# SUBSURFACE GEOLOGY OF GRAHAM COUNTY, KANSAS

by

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B. S., Kansas State College
of Agriculture and Applied Science, 1955

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A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1957

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# INTRODUCTION

## Purpose

The purpose of this investigation was to study the structure and stratigraphy of Graham County, Kansas, and to relate these geological factors to the accumulation of petroleum.

## Location and Physiography

Graham County is in the second tier of counties south of the Kansas-Nebraska state line and is the fourth county east of the Colorado-Kansas state line in this tier (Fig. 1. Appendix). The county is bounded on the north by Norton and Phillips Counties, Rooks County on the east, Trego County on the south, and Sheridan County on the west, and covers approximately 891 square miles. The county lies entirely within the High Plains section of the Great Plains Physiographic Province (Prescott, 1955). The topography is that of an upland moderately dissected by streams, somewhat different from the flat upland character found farther west in the state. The county is drained by the South Fork Solomon River and its tributaries running eastward through the central part of the county and by the North Fork Solomon River and its tributaries in the northern part. The Saline River and its tributaries drain the southern part of the county.

## Procedure

The stratigraphy and lithology were obtained by reviewing literature and by examination of Kansas Sample Log Service strip logs at Kansas University.

The Lansing-Kansas City group and the Arbuckle group were mapped because of their structural significance and economic importance with respect to petroleum production within the county. Tops of formations from Herndon maps supplied the data in most cases. Drillers logs were used when available to supplement Herndon data.

The structural map of the Arbuckle was contoured using a contour interval of 25 feet. A smaller contour interval might be practical in a few areas within the county if plotted on a large scale base map, but this was not practical for the county as a whole. Karst topography is indicated by occasional conjestion of contours.

The Lansing-Kansas City group was mapped structurally using a 10 foot contour interval. The writer is of the opinion that a contour interval of greater than 10 feet does not have too great a value for structural mapping of the area since exploration is based upon extremely localized structures not revealed by a larger interval.

A panel diagram was constructed showing the stratigraphy of Graham County (Fig. 6. Appendix) The exact location of wells used in this figure is shown in Table 2. (Appendix).

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. Lee (1956) endorsed the use of the top of the basal Pennsylvanian conglomerate as a datum for isopachous mapping and states that it represents a more nearly level surface than the top of the underlying Mississippian limestone. Due to a limited number of control points, a 25 foot interval was used. The interval did not show any direct relationship to petroleum accumulation, but was useful in depicting structural history.

## Review of Literature

One of the first published geologic reports to include and cover Graham County was given by Darton (1905) in a report on the geology and water resources of the central great plains. A more detailed discussion of the structure of the area was given by Darton (1918). Twenhofel (1925) located and described some minor structural features as shown by the Fort Hays limestone. Further work was done by Bass (1926) with his report on the structure of the Dakota group. Recent work by Prescott (1955) included a report on the geology and groundwater resources of Graham County.

Regional tectonic development was discussed by Koester (1935) in an article on the Central Kansas Uplift. Tectonic development on a regional basis covering Graham County was given by Merriam and Atkinson (1955) in a report on the tectonic history of the Cambridge Arch. A short review of the geologic history of the area was given by Merriam and Goebel (1954). The tectonic development of the Hugoton Embayment was given by Merriam (1955) and presented ideas on the development of the area.

The stratigraphy of Kansas was given by Moore et al. (1951). Landis and Keroher (1942) reviewed the lithology of subsurface well cuttings without too much detail in stratigraphy. The extent and stratigraphy of Cambrian-Ordovician rocks in Kansas was given by Keroher and Kirby (1948) in a report which included Graham County.

Further stratigraphic information was obtained from a report by Lee (1939) on the Mississippian rocks in Kansas. Specific formations in the Cretaceous and Tertiary were discussed by Swineford (1947) and by Frye et al. (1956).

## STRATIGRAPHY

### Pre-Cambrian Era

The pre-Cambrian is reported as consisting of gneisses, schists, quartzites, and granites. The granites are considered to be biotite bearing granites in that they are composed of quartz, pink feldspar, and biotite-mica. Reports from some wells have described the pre-Cambrian as being composed of chloritic and micaceous schist. It has been suggested (Merriam and Atkinson, 1955) that the granite is intrusive surrounded by meta-sediments of quartzite, schist and gneiss. The fresh granite or schist is usually overlain by a weathered arkosic zone of pre-Cambrian material sometimes called "granite wash".

