SUBSURFACE GEOLOGY OF ROOKS COUNTY, KANSAS

by

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INTRODUCTION

Purpose of Investigation

The purpose of this investigation is to study the structure, stratigraphy and geologic history of Rocks County, Kansas and to relate these factors to the accumulation of petroleum. The author has several reasons for choosing this county. One, it is one of the leading oil producing counties in the state. Another reason is that this area is, geologically, a very interesting region. And finally, the distribution of wells is such that it provides an opportunity to work with an area that is densely populated with wells as compared with an area where the wells are farther apart.

Location and Physiography

Rooks County is in the second tier of counties south of the Kansas-Nebraska state line and is the fifth county east of the Kansas-Colorado state line. The county includes townships 6 to 10 south, ranges 16 to 20 west and an area of 900 square miles. The county is bordered on the east by Osborne County, on the south by Ellis County, on the west by Graham County and on the north by Phillips County.

The topography of Rooks County is one of low to moderate relief which is characteristic of the border region of the Great Plains physiographic province (Byrne, 1949). The county is drained by the South Fork Solomon River which flows eastward through the north central part of the county. Bow Creek flows eastward along the Rooks-Phillips county line and turns abruptly north and flows into Phillips County where it empties into the North Fork Solomon River just east of the center line of the county. Other minor streams within the county are: Lost Creek, Box Elder Creek, Elen Creek and Medicine Creek.

Procedure

The stratigraphy and lithology were obtained by reviewing the literature and by examination of Kansas Sample Log Service sample logs on file with the Kansas Geological Survey at the University of Kansas.

The Lansing-Kansas City group and the Arbuckle group were mapped because of their importance as petroleum producers within the county and their ability to show structurally significant factors. Tops of formations were obtained from Herndon maps for the most part and from drillers logs.

The structural map of the Arbuckle group was contoured using a contour interval of 20 feet. A smaller contour interval might have been used in the northern half of the county, however, this was not feasible for the county as a whole. Karst topography is found as a structural feature of the Arbuckle group in Rooks County.

The structural map of the Lansing-Kansas City group was contoured with a countour interval of 10 feet. A smaller contour interval might have been practical in certain areas of the county but not for the county as a whole. A larger contour interval would only have obliterated most of the structure.

An isopachous map was constructed of the interval between the top of the Lansing-Kansas City group and the top of the basal Pennsylvanian conglomerate. This map was contoured with a contour interval of 10 feet.

The clastic ratio map was constructed of the intervalbetween the top of the Lansing-Kansas City group and the top of the basal Pennsylvanian conglomerate with a contour interval of 0.02. The clastic ratio was obtained by dividing the thickness of clastics by the thickness of non-clastics. The result is expressed as a decimal value. A relationship is noted between the isopachous map and the clastic ratio map with, in most cases, the thicker zones on the isopachous map showing a low value on the clastic ratio map and the thinner zones on the isopachous map showing a higher value on the clastic ratio map. It is possible, since it was necessary to use the work of several people, that slight discrepancies did arise with separate people giving slightly diverse interpretations of the section.

Review of Literature

One of the first published reports that included Rooks County was a report by Darton (1905) on the geology and water resources of the central great plains. Twenhofel (1925) made a study of some of the minor structural features of the Cretaceous rocks. Further work by Bass (1926) was a report on the Dakota group of

Cretaceous age. Recent work by Byrne (1949) has covered the economic importance of outcrops in Rooks County.

Regional tectonic development was covered by Koester (1935) in an article on the Central Kansas uplift. The tectonic history of the Salina basin was given by Lee (1956). Moore and Jewett (1942) gave a regional review of the pre-Mississippian geologic history. Merriam (1955) gave a history of the Hugoton embayment. Jewett (1951) gave a general review of the geologic structures in Kansas.

The stratigraphy of Kansas was detailed by Moore et al. (1951). Farquhar (1957) made a study of the pre-Cambrian rocks. The stratigraphy of Cambrian-Ordovician rocks was given by Keroher and Kirby (1948). Merriam (1955) discussed the history of Jurassic rocks in Kansas. A discussion by Swineford (1947) gave the stratigraphy of several formations of the Cretaceous. Frye et al. (1956) gave an outline of the stratigraphy of the Ogallala formation of Tertiary age.

STRATIGRAPHY

Pre-Cambrian Rocks

The pre-Cambrian rocks of Kansas are believed to have formed during two periods of granitic intrusion (Farquhar, 1957). The chief constituents of the pre-Cambrian rocks in Kansas are granite and quartzite with minor amounts of schist, gneiss and phyllite. The pre-Cambrian rocks of Rooks County are mainly granites. This has been determined by drilling because there are no exposed pre-Cambrian rocks in Kansas.

Cambrian System

Waucoban and Albertan Series. There are no rocks known to be of Waucoban or Albertan age in Rooks County.

Croixan Series. The Reagan (Lamotte) sandstone of Croixan age is the basal formation of this series. The Reagan sandstone overlies the deeply weathered pre-Cambrian surface throughout much of the area covered by this investigation. The Reagan sandstone is fine to course grained, poorly sorted, rounded, frosted and pitted with considerable arkosic material at the base of the formation. The thickest section of Reagan sandstone that was discovered by drilling in Rooks County was 40 feet.

The Bonneterre dolomite overlies and is conformable with the Regan sandstone throughout most of Rooks County. In the eastern section of Rooks County the Bonneterre dolomite lies uncomformably upon the pre-Cambrian surface. The Bonneterre dolomite is pink, red and red-brown, and coarsely crystalline. It has sandy dolomite at its base that contains some feldspathic material particularly where it is in contact with the pre-Cambrian surface. The distinction between the Bonneterre dolomite and the overlying Arbuckle group is very slight.

The Eminence dolomite, the final Cambrian deposit in Kansas, is not present in Rooks County.

Ordovician System

Lower Ordovician. Arbuckle Group. The Arbuckle group consists of the Gasconade dolomite, the Van Buren formation, the Roubidoux dolomite, the Cotter and Jefferson City dolomites in ascending order.

The Gasconade dolomite and Van Buren formation are missing in Rooks County. The Roubidoux dolomite unconformably overlies the Bonneterre dolomite. The Roubidoux dolomite consists of a pink, coarsely crystalline, sandy dolomite with rounded sand grains that are polished or frosted. It has a maximum thickness of 250 feet in Rooks County. The undifferentiated Jefferson City-Cotter dolomites overlie the Roubidoux dolomite in the southern part of the county. These dolomites are white to gray, dense and argillaceous dolomites that range in thickness from 0 to 125 feet.

Middle Ordovician. Simpson Group. The Simpson group, found only as an inlier in southern Rooks County, unconformably overlies the Arbuckle group. The group consists of white to green shales and angular to sub-rounded, glauconitic, slightly dolomitic sandstones. The thickness is from a feather-edge to 75 feet.

Viola Group. The Viola group is found in the eastern end of the area under investigation and unconformably overlies the Simpson group. It consists of white, buff, and/or gray, cherty dolomites and limestones and has a thickness ranging from a beveled edge to 70 feet. It has been removed from the Central Kansas uplift by post-Viola uplift and erosion.

Silurian, Devonian and Mississippian Systems

No rocks of Silurian, Devonian and Mississippian age are recognized in Rooks County. The Hunton limestone of Silurian and Devonian age is found east of the area under investigation. Rocks of Mississippian age are recognized both to the east and west of Rooks County.

Pennsylvanian System

Morrowan and Atokan Series. No rocks of Morrowan or Atokan age are found in Rooks County.

Desmoinesian Series. Marmaton Group. The oldest formation of Pennsylvanian age in Rooks County is the basal Pennsylvanian conglomerate (Sooy conglomerate). Its exact age has not been determined, however, it appears to be of Marmaton age in Rooks County. There is also the possibility that a portion of this formation may be of Cherokee age. This basal conglomerate formation consists of chert and quartz grains mixed with variecolored shales. Otherwise the Marmaton group consists of limestones, shales and sandstones and has a thickness of 0 to 100 feet in Rooks County. The limestones are gray, dense and fossiliferous. The shales are gray to black, fissile, clayey and fossiliferous in part. The sandstones are buff to gray, fine grained and thin bedded.

Missourian Series. Pleasanton Group. The Pleasanton group is not represented in Rooks County.

Kansas City Group. The Kansas City group consists of thin-bedded limestones and shales. It is the first group to completely cover Rooks County in Pennsylvanian time. The Zahar subgroup, Linn subgroup and Bronson subgroup, in ascending order, comprise the Kansas City group in the subsurface of Rooks County. It is very difficult to differentiate the Kansas City group from the overlying Lansing group in well samples. The Kansas City group consists of limestones that are massive, fossiliferous and oolitic in part. The shales are gray to black, clayey and slightly calcareous. This group is 100 feet thick.

Lansing Group. The Lansing group overlies the Kansas City group and consists of thin beds of limestone and shale. The limestones are white to gray, finely crystalline and slightly fossiliferous. The shales are gray to black, slightly sandy and clayey. The total thickness of the Lansing group is 100 feet.

Pedee Group. The Pedee group consists of the Iatan limestone and the Weston shale. The Iatan limestone is white to buff, finely crystalline and fossiliferous. The Weston shale is dark gray and unfossiliferous.

<u>Virgilian Series</u>. Douglas Group. The Douglas group unconformably overlies the Pedee group and consists of sandstones and shales. The sandstones are tan to gray, massive and cross-bedded in part. The shales are gray, calcareous and locally sandy. The Douglas group is 20 feet thick in Rooks County.

Shawnee Group. The Shawnee group overlies the Douglas group and consists of cyclic deposits of limestone and shale. The most distinctive formation of the Shawnee group is the Topeka limestone at the top of the group. The limestones are white to gray, finely crystalline and fossiliferous. The shales are gray, clayey and sandy. The Shawnee group is 200 feet thick.

Wabaunsee Group. The Wabaunsee group is made up of the Richardson subgroup, Nemaha subgroup and Sacfox subgroup. The limestones are gray, soft to medium hard, massive and fossiliferous. The shales are gray, sandy, micaceous and calcareous. The Wabaunsee group attains a thickness of 400 feet in Rooks County.

Permian System

Wolfcampian Series. Admire Group. The Admire group consists of limestones and shales that were laid down in cyclic order in the same fashion as the preceeding Pennsylvanian sediments. This group consists of gray limestones and red, green and gray shales and it rests unconformably upon the Pennsylvanian rocks. The Admire group is 50 feet thick in Rooks County.

Council Grove Group. The middle group of the Wolfcampian series is the Council Grove group. Deposition of thin beds of limestone and shale continued in Council Grove time. It consists of white to gray limestones and red, green and gray shales. The Americus limestone member of the Foraker limestone is the bottom zone of this group and it is recognized because of its bluish-gray color and the abundance of fusulinids and brachiopods. The Council Grove group is about 260 feet thick.

Chase Group. The Chase group is comprised of limestones and shales. The shales are gray and varicolored, calcareous, fossiliferous and clayey. The limestones are white to gray, dense, cherty, slightly argillaceous and fossiliferous and clayey. The limestones are white to gray, dense, cherty, slightly argillaceous and fossiliferous in part.

Leonardian Series. Nippewalla Group. The Nippewalla group consists of shales, sandstones and evaporites. The shales are red, silty and gypsiferous in part. The sandstones are red, silty and feldspathic in part. The evaporites are deposits of gypsum. This group is 300 feet thick in Rooks County.

Sumner Group. The Sumner group consists of dolomites, evaporites and shale. Three distinctive formations are represented in this group. They are the Wellington formation, the Minnescah shale and the Stone Coral dolomite in ascending order. The Wellington formation consists of gray shale with the Hutchinson salt member in the middle of the formation. The overlying Ninnescah shale is predominently red silty shale. The Stone Coral dolomite is made up of dolomite, gypsum and anhydrite. It is an excellent marker on electric logs.

