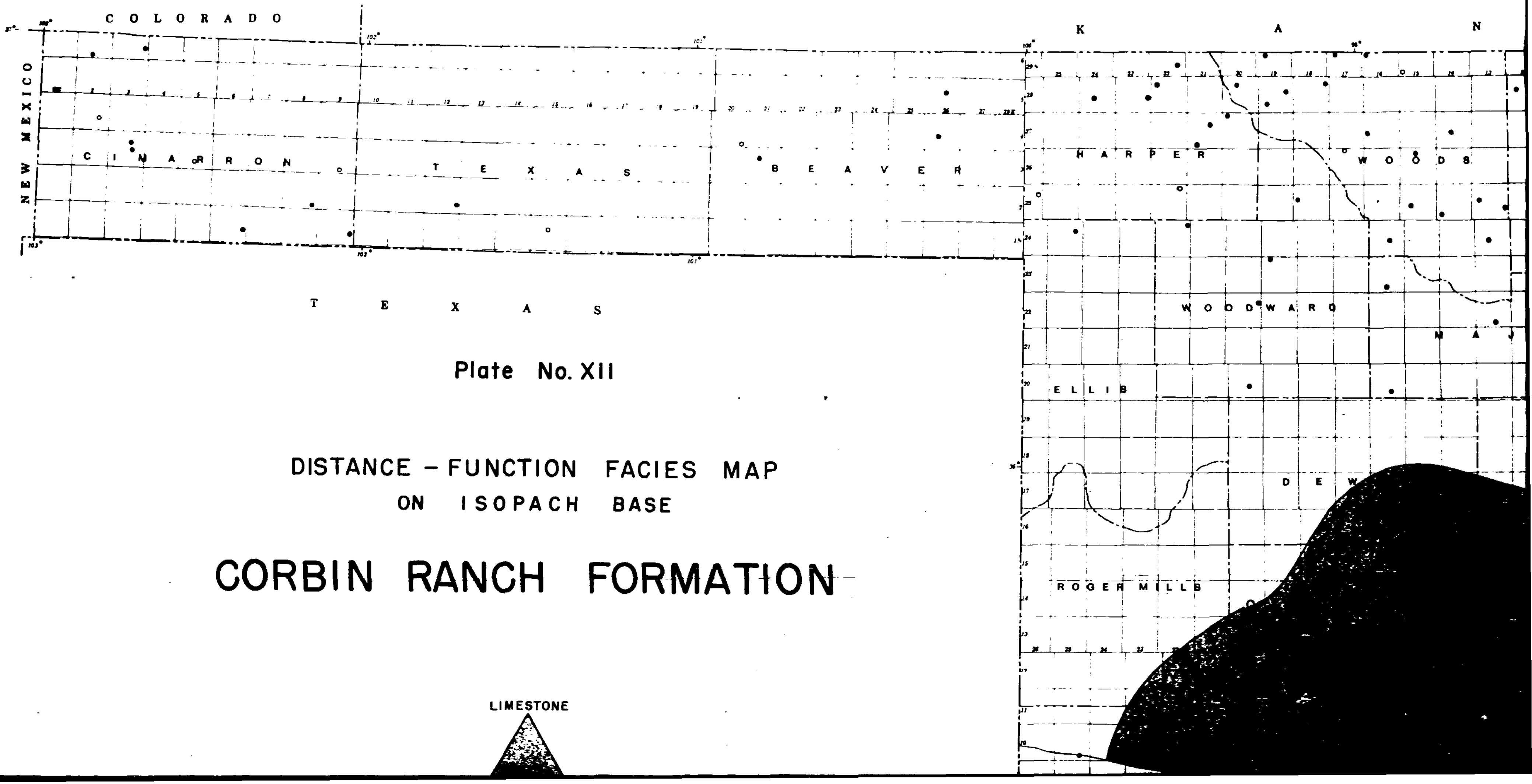
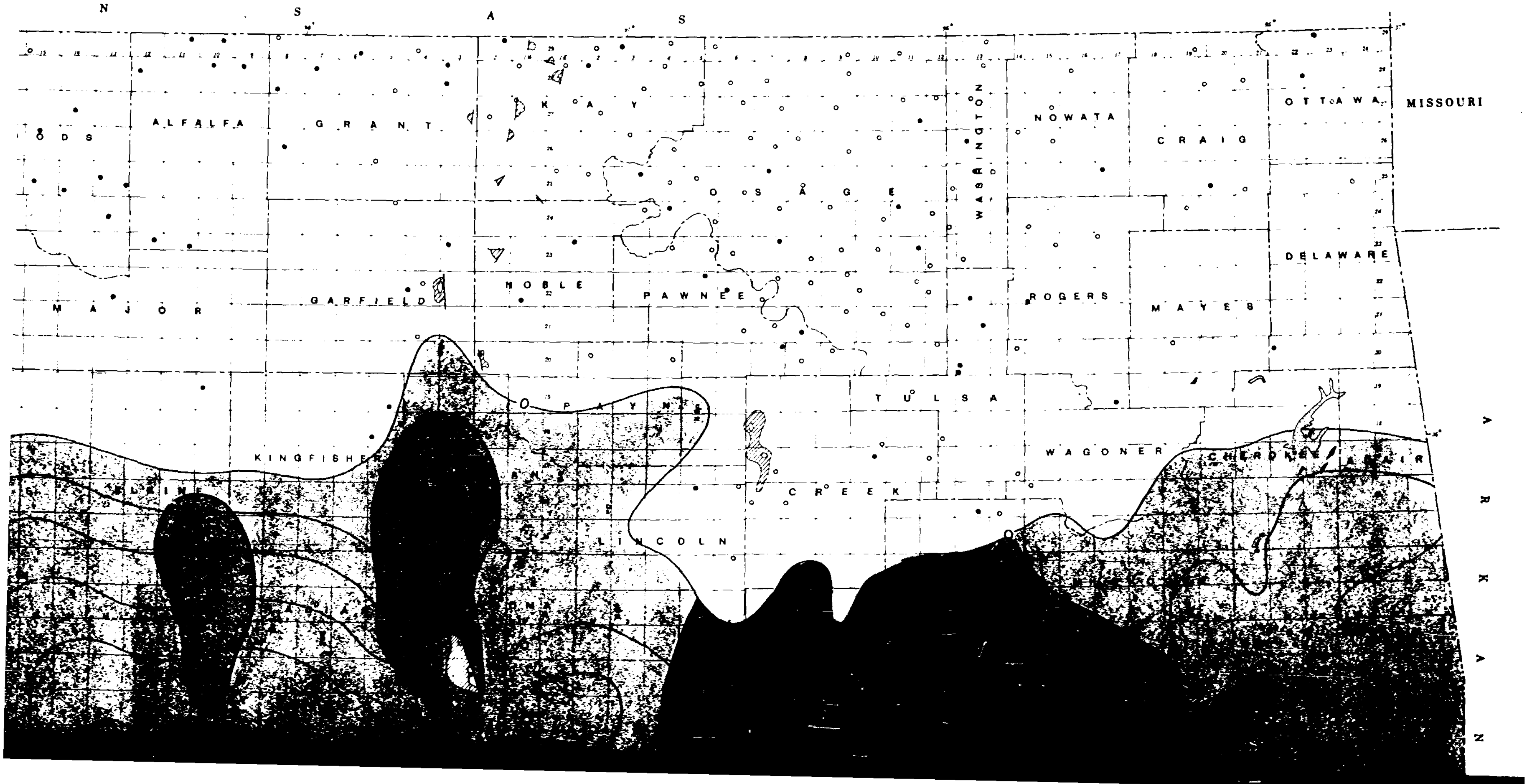