### Cambrian System

Waucoban and Albertan Series. There are no rocks known to be of Waucoban or Albertan age in Graham County (Moore et al., 1951).

Croixian Series. The Reagan sandstone (Lamotte sandstone) is the lowermost unit of the Croixian Series and unconformably overlies pre-Cambrian rocks. The Reagan sandstone overlies pre-Cambrian rocks as a blanket deposit, except where it is locally removed by post-Reagan erosion. In this area the Reagan is a white to gray, medium to coarse grained, angular to subrounded, frosted sandstone. The transgressive nature of this unit suggests that it was the first deposit of invading Croixian seas. The Bonneterre dolomite lies unconformably upon the Reagan sandstone. The Bonneterre dolomite is pink to white, medium to coarsely crystalline, sandy and glauconitic. The Eminence dolomite is white to buff, coarsely crystalline cherty dolomite and ranges in thickness from 0 to 50 feet.

## Ordovician System

Lower Ordovician. Arbuckle Group. The distribution of the Arbuckle group is shown in Fig. 7 (Appendix). The Roubidoux dolomite rests conformably upon the Eminence dolomite and has a lithology similiar to the Bonneterre dolomite. The Roubidoux dolomite is buff to pink, coarsely crystalline, sandy and ranges in thickness from 0 to 150 feet. The Jefferson City-Cotter dolomites overlie the Roubidoux dolomite and are white to gray, dense and somewhat argillaceous. Brown dolomite occurs in the lower part of the Jefferson City-Cotter dolomites in many wells.

Middle Ordovician. Simpson Group. The Simpson Group unconformably overlies the Arbuckle group and consists of green shales and white to gray, angular to subrounded sandstone. The thickness ranges from a feather-edge to 10 feet.

Viola Group. The Viola limestone unconformably overlies the Simpson group and consists of gray, buff or tan, fine to medium crystalline limestone and dolomite with milky white chert. The thickness varies from a feather-edge to 20 feet.

## Mississippian System

<u>Osage Series</u>. The Kinderhook shale unconformably overlies the Viola limestone in Graham County. It is a green to brown shale and ranges in thickness from 0 to 150 feet.

## Pennsylvanian System

<u>Morrowan and Atokan Series</u>. No rocks of Morrowan or Atokan age have been reported in Graham County.

<u>Desmoinesian Series</u>. Cherokee Group. The Pennsylvanian rocks from the base of the Marmaton group to the top of the Mississippian limestone are considered to be Cherokee in age. The lowermost unit is the basal Pennsylvanian conglomerate (Sooy conglomerate). The basal Pennsylvanian conglomerate is transgressive in nature like the Reagan sandstone and its exact age relationship is somewhat indefinite. The basal Pennsylvanian conglomerate consists of detrital chert and quartz grains imbedded in vari-colored micaceous shales. Above this detrital zone, the Cherokee group consists of thin bedded, dark colored, finely crystalline limestones and black shales. The Cherokee group unconformably overlies Mississippian rocks.

Marmaton Group. The Marmaton group consists of alternating shales and thin gray limestones containing gray to tan chert and seems to lie conformably upon the Cherokee group when the latter is present. The contact between the Marmaton Group and overlying Missourian rocks is marked by a thin bed of sandstone.

<u>Missourian Series</u>. Pleasanton Group. The Pleasanton group consists of sandstone and shale in Graham County.

Lansing-Kansas City Group. The Lansing-Kansas City group is composed of white to cream, oolitic limestones with interbedded shales. Some of the limestones contain pink chert or fine-grained sand. Many of the limestones are oil-stained, particularly those of Lansing age. The Kansas City group consists of the following limestones in ascending order: Hertha, Swope, Dennis, Winterset, Drum, Iola, and Wyandotte limestones. The Lansing group consists of the Plattsville and Stanton limestones in ascending order. The total thickness of these two groups in Graham County is about 230 feet.

Virgilian Series. Pedee Group. The Pedee group consists of the Weston shale and the Iatan limestone in ascending order. The Weston shale, unconformably overlying the Lansing group, is a gray-blue shale from 2 to 10 feet in thickness. The Iatan limestone overlies the Weston shale and is dense and white to blue. The Iatan is about 8 feet thick in Graham County.