Triassic System

The Dockum (?) group of Triassic age is found in the southwestern corner of Kansas, however, no rocks of this system are found in Rooks County.

Jurassic System

The Morrison formation is the only unit of Jurassic age found in Kansas. In Rooks County it is found in the northwestern corner of the county and unconformably overlies the eroded Permian surface. It consists of sandy shales that is characterized by a greenish gray color with other colors such as buff, brown, red and purple. Sand grains are distributed randomly through the shale. The sand is very fine to fine grained, subrounded to rounded and are clear or white quartz. The chert and anhydrite so characteristic of the Morrison formation in the western border counties of Kansas are absent in Rooks County. The Morrison formation in Rooks County is 100 per cent clastic and is believed to be of continental origin. The thickness of the Morrison formation is from a beveled edge to 20 feet in thickness.

Cretaceous System

Commanchean Series. The Cheyenne sandstone is the basal formation of the Commanchean series in Rooks County. This formation rests unconformably upon the Permian surface everywhere but the northwestern corner of the county where it rests unconformably upon the Morrison formation of Jurassic age. This sandstone is probably a non-marine deposit as indicated by the presence of continental flora fossils. The Cheyenne sandstone consists of a gray, argillaceous, fine grained sandstone. The Kiowa shale overlies and is conformable with the Cheyenne sandstone. The Kiowa shale consists of a gray, micaceous and silty shale. This shale is a marine deposit as indicated by the abundance of marine fossils.

Merriam (1957) reorganized the lower Cretaceous terminology of Kansas. He changed the name of the Dakota formation to the Omadi formation. The Dakota formation has been given the rank of group which includes the Cheyenne sandstone and the Kiowa shale of Commanchean age and the Omadi formation of Gulfian age. However, because of the comparative newness of this terminolgy change it is felt advisable, at this time, to use the old terminology.

Gulfian Series. Dakota formation. The Dakota formation unconformably overlies the Kiowa shale. It consists of nonmarine sandstone and shales. The sandstones are white to reddish brown, fine to medium grained, sub-rounded to rounded and argillaceous. The shales are predominantly gray and micaceous. Both the sandstones and shales are notably lacking in calcareous content.

Colorado Group. The Colorado group consists of the Graneros shale, Greenhorn limestone, Carlile shale and Niobrara formation in ascending order. The Graneros shale is a black, fissile and non-calcareous shale. The Greenhorn limestone consists of gray chalky limestone with calcareous shale partings. The Carlile shale overlies the Greenhorn limestone and consists of gray to black, clayey shale. The Blue Hill shale member of the Carlile shale is the oldest exposed unit in Rooks County. The Niobrara formation is conformable with the Carlile shale and consists of the Smoky Hill chalk member overlying the Fort Hays limestone. The Smoky Hill chalk member is a marine deposit consisting of beds of gray, chalky shale and thin beds of gray, massive chalk. The Fort Hays limestone is a marine deposit. It is a light gray, soft, chalky limestone separated by thin beds of chalky shale. The Niobrara formation has a thickness of from 0 to 350 feet in Rooks County.

Tertiary System

Pliocene Series. The Ogallala formation represents the only Tertiary deposit found in Rooks County. It is a continental deposit which was formed by eastward flowing streams which headed in the Rocky Mountain area. It consists of the Kimball, Ash Hollow and Valentine members. The Ogallala formation consists of sands, silts and gravels with thin beds of limestone and volcanic ash also present. The thickness of the Ogallala formation is 0 to 175 feet. The Ogallala formation is an unconformable deposit upon the Cretaceous deposits. However, it is only found on the upland divides in Rooks County. The main part of the Ogallala formation has been removed by post-Ogallala erosison.

Quaternary System

The Quaternary system is represented by the Meade formation, the Sanborn formation, sand dunes and alluvium. The Meade formation consists of sands, silts and clays with the distinctive

Pearlette volcanic ash bed which is present as lentils within the Sappa member. The overlying Sanborn formation consists of sands and silts and contains eolian deposits in part. The overlying dune sands and alluvium are of wind and stream origin respectively and are of Recent age.

STRUCTURE

Major Structural Features

Kansas can be considered an epirogenic area. The major structural features that played an important role in the geologic history of the area are shown in Fig. 2 (Appendix).

Central Kansas Uplift. The term Central Kansas Uplift was first used by Morgan (1932) for the post-Mississippian uplift found in west-central Kansas. This name replaced the term Barton Arch which was first proposed by Barwick (1928).

The Central Kansas Uplift is a northwest-southeast trend-anticline located on an arc of uplift extending from the Black Hills area to the Ozark Uplift. The Central Kansas Uplift is bounded on the east by the Salina basin, on the south by the Sedwick basin, on the west by the Hugoton embayment and on the north by an unnamed saddle that separates the Central Kansas Uplift from the Cambridge Arch. This arc of uplift includes, in addition to the Central Kansas Uplift, the Chatauqua Arch in southeastern Kansas, the Cambridge Arch in northwestern Kansas and the Chadron Arch in Nebraska. The trend of the axis of the Central Kansas Uplift is slightly more toward the north than the pre-Mississippian Ellis Arch. The Central Kansas Uplift also has a narrower width than the Ellis Arch. These are means of differentiating one from the other.

Uplift of the Central Kansas Uplift occurred in Pennsylvanian, and lower Permian time but probably no later than the deposition of the Hutchinson salt member (Lee, 1956). There is also a possibility that the uplift began in late Mississippian (Chesteran) time but this is not certain.

Hugoton Embayment. The Hugoton embayment is a northward extending embayment of the Anadarko Basin in Oklahoma. It is located in the panhandles of Texas and Oklahoma, southwestern Kansas and southeastern Colorado. The embayment is delineated by the Central Kansas Uplift, the Cambridge Arch, the Las Animas Arch, the Sierra Grande Uplift, the Amarillo and Pratt anticlines. These positive areas served as source areas at various times throughout the depositional history of the embayment. The initial downwarp of the embayment apparently began in pre-Cambrian time with other major diastrophic events occurring in post-Arbuckle, post-Viola, post-Chesteran, post-Morrowan and post-Permian times (Merriam, 1955).

Maher and Collin (1948) applied the term Hugoton embayment to replace McClellan's (1930) name for this area of the Dodge City Basin.

Salina Basin. The Salina Basin is located in north-central and central Kansas and is bordered on the east by the Nemaha Uplift, on the south by an unnamed saddle that separates it from the

Sedwick Basin, and on the west by the Central Kansas Uplift. Barwick (1928) named this structure.

The area in Kansas that is occupied by the Salina Basin today was in pre-Simpson time the location of the Southeast Nebraska Arch (Lee, 1956). Differential subsidence began in post-Simpson time. Diastrophism, at the close of the Devonian, formed the Ellis Arch and the Chatauqua Arch and the North Kansas Basin was developed to the north and east of these structures, respectively (Barwick, 1928). The dip of the Mississippian beds is generally to the north. In post-Mississippian time the Central Kansas Uplift and the Nemaha Uplift arched and formed the Salina Basin. At the close of the Permian period the Salina Basin along with the Central Kansas Uplift were tilted westward toward the Hugoton embayment and in post-Cretaceous time it was tilted northwest toward the Denver Basin (Lee, 1956).

<u>North Kansas Basin.</u> The North Kansas Basin was first described as a pre-Mississippian Basin by Rich (1933) for an area east of the Ellis Arch and north of the Chatauqua Arch. The area was a positive area known as the Southeast Nebraska Arch prior to the end of St. Peter time when differential subsidence started and the North Kansas Basin developed (Lee, 1956).

<u>Ellis and Chatauqua Arches</u>. Different names have been applied to these two pre-Mississippian uplifts at various times. Barwick (1928) named the Chatauqua Arch for the extension of the Ozark Uplift into Kansas. Rich (1933) proposed the name Central Kansas Arch for the arch extending from the Ozark

Uplift into Norton County, Kansas. The Ellis Arch was suggested by Moore and Jewett in 1942 for the ancestral Central Kansas Uplift. The Ellis Arch is bounded on the east by the North Kansas basin, on the south by an unnamed saddle that separates the Ellis Arch from the Chatauqua Arch and on the west and southwest by the Southwest Kansas Basin. The names of Ellis Arch and Chatauqua Arch have come into general usage in the literature.

At the close of the Devonian the Ellis Arch was uplifted and eroded down to the Arbuckle. At this time the Ellis and Chatauqua Arches were connected for the one and only time.

Minor Structural Features

Russell Rib. The Russel Rib is a structural high that is reflected in Ordovician and pre-Ordovician rocks. It begins in southwestern Ellsworth County and extends northward through Russell County where it turns northwestward and cuts across northeastern Ellis County and into Rooks County (Koester, 1935). In Rooks County it shows in township 10 south, range 16 west on the structural map of the Arbuckle group, Fig. 9 (Appendix), and has the appearance of a horst with faulting on either side.

Stockton Anticline. The Stockton anticline was named by Bass in 1926 (Jewett, 1951) for a fold found in the Cretaceous rocks of Ellis, Rooks and Phillips Counties.

GEOLOGICAL HISTORY

Pre-Cambrian Era

The Pre-Cambrian Era is the least known, geologically, of all the eras in Kansas. This is due primarily to the comparatively few wells that have been drilled to the Pre-Cambrian and no outcrops of Pre-Cambrian rocks in Kansas have been found. Both igneous and metamorphic rocks make up the Pre-Cambrian in Kansas with granite, schist, gneiss and quartzite the most prevalent types. Walters (1946) has indicated that the intrusion of igneous rocks caused the metamorphism of pre-existing sediments. Farquhar (1957) found that there were two periods of granitic intrusion. The earlier granite intruded into sediments either before or during regional metamorphisis and received the same metamorphic impress as the sediments. The later granitic intrusives, of batholithic dimensions, cut across the metamorphic rocks in what appears to be a series of intrusions and not just one. In general it can be said of the Pre-Cambrian surface, as found today, that the igneous rocks are found on the uplifts and the metamorphics in the basins. Extensive erosion followed well into Cambrian time in which the Pre-Cambrian surface was reduced to a peneplain with low monadnock hills.

Paleozoic Era

The Croixan seas transgressed across Kansas, reworked the weathered material of the Pre-Cambrian surface and deposited the

Lamotte (Reagan) sandstone. The Lamotte sandstone may have been a sheet type of deposit as suggested by Merriam and Atkinson (1955) however, because of the lack of wells that have been drilled to the Lamotte this can only be theorized. The Lamotte sandstone grades upward into and is conformable with the Bonneterre dolomite. The Lamotte sandstone is present in the western two-thirds of Rooks County. In the eastern part of Rooks County the Bonneterre dolomite rests unconformably upon the Pre-Cambrian surface. Keroher and Kirby (1948) believed that the Lamotte sandstone was never deposited in this area because of the Southeast Nebraska Arch located in the central part of Kansas. Later the Bonneterre seas overlapped the area of Lamotte sandstone deposition. Pre-Roubidoux erosion removed any sediments that may have been deposited after the Bonneterre dolomite and subjected the Bonneterre dolomite to erosion before the Ordovician rocks were deposited.

The Roubidoux formation, Jefferson City and Cotter dolomites were deposited in early Ordovician time. The Arbuckle, in Rooks County, was deposited on a broad flank of a syncline that developed to the south as shown by a thickness map of Lee (1956). The Roubidoux formation unconformably overlies the Bonneterre dolomite throughout the country. Post-Roubidoux erosion has thinned the Roubidoux in the northern half of the county to one-tenth the thickness in the southern half of the county. The undifferentiated Jefferson City-Cotter sequence rests unconformably upon the Roubidoux formation in the southern half of the county and is missing in the northern half of the county. After the Cotter dolomite was deposited the beds in northern Kansas were elevated and truncated. All of the Jefferson City dolomite, Cotter dolomite and part of the Roubidoux formation were removed from the northern half of the county and the Cotter dolomite was probably removed from all of the county (Keroher and Kirby, 1948). Movement of the Ellis Arch occurred at this time. Whether or not this was the initial movement of the Ellis Arch is problematical. There is a possibility that the initial movement took place at some time in pre-Arbuckle time. The Arbuckle group is 1000 feet thick on the Chatauqua Arch where it is overlain by Mississippian rocks. The Arbuckle group on the Central Kansas Uplift is only 250 feet thick. The difference may represent approximately the amount removed from the Central Kansas Uplift by post-Mississippian erosion (McClellan, 1930).