Plate No. XII

DISTANCE – FUNCTION FACIES MAP
ON ISOPACH BASE

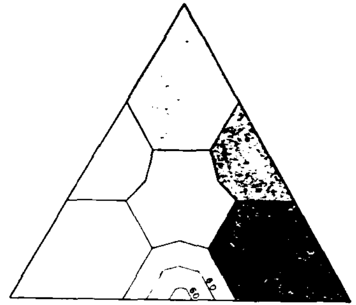
CORBIN RANCH FORMATION

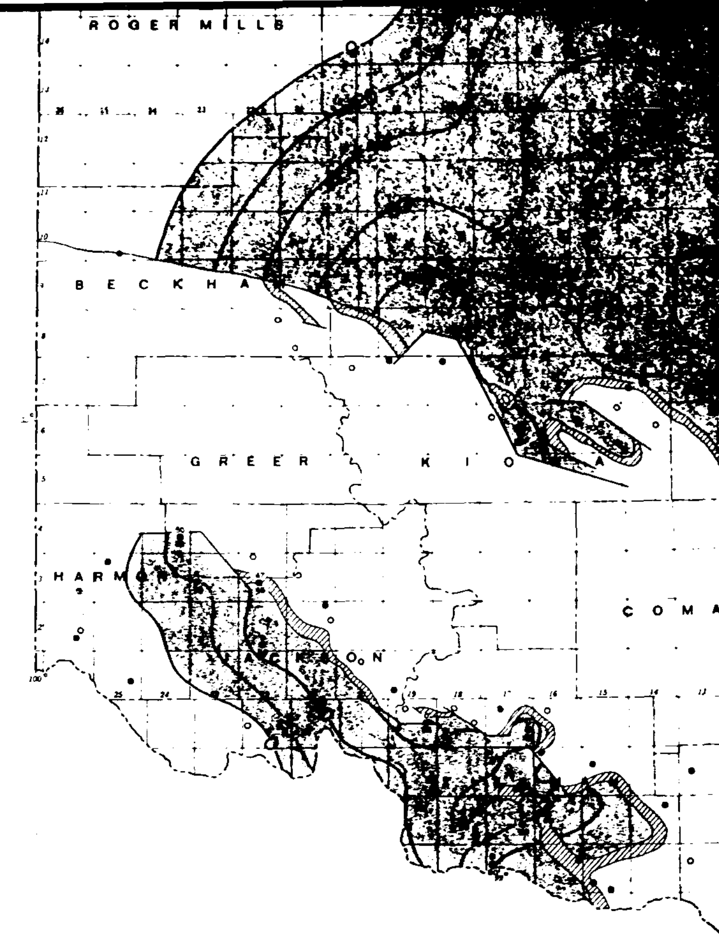
LIMESTONE



N S A S
MISSOURI
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
NOWATA
CRAIG
OTTAWA
DELAWARE
MAYES
ROGERS
PAWNEE
NOBLE
GARFIELD
MAJOR
PAYNE
TULSA
WAGONER
KINGFISHER
CREEK
LINCOLN
A R K A N