Douglas Group. The Douglas group consists of undifferentiated clastics and shales in Graham County.

Shawnee Group. The Shawnee group consists of cherty dolomitic limestones and interbedded shales. The Heebner shale near the base of the group is a prominent marker bed in the area. The Heebner shale is a black, organic, and micaceous shale. The top of the Shawnee group is marked by the Topeka limestone which is an oolitic dolomitic limestone.

Wabaunsee Group. The Wabaunsee group consists of gray to cream and buff, dense to finely crystalline limestones with interbedded shales and sandstones. The shales are red to gray and the base is marked by a very fine grained sandstone.

## Permian System

Wolfcampian Series. Admire Group. The Admire group lies unconformably upon the Pennsylvanian and consists of gray, chalky limestones and shales.

Council Grove Group. The Council Grove group consists of light gray to buff fossiliferous limestones and red to green shales. The Foraker limestone marks the base of the Council Grove group. The lower zone of the Foraker is characterized by chert and abundant fuselinids. The Neva limestone is about in the middle of the group and is one of the easiest formations to pick on an electric log in the section. The Speiser shale is the uppermost unit of the group. The Council Grove group is about 300 feet thick in this area.

Chase Group. The Chase group consists of gray to tan, flinty, limestones separated by red and green shales. The Wreford limestone is the lowermost unit and contrasts rather sharply to the underlying Speiser shale on electric logs. The Herington limestone marks the top of the Chase group.

Leonardian Series. Sumner Group. The Sumner group includes the Wellington formation, Ninnescah shale and the Stone Corral dolomite. The Wellington formation consists of red to gray shales with a few limestones present. The Hutchinson salt member occurs in the middle part of the formation in the southern and eastern part of the county but is absent in the northern and western part of the county. The Ninnescah shale consists of red and gray sandy shales and is about 250 feet thick in this area. The Stone Corral dolomite marks the top of the Sumner group and is an extremely good marker bed for either electric log interpretation or sample examination. The Stone Corral is a white to gray dolomite.

Nippewalla Group. Red to gray shales with thin anhydrite breaks near the top make up the Nippewalla group.

## Jurassic System

The Morrison formation of the Jurassic System unconformably overlies the pre-Mesozoic rocks in the subsurface of Northwestern Kansas. The Morrison is composed of green to gray sandy shale with some limestone, anhydrite and chert. The chert is translucent and pink. The Morrison formation of Jurassic age is present in the subsurface of Graham County as chert, shale and sandy shale. A persistent zone of cherty shales are present near the center of the formation. The bottom of an anhydrite bed marks the lower boundry in two townships in the southwest corner of the county (Merriam, 1955). Elsewhere in the county the bed is absent. The thickness of the Morrison formation ranges from a feather-edge in the southern and eastern part of the county to 175 feet in the northwestern part of the county.

## Cretaceous System

Comanchean Series. The Cheyenne sandstone and the Kiowa shale represent the Comanchean series in Graham County. The Cheyenne sandstone is fine to coarse grained and white to buff. A great deal of clay and silt is mixed in with the quartz grains. The Kiowa shale overlies the Cheyenne sandstone and consists of fissile gray shale.

Gulfian Series. Colorado Group. The Colorado group consists of the Dakota formation, Graneros shale, Greenhorn limestone, Carlile shale, Niobrara formation and Pierre shale in ascending order. The Dakota formation consists of clay and siltstone containing carbonaceous material, pyrite, siderite, limonite and other iron minerals. Clay is the principal constituent of the Dakota group at the outcrop areas (Plummer and Romary, 1947). The Graneros shale is fissile, non-calcareous and blue-black. The Greenhorn limestone occurs as alternating shale, chalk and limestone layers. The Fencepost limestone is a prominent unit near the top of the Greenhorn limestone. The Carlile shale is divided in ascending order, into the Fairport shale, a blue-black non-calcareous shale, and the Blue Hills shale which is blue and calcareous. The Fort Hays limestone and the Smoky hill chalk are grouped as the Niobrara formation. The Fort Hays limestone is cream colored, massive and forms prominent outcrops east of Graham County. The Smoky Hill chalk member of the Niobrara formation is the oldest rock outcropping in the county. It consists of chalk and chalky shales which are yellow, orange, and tan in weathered exposures, with a few massive chalk beds similiar to the underlying Fort Hays limestone. The Smoky Hill chalk erodes to form badland topography in many areas. The entire county is underlain by the Smoky Hill chalk and many outcrops are observable. The Pierre shale is a soft fissile blue-gray shale in Graham County. The Pierre shale outcrops are confined to the western part of the county. The maximum thickness of the Pierre shale in outcrops is 18 feet (Prescott, 1955).