The seas advanced again and the Simpson group was deposited. This was followed by a period of erosion in which all of the upper Simpson (Platteville formation) was removed and the St. Peter sandstone was deeply weathered and removed. Simpson beds are absent in Rooks County except for an inlier that is found in the southern part of the county (Koester, 1935).

The seas returned and deposited the Viola limestone unconformably upon the Simpson, however, all but a small area in the eastern part of the county has been removed by post-Viola erosion. This brought to a close the Ordovician period.

No deposits of Silurian, Devonian and Mississippian age have been found in Rooks County. Silurian and Devonian rocks are missing below Mississippian sediments just east of Rooks County. This would seem to indicate that if there had been Silurian-Devonian deposition it was removed in pre-Mississippian time. There is considerable doubt, however, whether any Silurian or Devonian sediments were ever deposited. They are found in the deeper parts of the Salina Basin but are absent on the western side of the basin, the Central Kansas Uplift and westward in the Hugoton embayment (Merriam, 1955). At the close of Devonian time the Ellis Arch was uplifted for the final time and eroded.

No Mississippian deposits are found in Rooks County. It appears, however, that Mississippian sediments were deposited in this area at one time. Walters (1946) has stated:

> From the present widespread deposition of the Mississippian rocks on all sides of the Central Kansas Uplift and from their extensive truncation by late Mississippian and early Pennsylvanian erosion it is reasonable to infer that beds of Mississippian age formerly covered this area.

Uplifting in post-Mississippian time, in a somewhat more northerly direction than the Ellis Arch, produced the Central Kansas Uplift (Eardley, 1951).

With the beginning of Pennsylvanian time the seas were depositing Morrowan and Atokan rocks to the south in the Hugoton embayment (Merriam, 1955).

The Desmoinesian seas occupied the Salina Basin and the Cherokee and Marmaton groups were deposited on the flank of the Central Kansas Uplift with the Marmaton overlapping the Cherokee.

The basal Pennsylvanian conglomerate may, in part, be of Cherokee age. The area was subjected to erosion before the Missourian seas advanced. The Pleasanton group was deposited on the flank of the Central Kansas Uplift and overlapped the weathered Marmaton group. With the deposition of the Lansing and Kansas City groups the Central Kansas Uplift appears to have been completely inundated for the first time in the succession of Pennsylvanian sediments (Lee, 1956). However, it apparently did not take place until the middle of upper Kansas City time.

The Virgil series that followed continued to lay down cyclic sediments. The Wabaunsee group, the last of the Virgil rocks to be deposited in this area, was deeply eroded by the hiatus that separated the Wabaunsee group from the Permian as evidenced by cuttings from a well in sec. 6, T.7 S, R.20 W. (Lee, 1956).

The Central Kansas Uplift continued to arch contemporaneous with deposition during the Pennsylvanian period and into the Permian period as evidenced by the differential thinning of these sediments on the Central Kansas Uplift.

The Wolfcampian seas of lower Permian age inundated the area and deposited great thicknesses of this series. They consist of alternating shales and limestones. This was followed by the Leonardian seas which deposited sediments, primarily, of evaporitic nature. These are the final deposits of a dying sea that had, intermittently, covered this area for a long time in geological history. An outstanding example of this type of deposit is the Hutchinson salt member of the Wellington formation which is found in the southern half of Rooks County where it has an unusual occurrence. The Hutchinson salt member is thickest on local anticlines that is apparently the result of movement of the plastic evaporites toward the high areas (Lee, 1956). Differential uplift of the Central Kansas Uplift was brought to a close at this time. No Guadalupian sediments appear to have been deposited, however, it is possible that they were eroded during the long hiatus that ensued.

The region of the Central Kansas Uplift was tilted westward in post-Permian times (Koester, 1935). Thus, with the withdrawal of the seas, the Paleozoic era came to a close.

Mesozoic Era

There are no rocks of Triassic age found in Rooks County. The Morrison formation of Jurassic age is found in the northwestern part of the county and is probably a non-marine deposit. The Morrison thickens into the Denver Basin which means that the area must have been tilted northwestward in pre-Morrison time. The present eastward limit in Rooks County apparently is erosional. Merriam (1955) has said: "As the coarser clastics, that normally would be present along a depositional pinch-out, are absent it is believed that the present margin of the Morrison formation represents an erosional boundary." Post-Morrison movement tilted the area slightly to the southeast.

The Cheyenne sandstone of the Comanchean series is the basal formation of the Cretaceous system in Rooks County. It represents a non-marine and littoral deposit that was laid down as the Cretaceous seas moved northward. It was deposited upon the deeply weathered Permian surface in most of Rooks County. The Kiowa shale that followed is of marine origin.

The seas retreated and then advanced again to deposit the Dakota formation which is continental and littoral in origin as evidenced by the plant fossils and land vertebrates that it contains (Moore, 1951). The seas covered the area and deposited the Graneros shale, Greenhorn limestone and the Niobrara formation which are all of marine origin. The end of the Mesozoic was marked by the retreat of the seas and the tilting of the area toward the northwest into the Denver basin (Merriam, 1955). Twenhofel (1925) believes that the structures in the chalk beds of the upper Cretaceous are the result of adjustment to movement of the underlying Cretaceous shales which in turn are adjusted to irregularities of the Permian surface. The deformation of the Mesozoic rocks in Rooks County took place sometime in post-Niobrara and brought a close to the Mesozoic era.

Cenozoic Era

During much of the Cenozoic era this area was subjected to subaereal erosion. The Ogallala formation, a fluvial type of sediment, was deposited in late Tertiary time. It was deposited on an alluvial plain by streams flowing eastward from the Rocky Mountains (Frye et al., 1956). Post-Ogallala erosion may have removed some of the formation from Rooks County. Pleistocene and Recent eolian and stream sediments overlie the eroded surface of the Cretaceous and Tertiary systems. Eolian and stream deposits continue to cover the area at the present time.

HISTORY OF DRILLING IN ROOKS COUNTY

The initial oil pool in Rooks County was the Laton pool which was discovered on July 5, 1927 with the completion of the Vickers Petroleum Company No. 1 Luhrman in the southwest corner of SE 1/4 of sec. 11, T.8S., R 16 W. It had an initial daily production of 238 barrels from the Lansing-Kansas City group. Through 1956 this oil pool had produced 4,869,448 barrels of oil.

The Laton and Webster oil pools were the two pools producing in Rooks County in 1930. By 1936 there were six pools in operation in Rooks County with an annual production of 40,831 barrels of oil. From 1937 to 1941 no new oil pools were discovered in Rooks County. In 1941 the Erway pool was opened.

Rooks County had, in 1946, more intensive study within its borders than any other county in the state for that year. In that year 66 wells were drilled in Rooks County. In 1950 nine new oil pools were discovered with one, the Kern, an Arbuckle group producer being brought in with a discovery well with an initial production of more than 3,000 barrels of oil per day.

At the close of 1956 Rooks County stood fifth in production in the state. For the past decade it had been among the top ten producing counties within the state. From 1927 through 1956 Rooks County has produced 67,069,840 barrels of oil.

DISCUSSIONS AND CONCLUSIONS

Lansing-Kansas City Group

The Alphin N. W., Baum, Belmont, Berland S., Flagler, Kruse, Kruse N. W., Laton, McClellan, Marc, Medicine Creek, Vohs, Vohs S, Whisman, Williams S. E., Yohe and Zurich Townsite pools show structural closure by closed contours. More than 30 feet of closure is found on the Baum, Kruse, Kruse N. W., Medicine Creek, Vohs and Zurich Townsite pools. Production from the Finnesy, Dorr, Williams N. W., and Riffe pools seems to be controlled by porosity traps because of the lack of contours.

The regional dip of the Lansing-Kansas City group is about five feet to the mile to the south. Lansing-Kansas City production does not extend below -1300 feet with a large segment of the production found above -1200 feet. The producing zone averages 15 feet in thickness throughout Rooks County.

In the northwestern corner of the county a fault is found. This fault seems to be the solution for the conjestion of contours. This fault is found to extend into Graham and Phillips Counties. It is a possible location for oil accumulation.

The structure of the Lansing-Kansas City group is one of shallow basins with small adjoining high areas. It is on these small high areas that most of the oil from the Lansing-Kansas City group is found.

In a great many instances the Lansing-Kansas City group reflects the structure of the Arbuckle group. In T 9 S., R. 18 W.

it will be noted, however, that some of the Karst topography as found in the Arbuckle group is not reflected in the Lansing-Kansas City group as much as might be expected. This is explained, possibly, by the filling in of these sink holes by the basal Pennsylvanian conglomerate.

Arbuckle Group

The Alliphin, Amboy S. W., Berland S. W., Brungardt N. W., Gick, Locust Grove, Lynd, S. W., Marcotte N., Marcotte S., Mayhew, Palco and Webster pools have closures of 20 to 40 feet. The Annon, Basett, Berland S. E., Berland S. W., Brungardt N. W., Kern, Locust Grove S. E., Lone Star S. W., Lynd, Palco S. W., Palco Townsite, Paradise Creek W. and Sweet pools produce from structure of less than 20 feet or they are porosity traps.

The Arbuckle production zone averages 8.5 feet in thickness and no production is found below -1580 feet.

The surface of the Arbuckle group is influenced by regional structures such as the Central Kansas Uplift and the Salina Basin as shown in Fig. 9 (Appendix). A karst topography is exemplified in T. 8 and 9 S., R. 18 W. The possibility exists that the Arbuckle group, where there is at present not enough control for detail contouring, would show karst topography if the control were provided.

In T. 6 S., R. 19 and 20 W. the Arbuckle group is locally absent. This would seem to indicate differential thinning in this area and exclude the possibility of any large scale production.

In T. 10 S., R. 16 W. a fault zone is found. This horst is the northward extension of the Russell Rib. It appears to be the solution for the conjestion of contours that are found in this area.

Future Potential

The possibility of any large scale development in Rooks County is rather remote at this time. This does not, however, preclude exploration of many still unexplored possibilities.

The brightest hope for future oil production in Rooks County is the Lansing-Kansas City group. The southwestern part of the county and certain areas in the eastern sector have been drilled out. This leaves a large portion of the county that has not been explored to the fullest extent. This is especially true of the northern half of the county.

Wells in the Brungardt, Ganong and Mt. Ayr pools produce from the basal Pennsylvanian conglomerate and there is hope for this formation in the future.

New Arbuckle production may be found in the southeastern sector of Rooks County where unexplored acreage lies high on the Central Kansas Uplift.

The prospects are high for some Reagan sandstone production such as that found in the Norton County oil field. One pool, the Ray S. E., produces from the Reagan sandstone in Rooks County. The rest of the few wells that have reached the Reagan sandstone, however, have been dry. In most areas of Rooks County the drill has not reached this formation. This leaves many unexplored possibilities.

The relatively unexplored western flank of the Salina Basin is a possibility for the future. Merriam and Goebel (1956) have said that future possibilities are combinations of structural and stratigraphic traps on the flanks of the Salina Basin.