CORBIN RANCH FORMATION



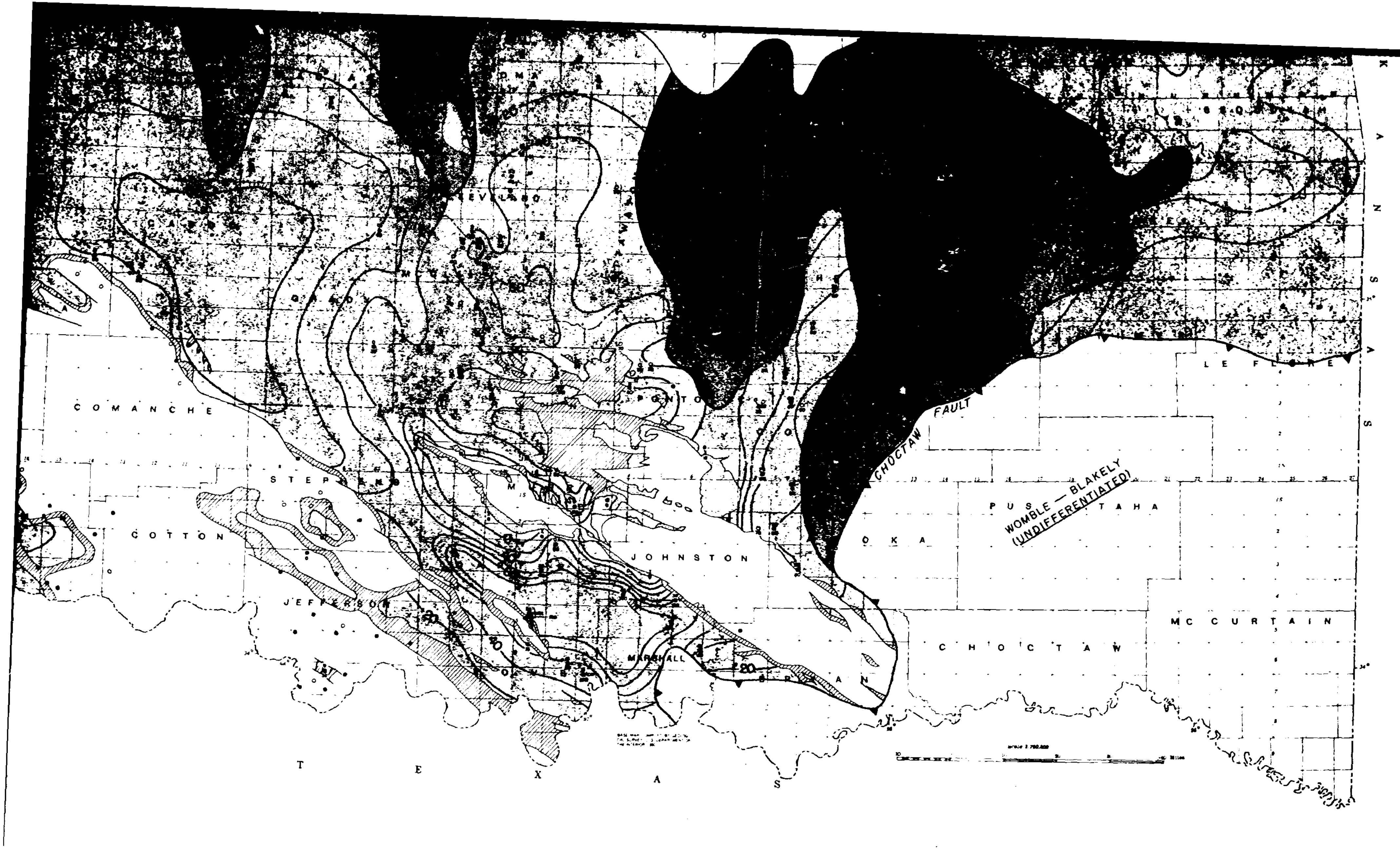


EXPLANATION

- ○ Control Point (Well)
- • Sample Control
- Distance Function Value
- Thickness
- X Measured Outcrop Section
- Outcrop of Simpson (Undifferentiated)
- Pre-Pennsylvanian Subcrop of Simpson (Undifferentiated)
- ~100~ Isopach (C.I.=20')

M. W. SCHRAMM, JR., PH. D.

MAY, 1963


K A N S A S
T E X A S
COMANCHE
STEPHENS
COTTON
JEFFERSON
JOHNSTON
MARSHALL
BRYAN
PONTOTOC
CHOCTAW
MC CURTAIN
PUSHMATAHA
ATOKA
LE FLORE
CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)