## Tertiary System

Pliocene Series. The Ogallala formation is the only representative of the Tertiary System in Graham County. It is divided into the Valentine, Ash Hollow, and Kimball members in ascending order. The Ogallala is composed of sand, gravel and silt locally cemented by calcium carbonate and occasionally by opaline silica forming "quartzite" of the Ogallala which is a very durable construction material. At one time the Ogallala covered the entire county but was subsequently removed from present topographically low areas by stream erosion and at present is found outcropping on upland areas.

## Quaternary System

Pleistocene Series. The Pleistocene series is represented by the Meade formation, Sanborn formation, dune sand, and alluvium. The Meade formation consists of sand, gravel, silt, and clay. The Sanborn formation consists principally of sand and silt. The dune sand is fine to coarse, wind deposited sand and the alluvium is sand, gravel and silt in stream channels and flood plains. These surficial sediments are unconsolidated and are important sources of ground water (Prescott, 1955).

# STRUCTURE

## Major Structural Features

The major structural features are shown in Fig. 2 (Appendix). They are considered to be those of major structural dimension that played an important role in the geologic history of the area.

Central Kansas Uplift. The Central Kansas Uplift is a southeast-northwest trending anticline in central and northern Kansas. Located on a major arcuate anticlinal trend from the Ozark dome to the Black Hills uplift, it is the dominant structural feature in the subsurface of Kansas. Koester (1935) indicates that the uplift originated in pre-Cambrian as a series of parallel batholiths which persisted as a positive feature throughout much of the Paleozoic Era.

Deformation occurred in post-Algokian, post-Canadian, post-Hunton, Early Pennsylvanian, post-Missourian and post-Cretaceous (Koester, 1935). These structural movements caused depositional thinning toward the north and west in Cambrian, Ordovician and Pennsylvanian rocks.

Cambridge Arch. The Cambridge Arch is a large anticlinal structure in north central Nebraska and northern and western Kansas. It is separated from the Central Kansas Uplift by a structural saddle in northeastern Graham County and adjoining areas and is a part of the positive axis from the Ozarks to the Black Hills. The Cambridge Arch lies south of the Chadron Arch.

Warping of the Cambridge anticline occurred in pre-Cambrian, post-Mississippian and post-Cretaceous (Merriam and Atkinson, 1955).

The Cambridge Arch is separated from the Central Kansas Uplift by a series of synclinal basins in northern Graham County.

Salina Basin. The Salina Basin, a true structural basin, is bordered by the Nemaha uplift on the east, on the south by a broad upwarp between the Central Kansas uplift and the Nemaha uplift, and by the Central Kansas uplift on the west.

The following periods of deformation are recognized:

1. Pre-Simpson as shown by Lee (1956). The subsidence of a major basin in Missouri and Kansas accompanied by the rejuvenation of the Central Kansas uplift, occurred at this time.

2. Pre-Mississippian warping produced the North Kansas basin and uplifted the Ozark area.

3. Early Mississippian to early Permian warping produced the Nemaha anticline and reactivated the Central Kansas uplift.

4. Deformation after Permian time tilted the western area of the basin toward the southwest.

5. Subsidence of the Denver Basin seemed to tilt the western part of the basin toward the west at the close of the Mesozoic.

Hugoton Embayment. The Hugoton embayment is considered to be a northern extension of the Anadarko Basin and is bordered by the Central Kansas uplift, Cambridge Arch, and the Las Animas Arch. These positive areas served as source areas for sediments in the embayment.

Regional development occurred as structural warping during pre-Arbuckle, post-Arbuckle, post-Viola, post-Chesteran, post-Morrowan and post-Permian times.