ACKNOWLEDGMENTS

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APPENDIX

Table 1. Producing oil fields in Rooks County, Kansas

Field name and year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
Allphin ('53)	33-10-20W	Now called Trico			
Allphin Northwest ('54)	32-10-20W	Now called Trico			
Amboy Southwest ('55)	17-10-20W	Combined with Marcotte			
Annon ('51)	27-10-20W	Now called Trico			
Annon South ('56)	34-10-20W	Now called Trico			
Barry ('42)	11- 9-19W	127,802 433,780	8,256,154	17 49	Lans.-K.C. Arbuckle
Barry East ('47)	6- 9-18W	54,273	727,043	10	Lans.-K.C. Arbuckle
Barry Southeast ('46)	13- 9-19W	128,157	1,884,387	26	Lans.-K.C. Arbuckle
Bassett ('51)	20-10-20W	Now called Trico			
Baum ('42)	10-10-16W	1,356	25,700	1	Lans.-K.C.
Baumgarten ('50)	25- 9-19W	16,453 137,900	616,297	4 20	Lans.-K.C. Arbuckle
Belmont ('49)	28- 7-19W	1,840	16,765	1	Lans.-K.C.
Berland South ('51)	31-10-19W	Combined with Marcotte			

Table 1. (Cont'd)

Field name and year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
Berland Southeast ('53)	29-10-19W	16,144	74,060	3	Arbuckle
Berland Southwest ('49)	26-10-20W	Combined with Marcotte			
Brungardt* ('52)	35-10-17W	47,805	230,866	14	Lans.-K.C. Penn.congl. Arbuckle
Brungardt Northwest ('53)	34-10-17W	no report	14,090		Arbuckle
Burnette* ('37)	1-11-18W	99,326	1,634,834	25	Lans.-K.C. Arbuckle
Burnett Northwest* ('46)	3-11-18W	32,361	474,447	5	Lans.-K.C. Arbuckle
Carmichael ('55)	33- 8-18W	27,646	55,958	3	Lans.-K.C.
Colby ('53)	27-10-17W	no report	1,462		Lans.-K.C.
Cooper* ('43)	5-10-20W	176,218	1,579,085	35	Lans.-K.C. Arbuckle
Cresson ('56)	11- 9-20W	2,939	2,939	1	Arbuckle
Dancer ('52)	4- 8-17W	186	9,671	1	Lans.-K.C.
Dopita ('34)	31- 8-17W	349,883	2,182,834	72	Lans.-K.C. Arbuckle
Dopita East ('52)	29- 8-17W	49,841	206,501	9	Lans.-K.C. Arbuckle

Table 1. (Cont'd)

Field name and Year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
Dorr ('42)	20- 9-16W	147,656	1,114,531	37	Lans.-K.C.
Dorr South ('53)	20- 9-16W	18,250	52,664	5	Toronto Lans.-K.C.
Faubion ('36)	12- 6-18W	4,450	56,579	1	Lans.-K.C.
Fehnel ('52)	16-10-19W	7,263	49,994	2	Lans.-K.C.
Finnesy ('47)	10-14-18W	4,422	41,696	2	Lans.-K.C.
Flagler ('55)	15-10-18W	6,625	12,366	1	Lans.-K.C.
Ganoung ('53)	31- 9-17W	4,635	29,391	2	Lans.-K.C. Penn. congl.
Gick ('47)	30- 9-19W	32,465	290,735	8	Arbuckle
Gra-Rook ('48)	30- 9-20W	160,793	1,357,463	20	Penn. congl. Arbuckle
Gra-Rook North ('56)	18- 9-20W	10,931	10,931	4	Arbuckle
Grover ('50)	22- 7-19W	19,240	158,728	9	Lans.-K.C. Arbuckle
Hayden ('49)	31- 8-19W	56,245	615,408	13	Lans.-K.C. Arbuckle
Hillside ('52)	12- 8-20W	1,948	14,100	1	Shawnee

Table 1. (Cont'd)

Field name and Year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
Jelinek ('47)	23- 9-19W	24,115 560,507	4,464,361	3 80	Lans.-K.C. Arbuckle
Kern ('50)	28- 9-20W	42,162	318,960	5	Arbuckle
Krueger* ('48)	35-10-16W	43,363	547,896	12	Lans.-K.C. Arbuckle
Kruse ('51)	3-10-16W	20,125	278,657	11	Lans.-K.C.
Kruse Northwest ('53)	34- 9-16W	7,763	33,850	3	Lans.-K.C.
Laton ('27)	11- 9-16W	203,778	4,869,448	102	Lans.-K.C.
Laura* ('50)	30-10-20W	Combined with Cooper			
Laura Southeast ('52)	30-10-20W	Now called Trico			
Locust Grove ('49)	8- 7-19W	2,209	26,520	1	Arbuckle
Locust Grove Southeast ('51)	9- 7-19W	No report	4,525		Arbuckle
Lone Star ('48)	4- 8-17W	67,523	384,258	19	Lans.-K.C. Arbuckle
Lone Star Southwest ('51)	8- 8-17W	2,549	26,265	1	Arbuckle
Lynd ('51)	32- 9-19W	50,189	375,233	15	Arbuckle
Lynd Southwest ('52)	5-10-19W	8,334	13,359	1	Arbuckle

Table 1. (Cont'd)

Field name and Year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
McClellan ('45)	9- 9-19W	2,208	68,434	1	Arbuckle
McHale ('48)	8- 9-18W	26,802	458,215	8	Lans.-K.C. Arbuckle
Marc ('48)	18- 9-19W	843	19,618	2	Lans.-K.C.
Marcotte ('43)	15-10-20W	1,887,109	15,321,029	337	Lans.-K.C. Arbuckle
Marcotte North ('50)	31- 9-19W	Combined with Marcotte			
Marcotte South ('51)	22-10-20W	Now called Trico			
Marcotte Southwest ('51)	21-10-20W	Combined with Marcotte			
Mayhew ('51)	24- 9-19W	19,837	42,556	5	Arbuckle
Medicine Creek ('52)	18- 8-16W	2,927	26,335	3	Lans.-K.C.
Mt. Ayr ('52)	13-10-18W	579	11,507	1	Lans.-K.C. Penn. congl.
Muilenburg* ('49)	1-10-21W	Combined with Cooper			
Nettie ('48)	34- 9-17W	136,375	1,027,840	34	Lans.-K.C. Simpson Arbuckle
Nettie Southeast ('55)	2-10-17W	3,677	6,489	1	Lans.-K.C.

Table 1. (Cont'd)

Field name and Year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
Northhampton ('48)	26- 9-20W	16,558 414,798	3,570,018	2 55	Lans.-K.C. Arbuckle
Nutsch ('54)	3-10-20W	Combined with Marcotte			
Nyra ('46)	16- 9-17W	13,247	214,127	8	Lans.-K.C. Arbuckle
Palco ('43)	5-10-20W	Now called Cooper or Marcotte			
Palco Southeast ('49)	3-10-20W	Combined with Marcotte			
Palco Southwest ('51)	7-10-20W	Combined with Cooper			
Palco Townsite ('45)	20- 9-20W	2,829	38,735	2	Arbuckle
Paradise Creek ('47)	21- 9-18W	122,574	2,387,985	34	Lans.-K.C. Arbuckle
Paradise Creek West ('53)	20- 9-18W	49,958	157,170	5	Arbuckle
Plainville ('48)	31- 9-17W	2,928	32,871	1	Lans.-K.C. Arbuckle
Ray Southeast ('42)	9- 6-20W	2,434	87,180	1	Reagan
Riffe ('51)	4- 7-19W	7,961	49,532	2	Lans.-K.C.
Slate ('51)	31- 6-19W	6,781	34,126	3	Lans.-K.C. Arbuckle

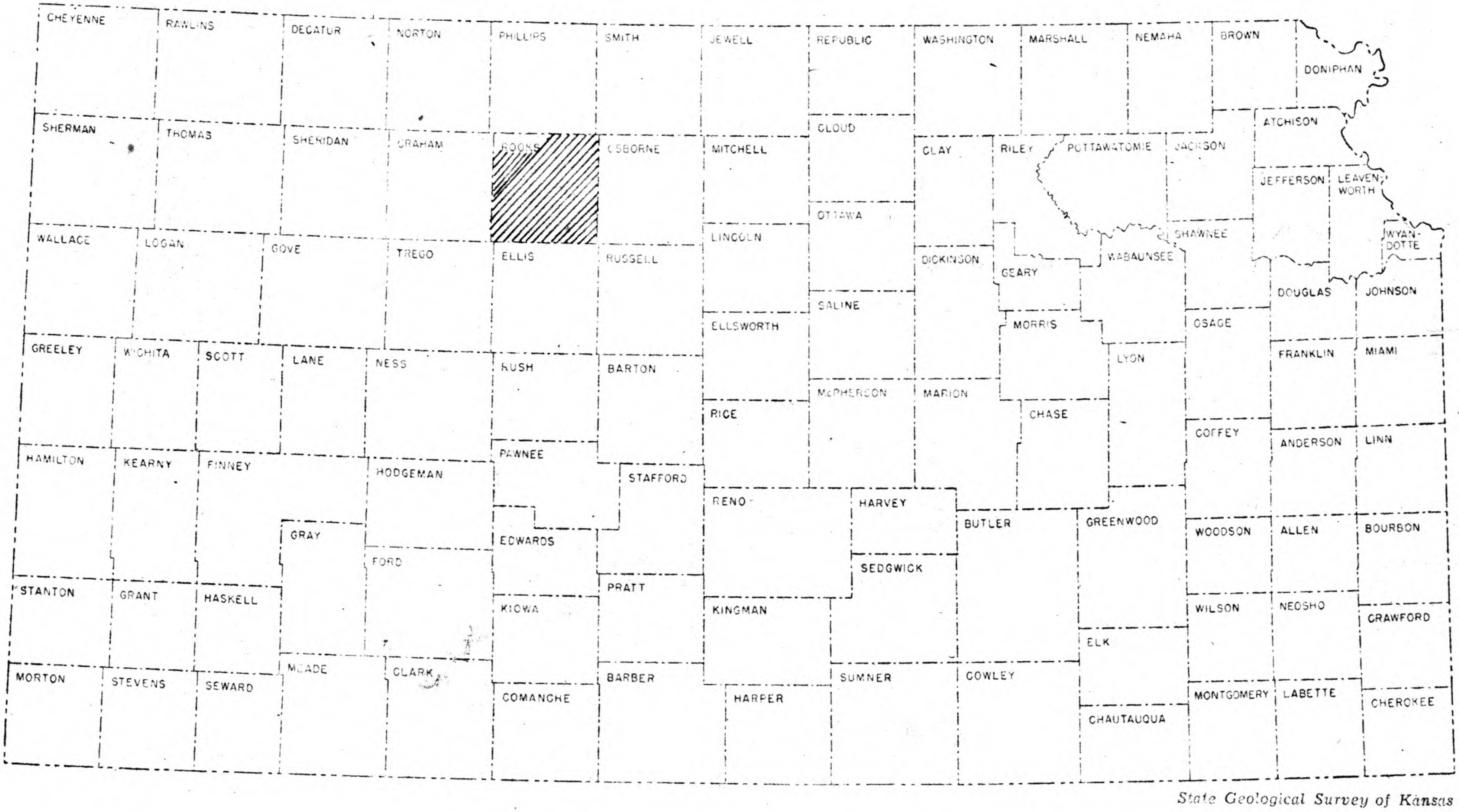
Table 1. (Cont'd)

Field name and Year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	Total	Producing Wells	Producing Horizon
Spaulding* ('53)	1-11-21W	Now called Trico			
Stamper ('50)	28- 8-17W	no report	910		Marmaton
Stockton ('37)	35- 7-17W	18,563	202,491	8	Shawnee Lans.-K.C.
Sweet ('51)	18- 8-18W	no report	4,738		Arbuckle
Trarbach ('56)	36-10-20W	Combined with Marcotte			
Trico* ('51)	30-10-20W	401,819	987,762	56	Lans.-K.C. Arbuckle
Vohs ('45)	14-10-19W	196,658	2,325,806	24	Lans.-K.C.
Vohs Northwest ('47)	9-10-19W	2,806	126,686	1	Lans.-K.C. Arbuckle
Vohs South ('47)	23-10-19W	no report	12,524		Lans.-K.C.
Webster ('46)	27- 8-19W	143,689	2,739,796	46	Shawnee Arbuckle
Westhusin ('36)	11- 9-17W	98,729	2,430,929	37	Lans.-K.C. Arbuckle
Whisman ('50)	9- 9-20W	no report	none		Lans.-K.C.
Williams ('53)	9-10-18W	64,564	284,821	9	Toronto Lans.-K.C. Simpson Arbuckle

Table 1. (Concl.)