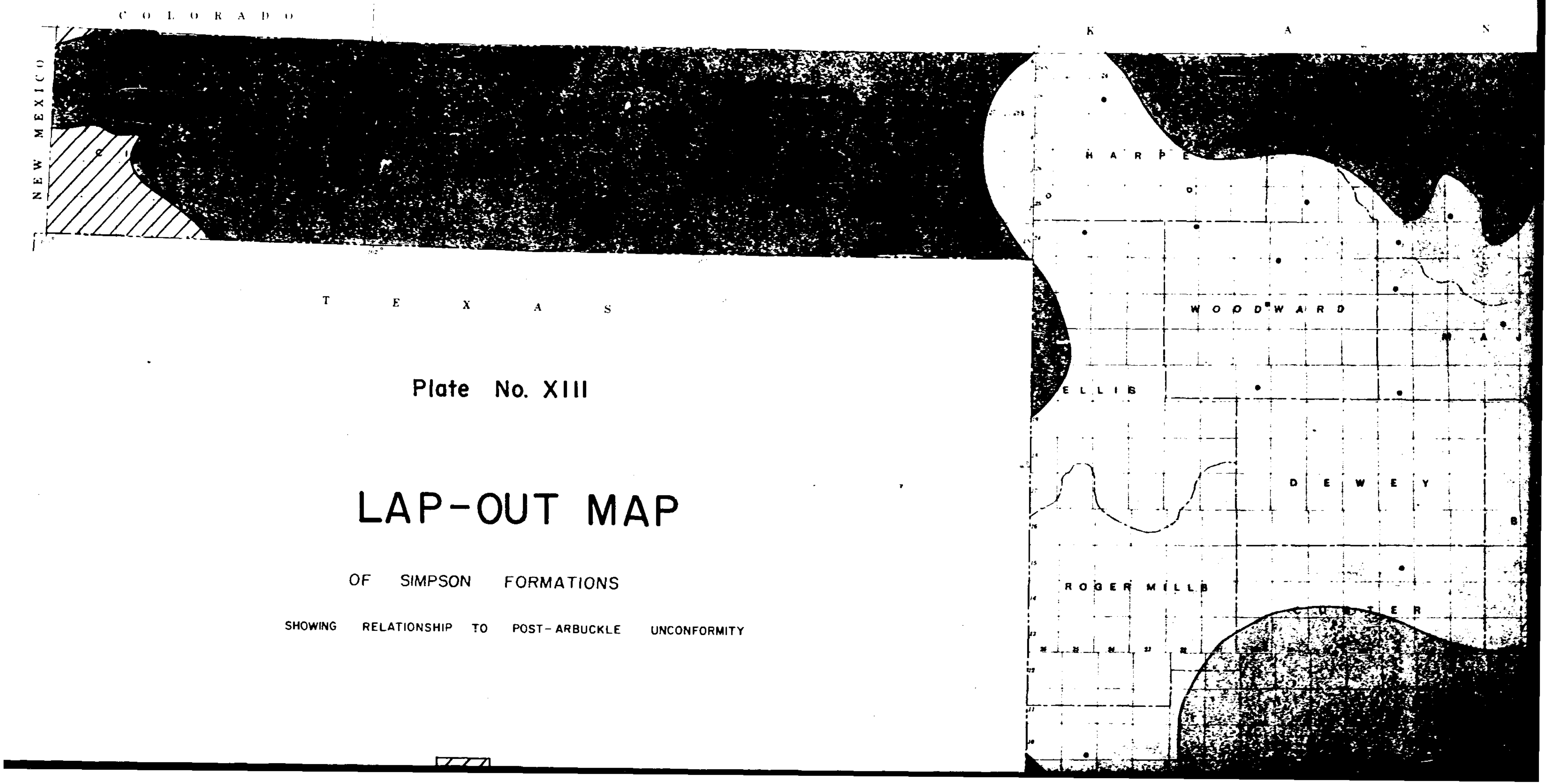
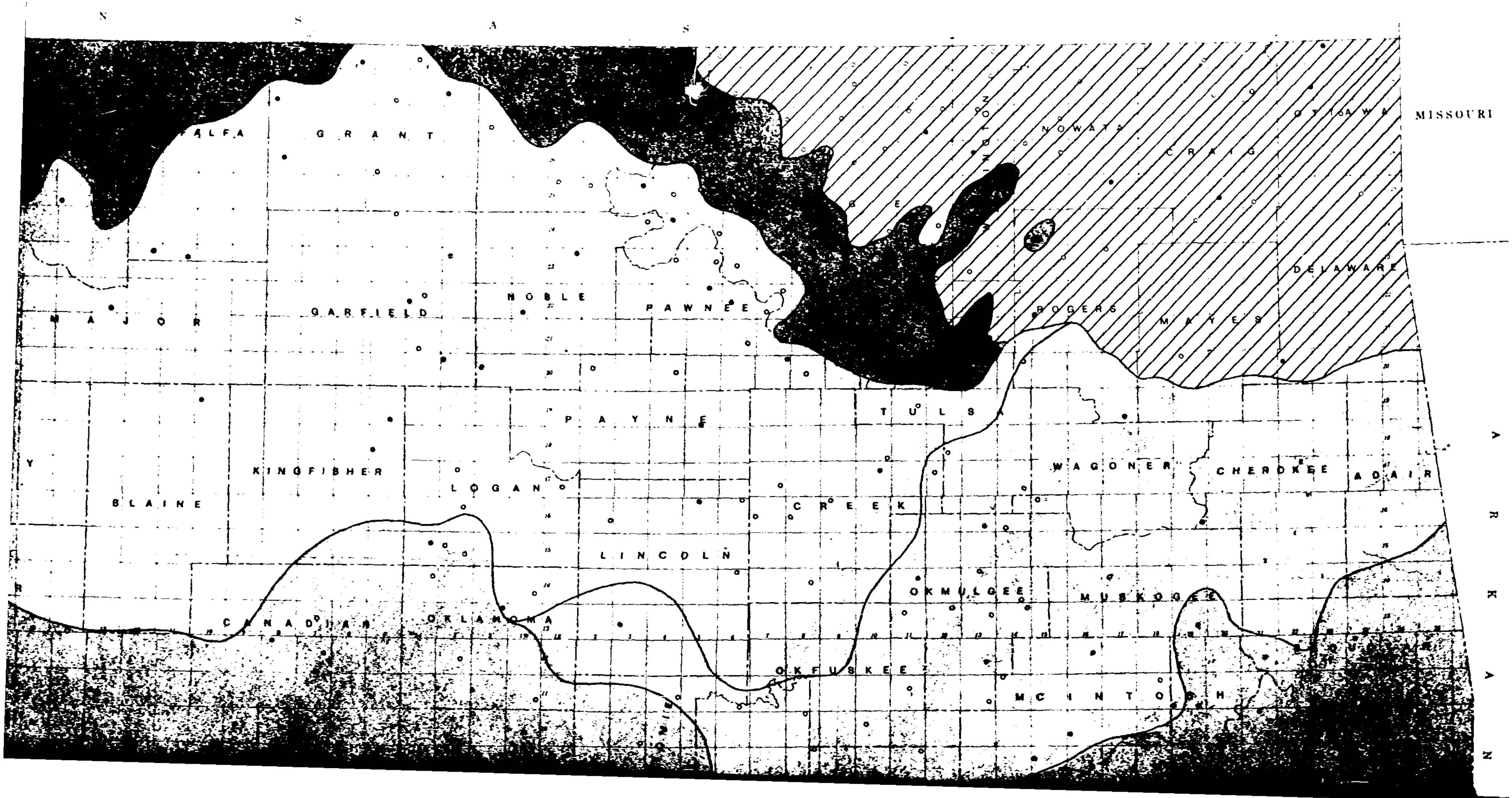