Field name and Year of discovery	Location of Discovery Well	Oil Production, bbls. 1956	total	Producing Wells	Producing Horizon
Williams North ('56)	32- 9-18W	2,729	2,729	1	Simpson Arbuckle
Williams Northwest ('53)	6-10-18W	3,761	17,564	1	Lans.-K.C.
Williams Southeast ('53)	16-10-18W	44,631	102,638	6	Lans.-K.C.
Yohe ('49)	4- 9-18W	3,565	48,236	1	Lans.-K.C.
Zurich ('35)	26-10-19W	21,970	432,987	9	Shawnee Lans.-K.C.
Zurich Southwest ('52)	34-10-19W	3,842	19,991	1	Lans.-K.C.
Zurich Townsite ('44)	27- 9-19W	8,835 40,665	537,569	1 7	Lans.-K.C. Arbuckle
Pools or fields abandoned			96,885		
TOTAL ROOKS COUNTY		6,988,701	67,069,840	1,360	

*Denotes pools found partially in other counties.



AREA COVERED BY THIS REPORT —

Fig. 1. Location of area covered by this report.

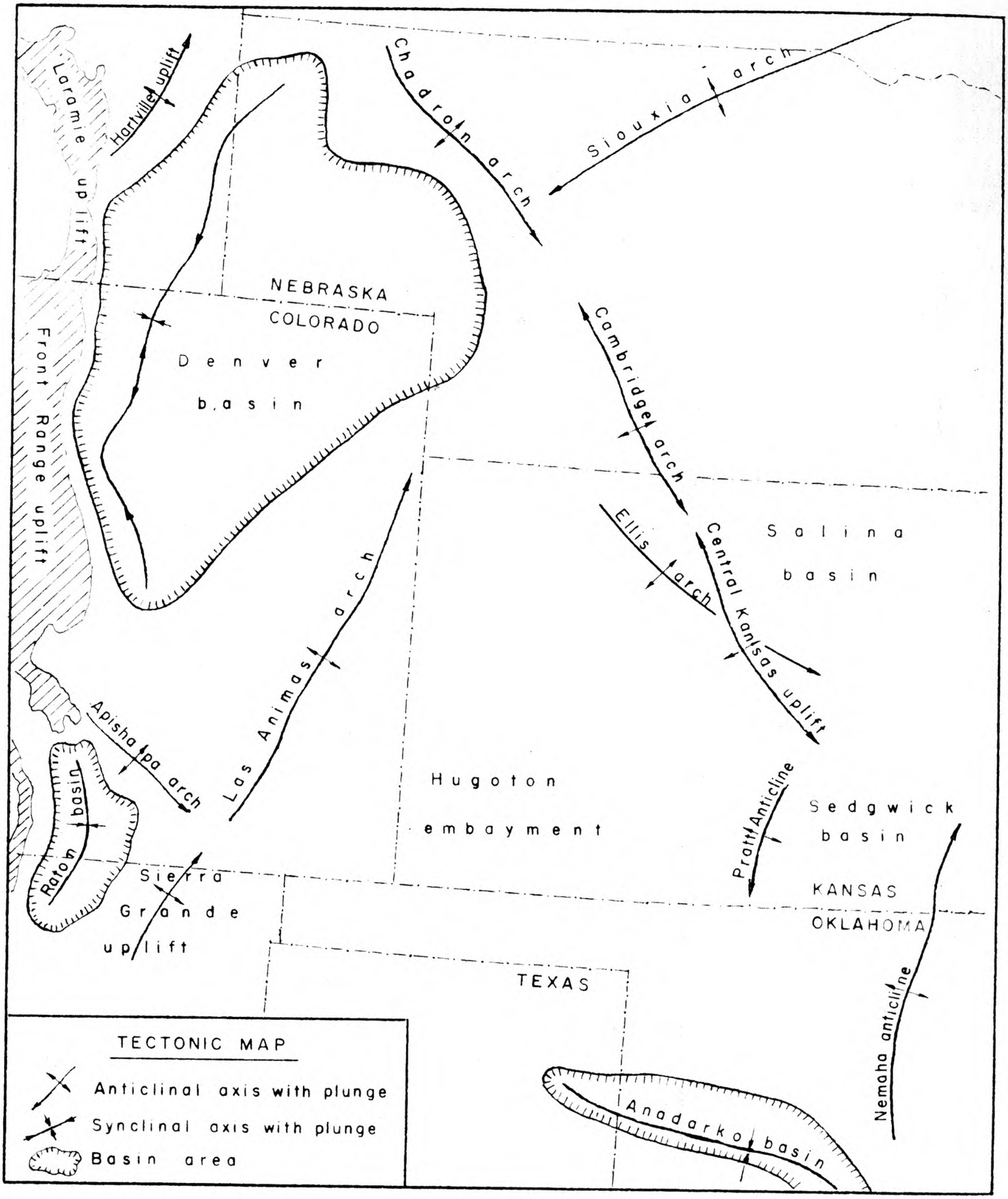


Fig. 2. Geographical distribution of major structures.

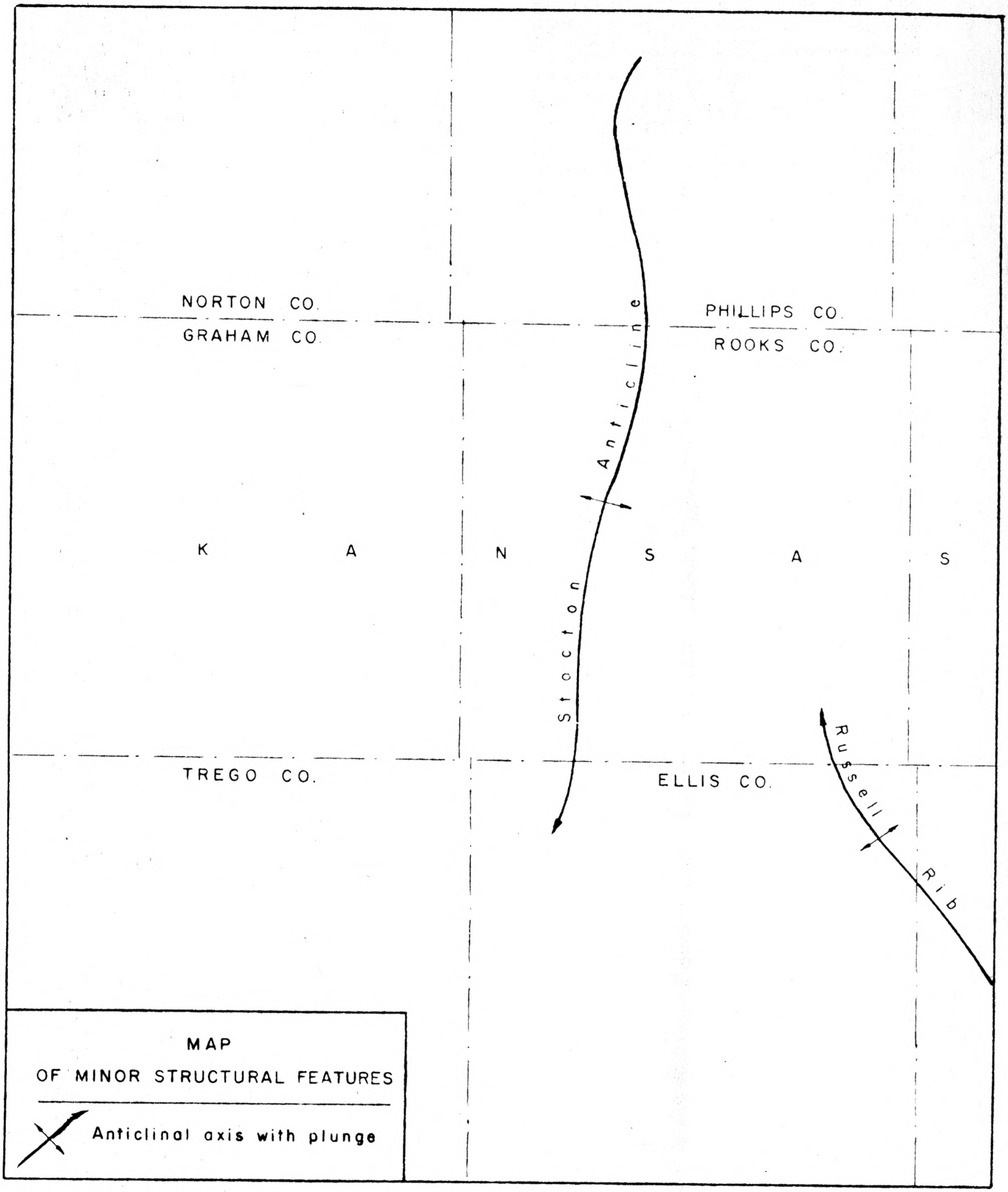


Fig. 3. Map of Rooks County showing minor structural features.

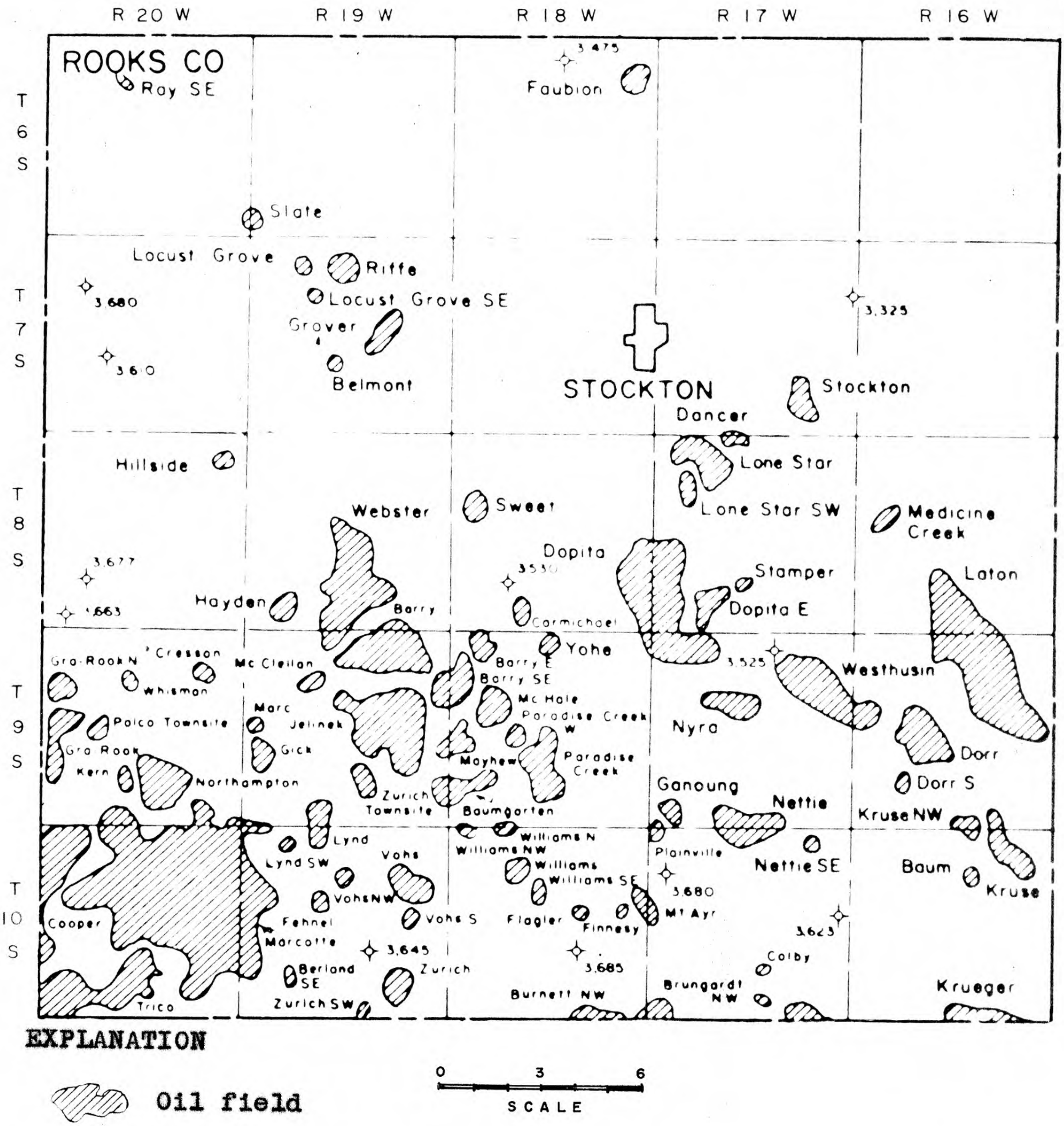


Fig. 4. Location of oil pools found in Rooks County, Kansas

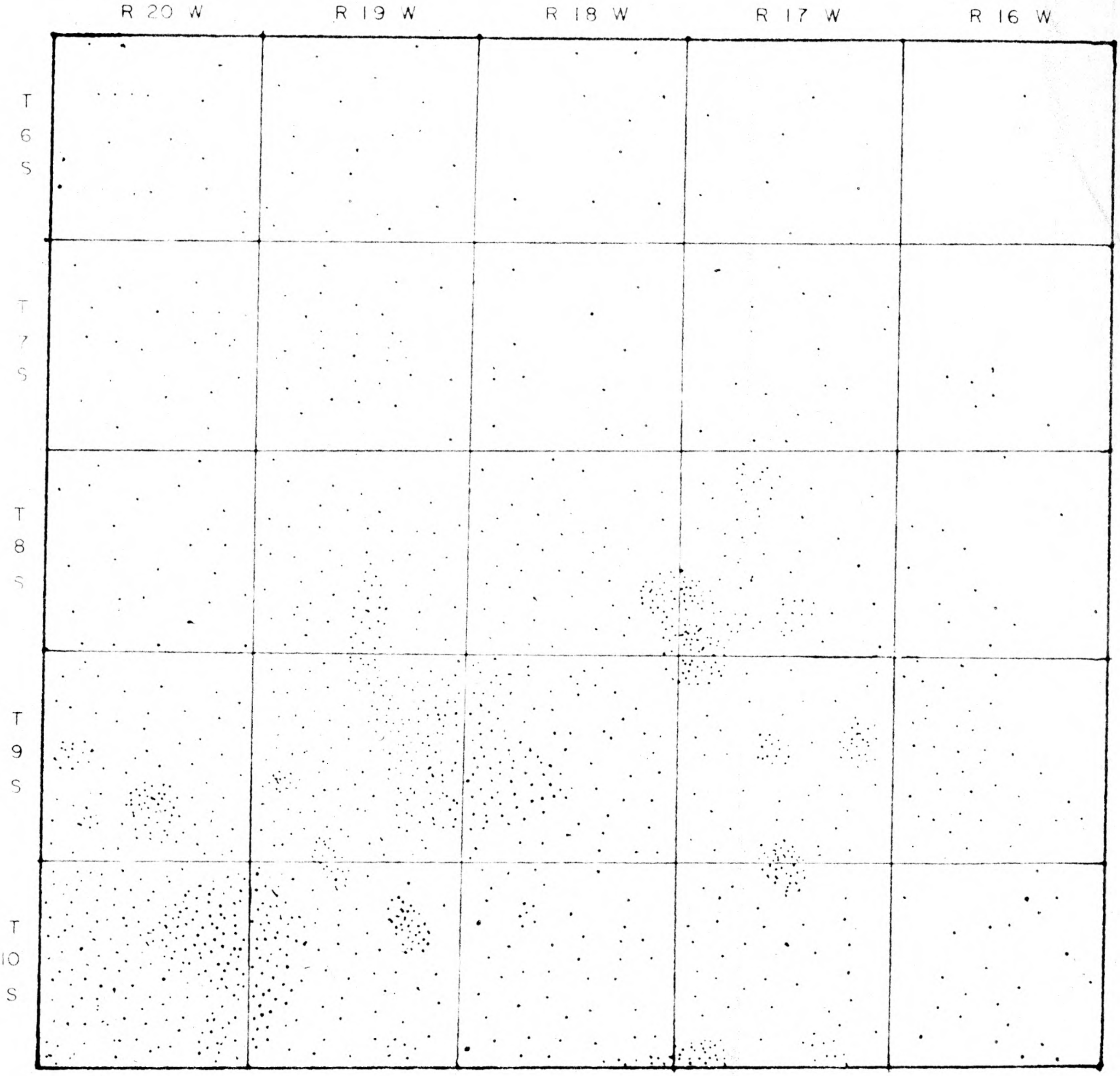


Fig. 5. Location of wells used on the Arbuckle group structural map, Rooks County, Kansas.

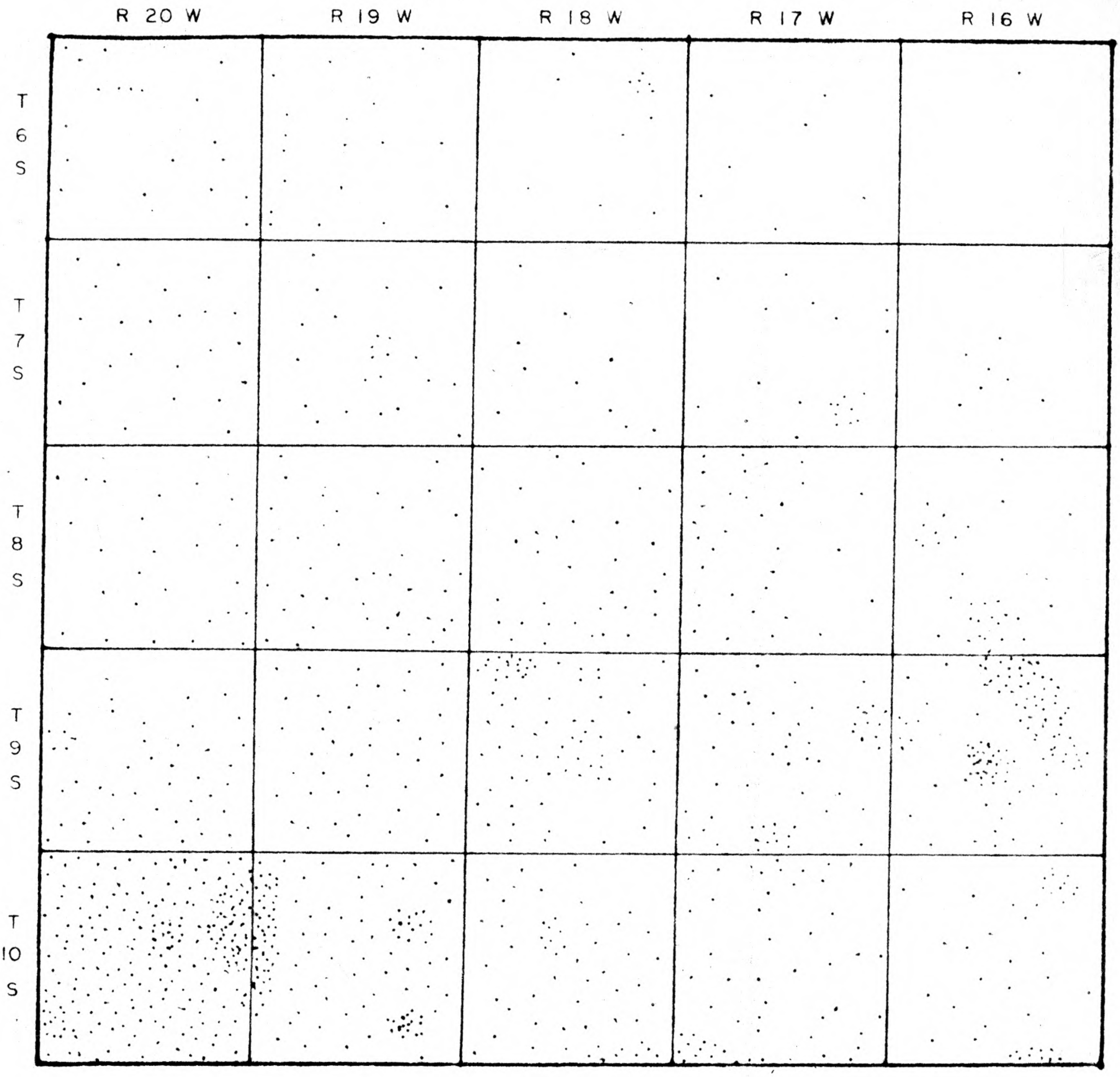


Fig. 6. Location of wells used on the Lansing-Kansas City group structural map, Rooks County, Kansas.

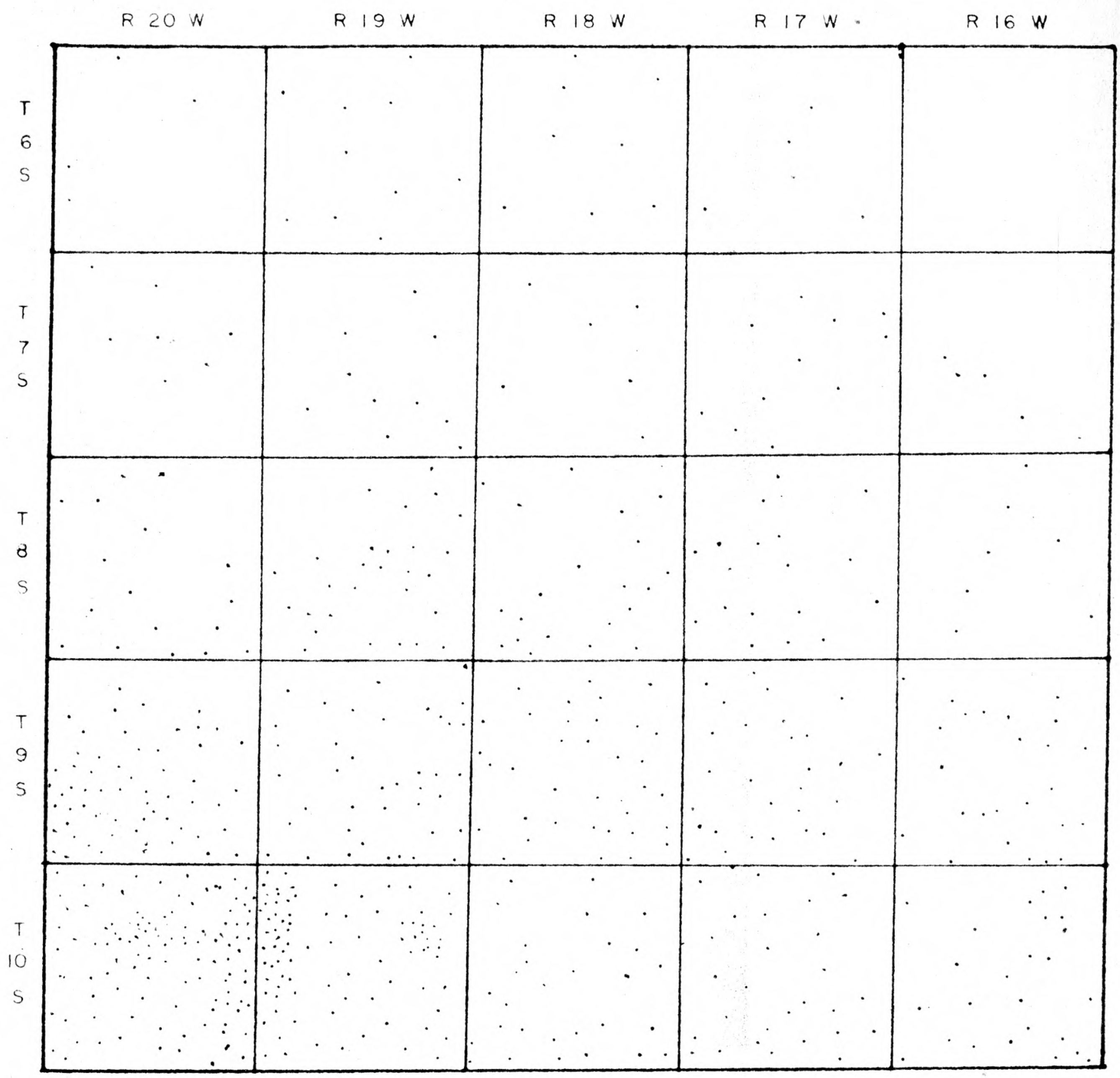


Fig. 7. Location of wells used on the isopachous map from the top of the Lansing-Kansas City group to the top of the Pennsylvania basal conglomerate, Rooks County, Kansas.