Plate No. XIII

LAP-OUT MAP

OF SIMPSON FORMATIONS

SHOWING RELATIONSHIP TO POST-ARBUCKLE UNCONFORMITY

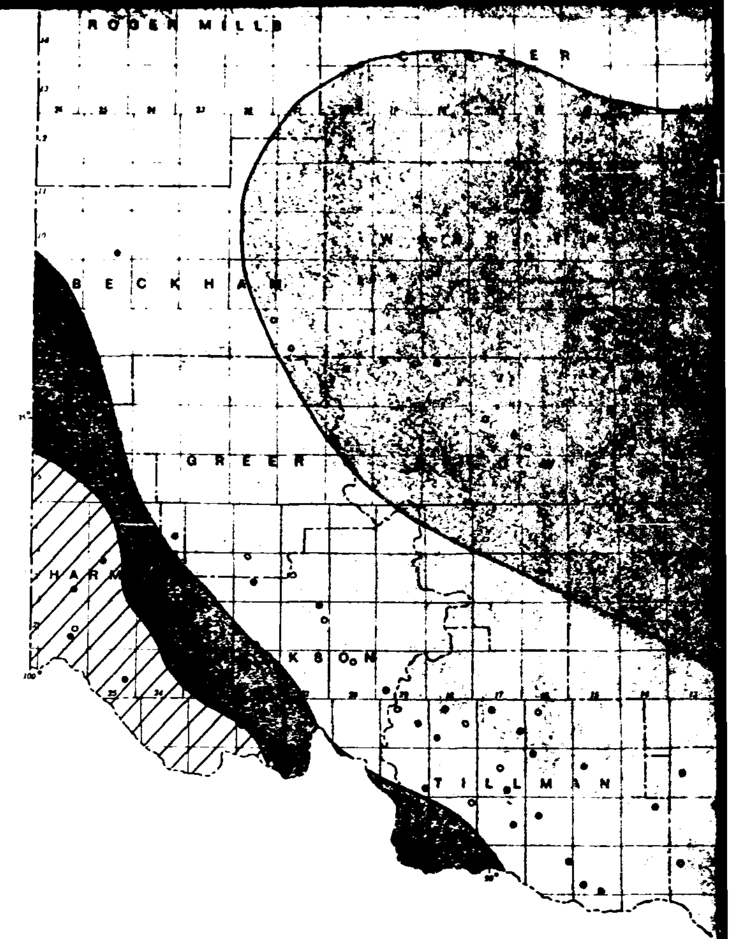


N S A S
MISSOURI
A R K A N
ALFA
GRANT
MAJOR
GARFIELD
NOBLE
PAWNEE
OSAGE
NOWATA
CRAIG
OTTAWA
DELAWARE
ROGERS
MAYES
TULSA
PAYNE
KINGFISHER
BLAINE
LOGAN
CREEK
LINCOLN
WAGONER
CHEROKEE
ADAIR
OKMULGEE
MUSKOGEE
CANADIAN
OKLAHOMA
OKFUSKEE
MCINTOSH

OF SIMPSON FORMATIONS

SHOWING RELATIONSHIP TO POST-ARBUCKLE UNCONFORMITY

- POST-SIMPSON
- CORBIN RANCH
- BROMIDE
- McLISH
- OIL CREEK
- BURGEN-OIL CREEK SANDSTONE
- JOINS



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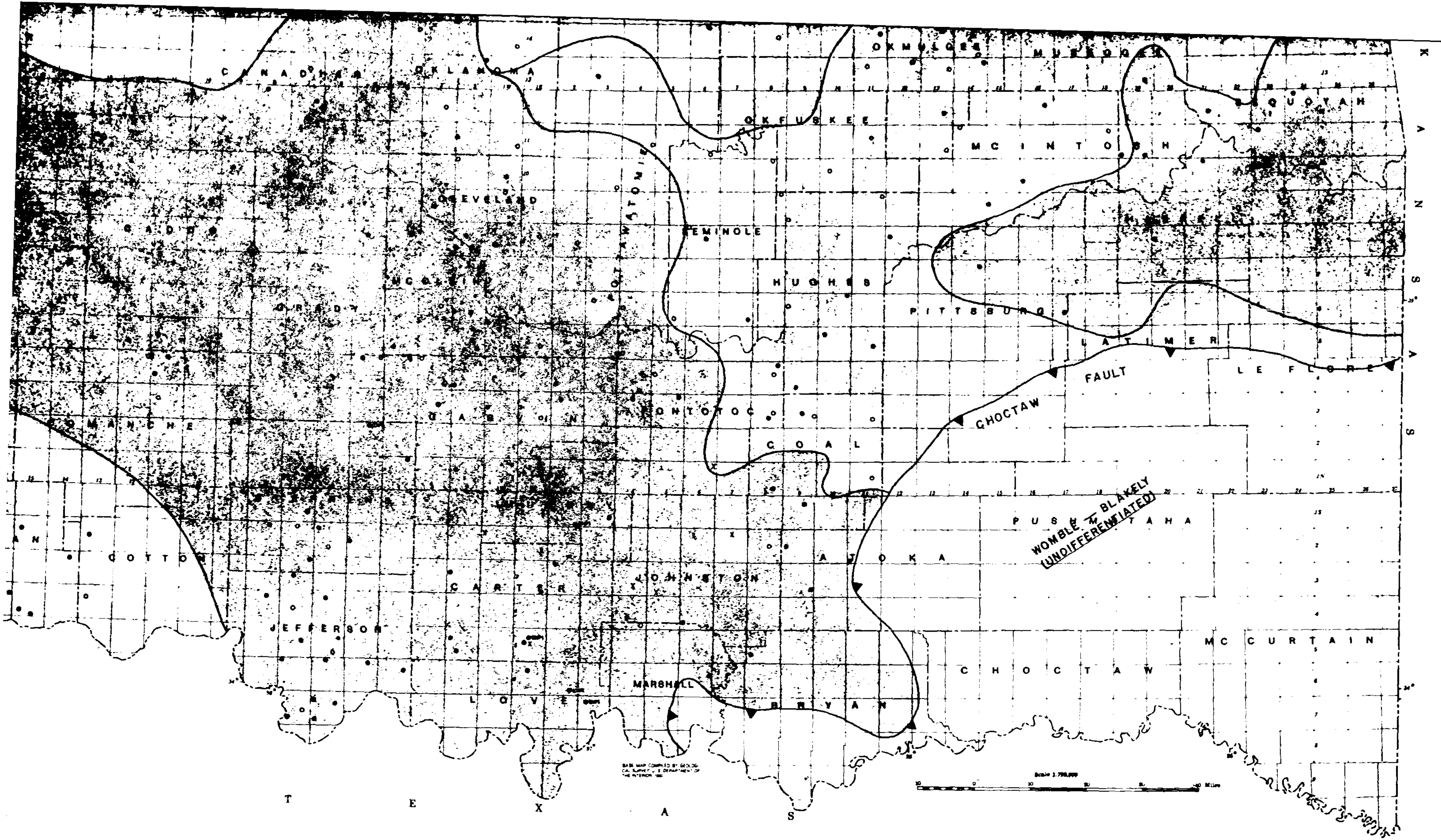
MAY, 1963



OKMULGEE
MUSKOGEE
SEQUOYAH
CANADIAN
OKLAHOMA
OKFUSKEE
MCINTOSH
CLEVELAND
SEMINOLE
CADDO
HUGHES
GRADY
PITTSBURG
LATIMER
LE FLORE
FAULT
CHOCTAW
PONTOTOC
COAL
COMANCHE
PUSHMATAHA
WOMBLE - BLAKELY
(UNDIFFERENTIATED)
COTTON
ATOKA
CARTER
JOHNSTON
JEFFERSON
MC CURTAIN
CHOCTAW
MARSHALL
LOVE
BRYAN
TEXAS
KANSAS

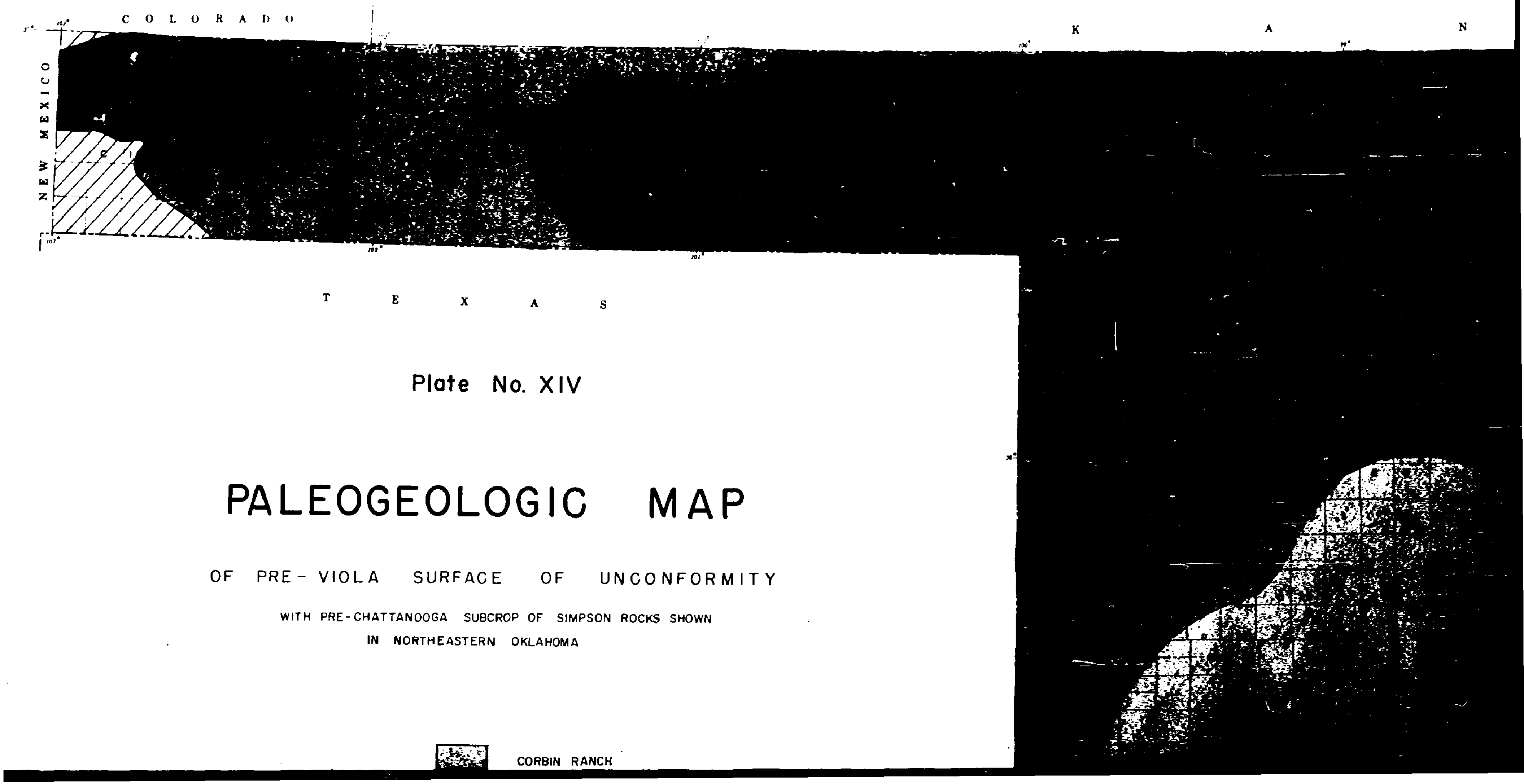
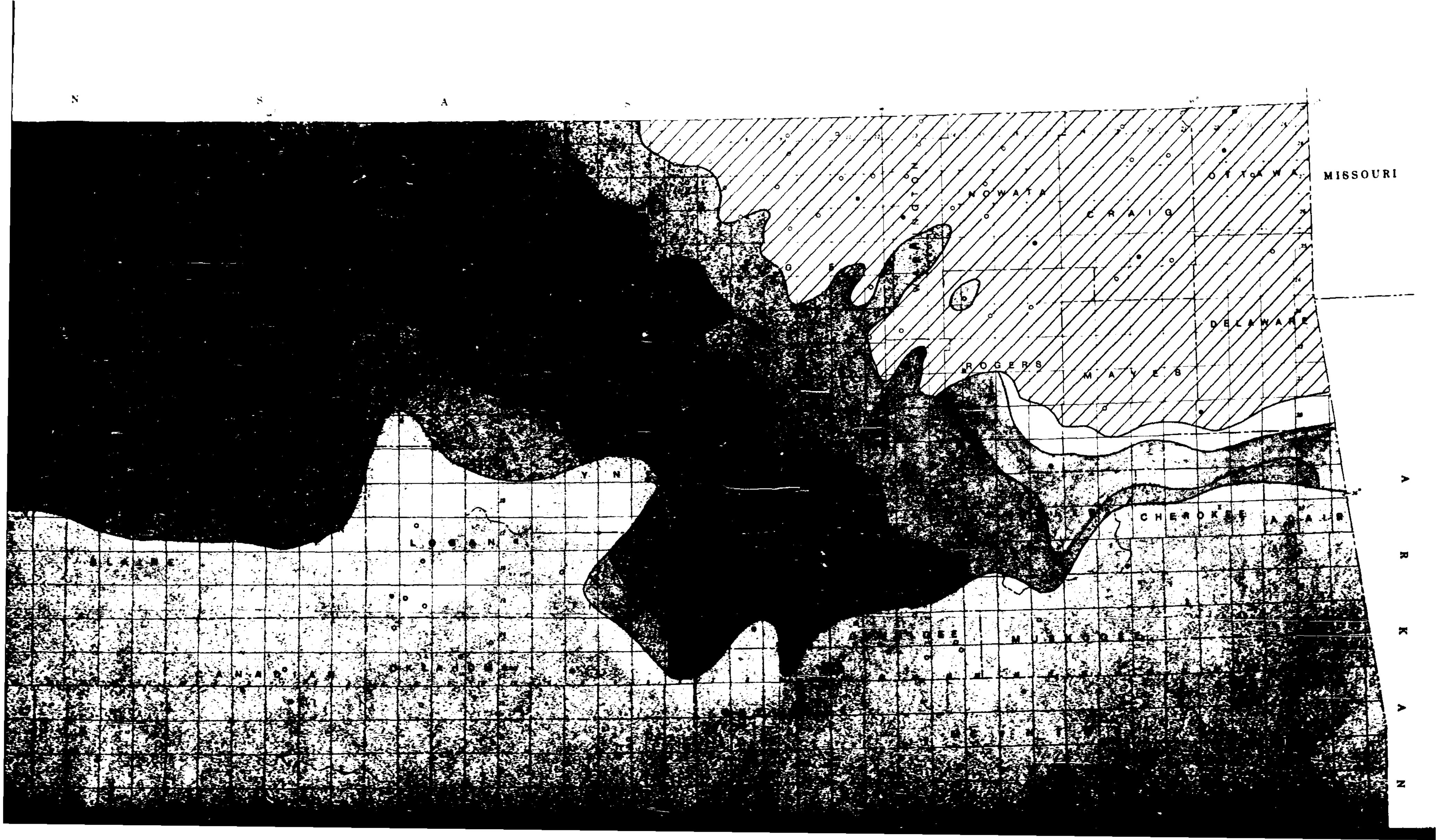