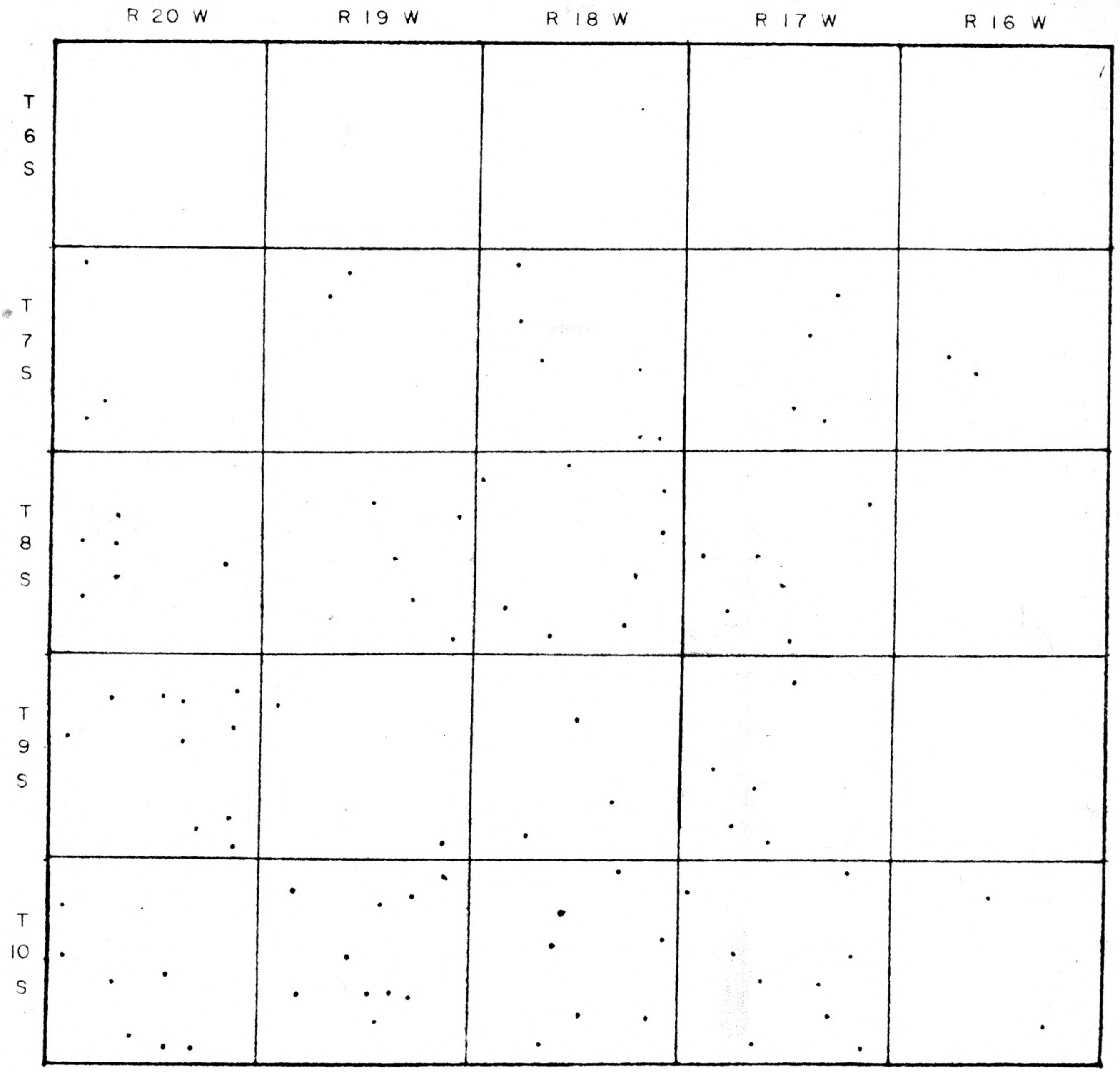
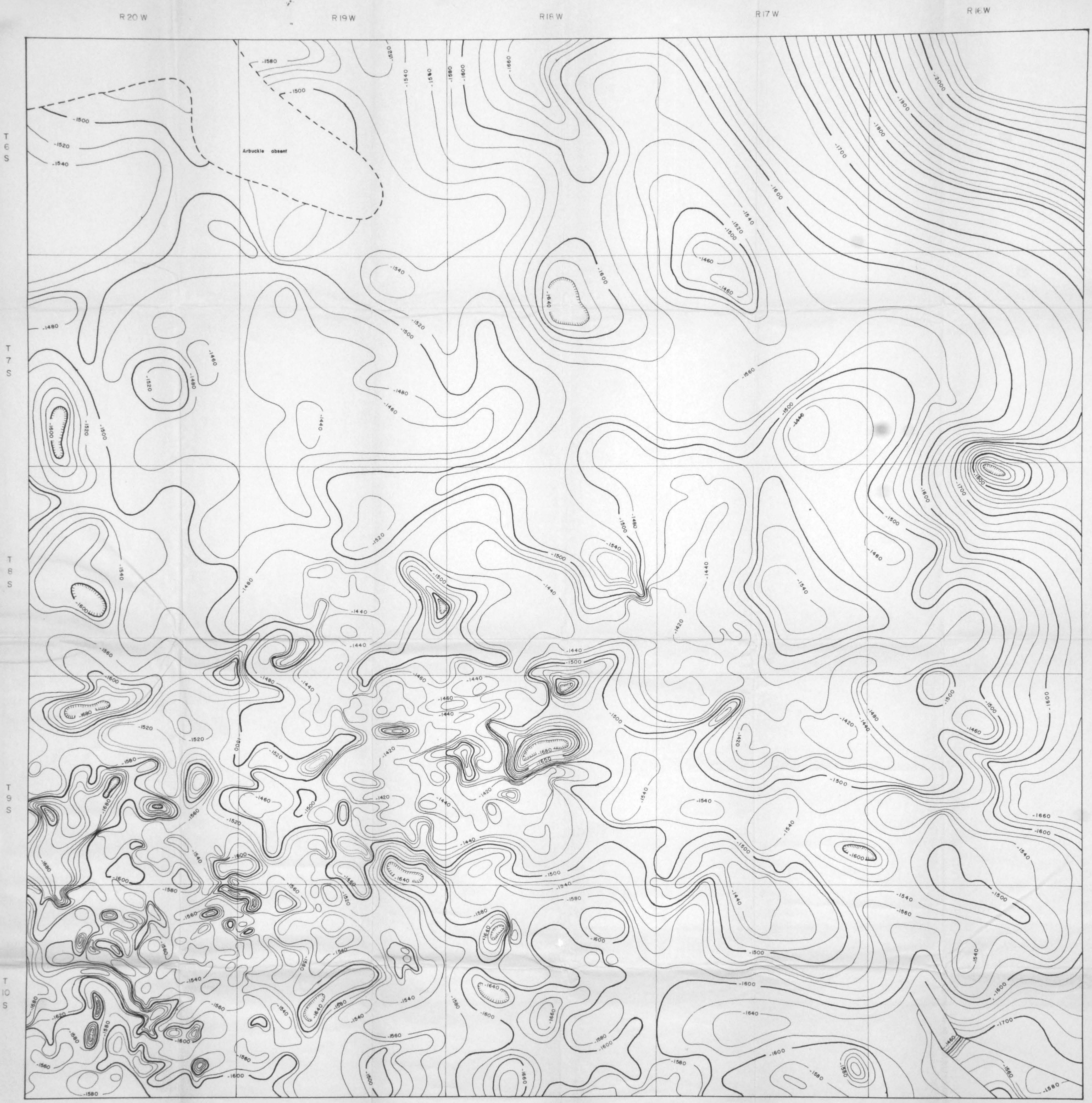


Fig. 8. Location of wells used on the clastic ratio map from the top of the Lansing-Kansas City group to the top of the Pennsylvanian basal conglomerate, Rooks County, Kansas.

FIGURES 9 TO 12 INCLUSIVE
(in accompanying plate box)