Plate No. XIV

PALEOGEOLOGIC MAP

OF PRE-VIOLA SURFACE OF UNCONFORMITY

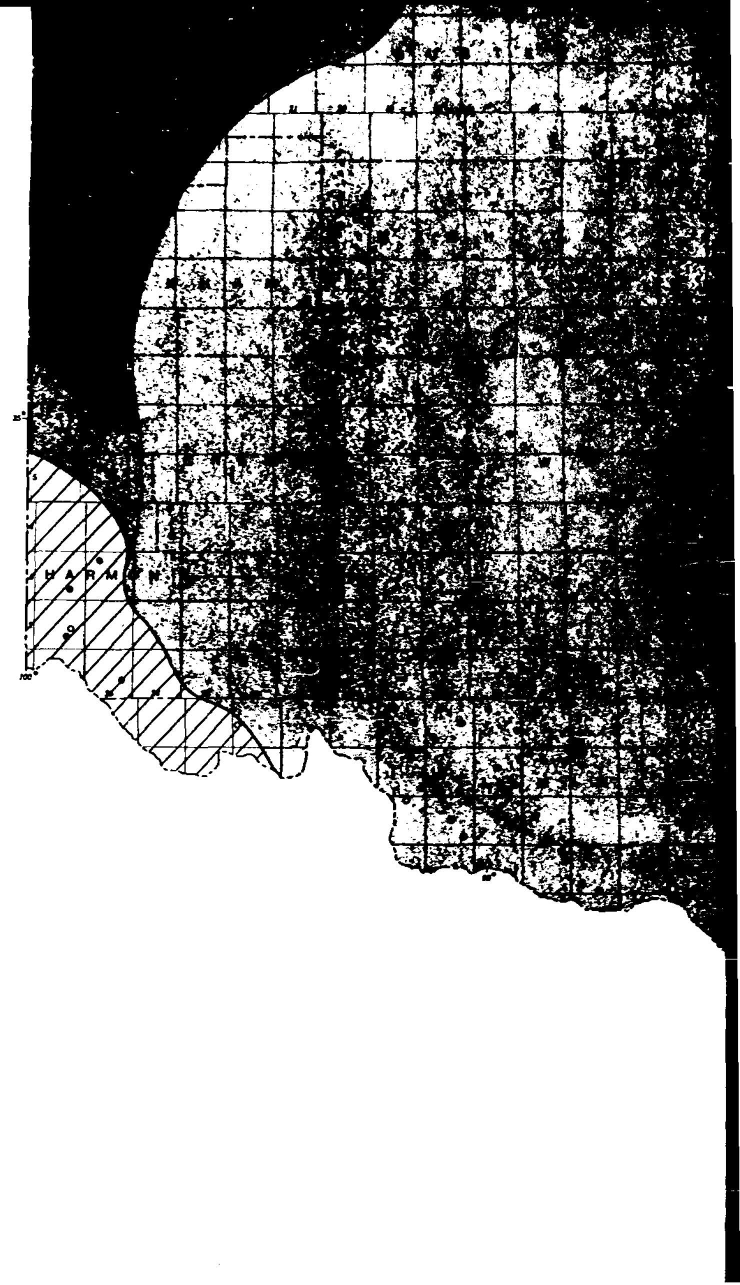
WITH PRE-CHATTANOOGA SUBCROP OF SIMPSON ROCKS SHOWN
IN NORTHEASTERN OKLAHOMA


MISSOURI
NOWATA
CRAIG
OTTAWA
DELAWARE
ROGERS
MAYES
CHEROKEE
LOGAN

OF PRE - VIOLA SURFACE OF UNCONFORMITY

WITH PRE - CHATTANOOGA SUBCROP OF SIMPSON ROCKS SHOWN
IN NORTHEASTERN OKLAHOMA

- CORBIN RANCH
- UPPER BROMIDE
- LOWER BROMIDE
- McLISH
- LOWER TYNER (OIL CREEK)
- BURGEN (OIL CREEK)
- ARBUCKLE - COTTER



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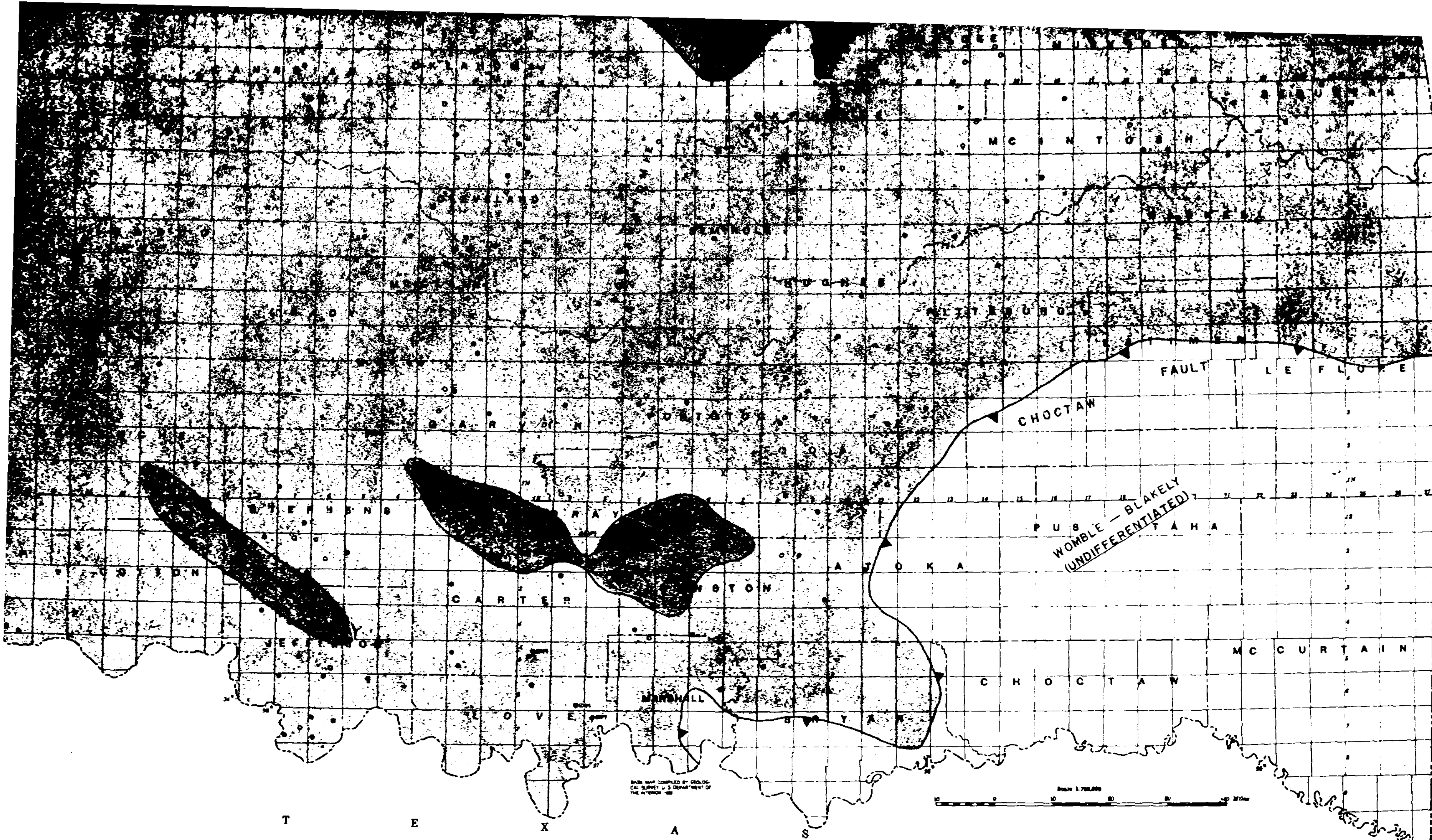
MAY, 1963


CHOCTAW FAULT
WOMBLE — BLAKELY
(UNDIFFERENTIATED)
MC INTOSH
LE FLORE
PUSHMATAHA
ATOKA
MC CURTAIN
CHOCTAW
BRYAN
MARSHALL
CARTER
LOVE
STEPHENS
ARKANSAS
TEXAS