Structure Contour Map on
Top of the Arbuckle Group,
Rooks County Kansas

Fig. 9

LEGEND

County line

Township line

Contour line

Contour interval 20 feet

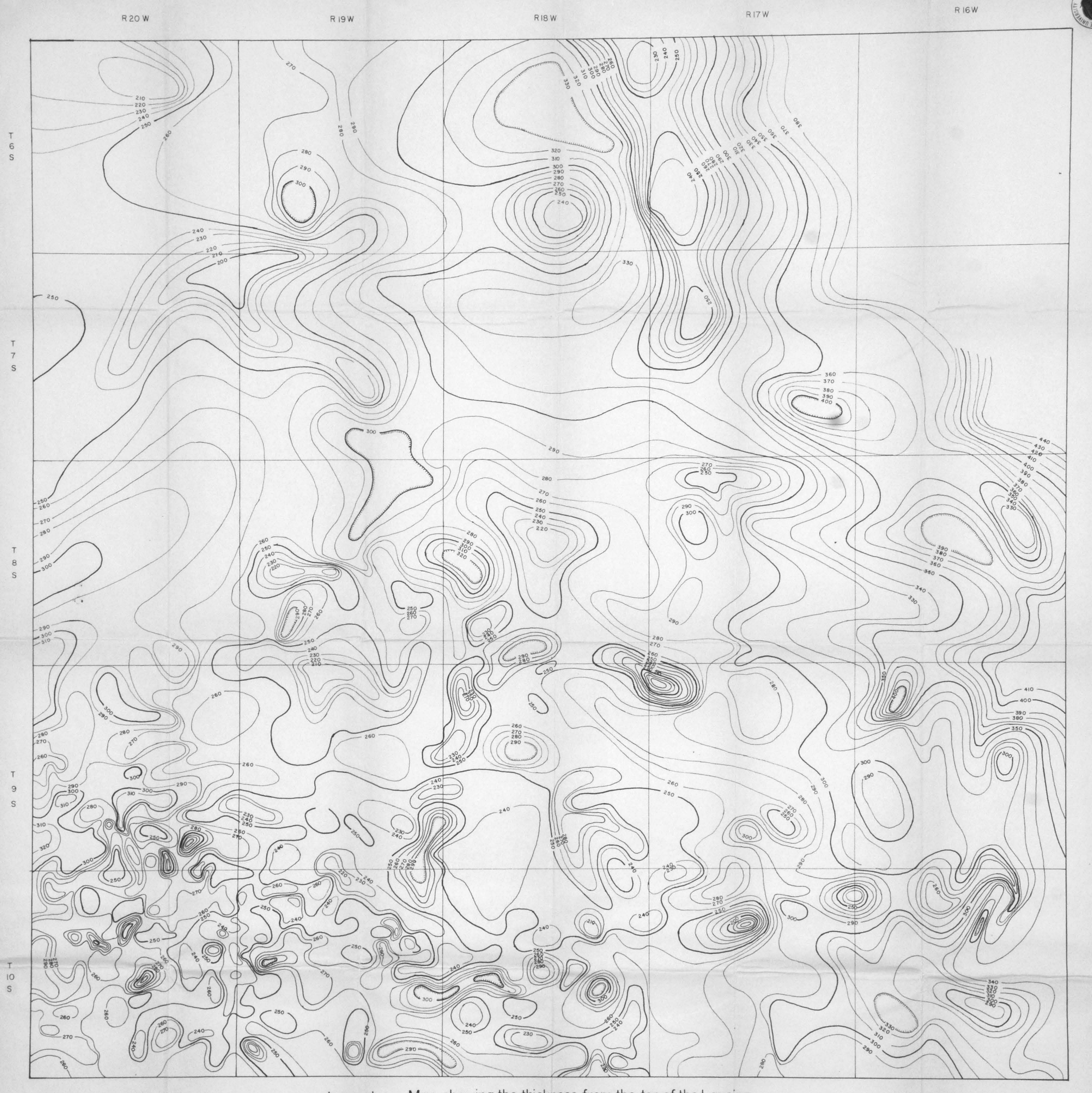
1 1/2 0 1 2

Scale 1" = 1 mile

Datum Sea level

N

Fred D. Eastty
1959



Isopachous Map showing the thickness from the top of the Lansing - Kansas City Group to the top of the basal Pennsylvanian conglomerate, Rooks County Kansas

Fig. 10

LEGEND

Scale 1" = 1 mile

Datum Sea level

County line

Township line

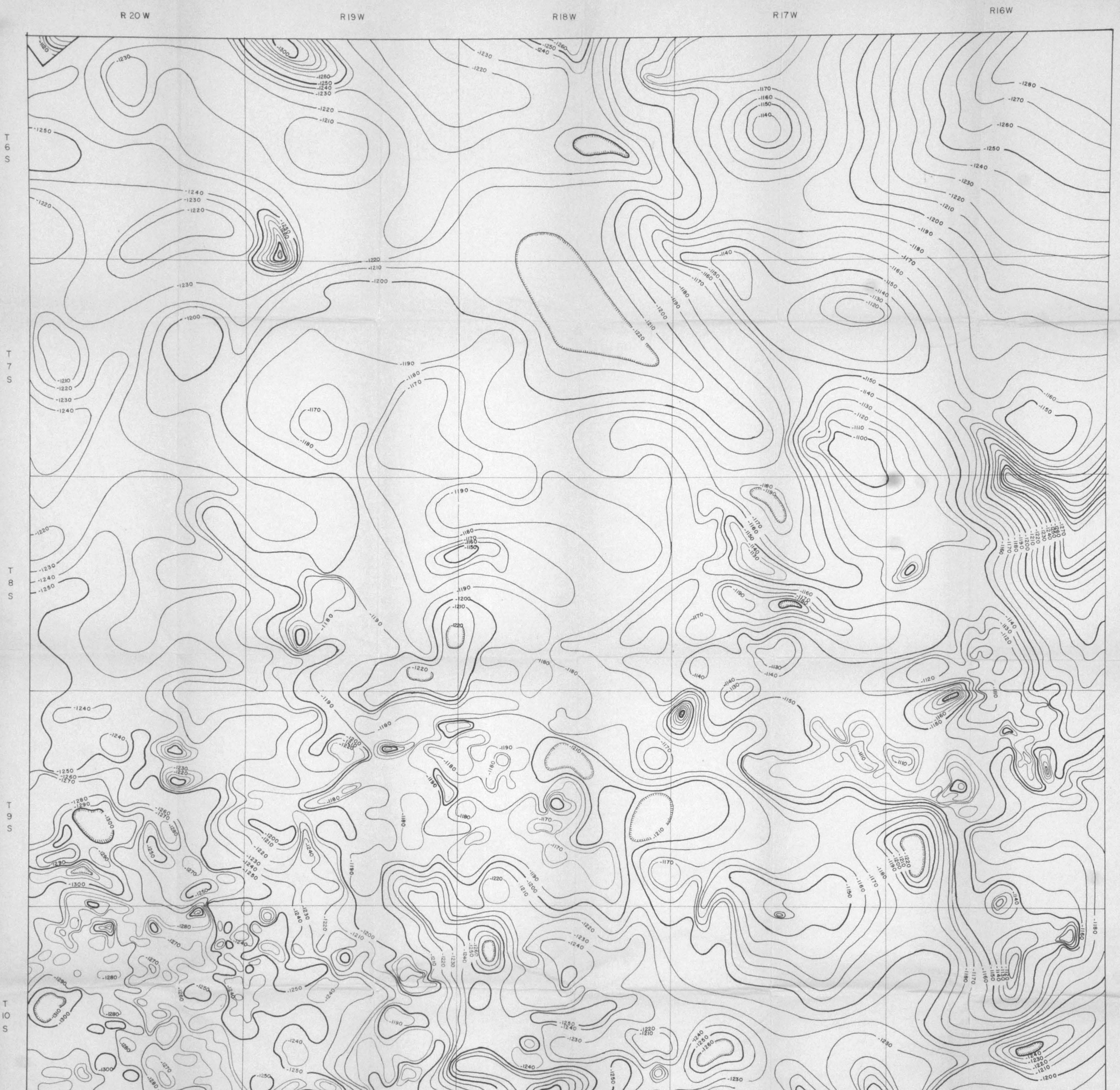
Contour line

Contour interval 10 feet

Area of greatest thickness

N

Fred D. Eastty
1959



Structure Contour Map on the top of the Lansing-Kansas City group, Rooks County Kansas

Fig. 11

LEGEND

1 1/2 0 1 2

Scale 1" = 1 mile

Datum Sea level

County line

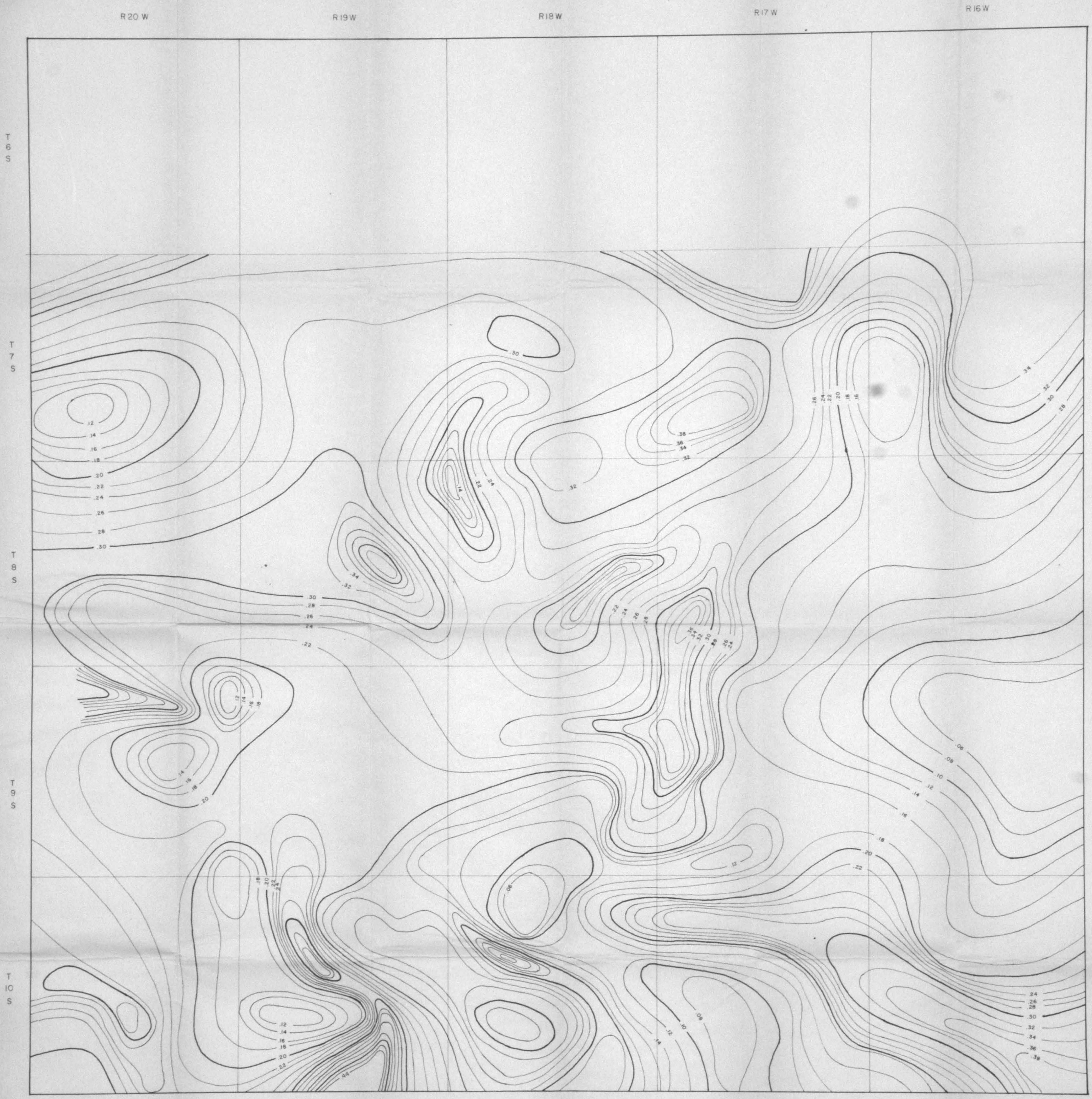
Township line

Contour line

Contour interval 10 feet

N

Fred D. Eastty
1959



Clastic ratio Map from the top of the Lansing - Kansas City group to the top of the basal Pennsylvanian conglomerate, Rooks County Kansas

Fig. 12

LEGEND

County line

Township line

Contour line

Contour interval .02

1/2 0 1 2

Scale 1" = 1 mile

N

Fred D. Eastty
1959

SUBSURFACE GEOLOGY OF ROOKS COUNTY, KANSAS

by

Frederick Dohrman Eastty, Jr.

B. A., Hofstra College, 1951

AN ABSTRACT OF A THESIS

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requirements for the degree

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1959

Rooks County is located in northwestern Kansas and covers an area of 900 square miles within 25 townships. The purpose of this investigation is to study the structure, stratigraphy and geologic history and their relation to the accumulation of petroleum. Structure maps, isopachous maps and a clastic ratio map were developed to show the relationship of these factors to the accumulation of petroleum. Rock units represented in Rooks County range in age from pre-Cambrian to Recent with all of the Silurian, Devonian, Mississippian and Triassic rocks absent.

Rooks County is located on the Central Kansas Uplift, Ellis Arch and the western flank of the Salina Basin. Two minor structures extend into Rooks County; the Russell Rib which is found in the southwestern corner of the county and the Stockton anticline which extends through the central part of the county.

A large majority of the oil production is obtained from the Lansing-Kansas City group and the Arbuckle group. Most of the oil accumulation of the Lansing-Kansas City group and the Arbuckle group is associated with structural closures. Minor amounts are associated with permeability traps. Producing zones with possibilities in the future are the basal Pennsylvanian conglomerate and the Reagan sandstone.

The drilling activity has continued to stay at a high level, however, the possibility of the discovery of major pools is scarce. The future potential of the county may well be limited to the flank of the Salina Basin located in northeastern Rooks County.