Denver Basin. The Denver Basin is a structural basin located in northeastern Colorado, southwestern Wyoming, southwestern Nebraska, and northwestern Kansas. The basin is structurally bounded by the Wet Mountains and the Front Range on the west; on the northwest by the Laramie Range and Hartville uplift; on the north by the Black Hills; on the northeast and east by the Chadron Arch and the Cambridge Arch; on the southwest by the Las Animas Arch; and by the Apishipa Arch on the south.

The development of the Denver Basin followed a period of time during early Paleozoic when the basin was a positive area. During Late Mesozoic the basin subsided rapidly and the present structural configuration was developed during Tertiary. (McCoy, 1953).

## Minor Structural Features

The minor structural elements are shown in Fig. 3 (Appendix). These elements have been previously described in geologic literature and are considered to be of relatively little regional significance.

Jennings Anticline. A southeastward plunging anticline has been described in southeastern Decatur County, northeastern Sheridan County and extending into northwestern Graham County (Merriam and Atkinson, 1955). The axis of this structural feature seems to pass through the northwest corner of the county and swings northward in township 6 south, range 21 west.

Seldon Syncline. The Seldon syncline parallels the Jennings anticline which is northeast of the syncline. The syncline seems to terminate in township 7 south but a synclinal structure is found further east in the county which may be a continuation of the Seldon Syncline (Fig. 3. Appendix). This structure is named for the small town of Seldon, Kansas along the axis of the syncline.

<u>Rush Rib</u>. The structural high starting in Barton County and extending northwestward across Ellis County into southwestern Graham County has been designated the Rush Rib by Koester (1935). The northern terminus of the structure is in township 9 south, range 21 west in Graham County.

<u>Surface Structures</u>. A limited amount of observable structure is found in parts of the county. Prescott (1955) describes faulting of magnitude enough that the Smoky Hill chalk is found above the younger Pierre shale. Twenhofel (1925) described two significant structures. The first being a closed anticlinal structure in townships 7, 8 and 9 south and ranges 20 and 21 west called the Clayton Anticline. Another closed anticlinal structure was described and located in and around the town of Penokee, Kansas. Seventy-five feet of closure was inferred on both of these structures. An observable dip in the strata can be noted from road cuts in the vicinity of both of these structures.

## STRUCTURAL DEVELOPMENT

### Pre-Cambrian Era

The emplacement of batholiths must have occurred to develop the structural features which were later to become Paleozoic structural elements. Merriam (1955) suggested that batholiths may have been responsible for the initiation of upward and downward warping by creating differences in elevation. Koester pointed out that pre-Cambrian rocks are arranged with granites and quartzites in the nucleus of uplifts with schists, arkoses and red clastics on the flanks of upwarped areas. This would create an isostatic unbalance and compensatory movements would have created the difference in elevation as needed. The area was undoubtedly subjected to several periods of unrest and finally uplifted at the end of the Proterozoic Era when the majority of the continental interior was a positive area.

## Paleozoic Era

The transgressing Croixian sea deposited the Reagan sandstone in the interior of the continent. The Reagan seems to have come from the Souxia uplift to the north and from the Sierra Grande uplift to the south.

The type of deposition at the end of Cambrian times seems to indicate that the positive areas had very little relief as the Bonneterre dolomite was deposited at the close of the Cambrian period. The nonclastic environment continued during lower Ordovician as indicated by the Gasconade and Jefferson City dolomitic sequence. Widespread structural movement occurred after Arbuckle deposition and the Cambridge Arch and the Central Kansas uplift were elevated. Erosion followed and Arbuckle sediments were completely removed from the Cambridge Arch (Merriam, 1955) and an erosional surface was developed on the Arbuckle in other areas.

The seas returned and the Simpson group was unconformably deposited on the Arbuckle group. Following Simpson deposition, a period of uplift and erosion occurred. The Simpson shale was removed in eastern Graham County except for an apparent erosional remnant in township 8 south, range 21 west indicated by two wells in which Simpson was reported while no Simpson was reported from surrounding wells. In township 8 south, range 24 west the Simpson is locally absent but surrounded by the Simpson group indicating irregularities in erosion.

The seas again advanced and deposited the Viola limestone. A period of erosion followed during which the Viola was eroded and formed a pinchout of Viola sediments in western Graham County. The Viola generally overlaps the Simpson group in Graham County.

The Mississippian seas advanced, depositing the Kinderhook shale. A period of erosion followed before Kinderhookian and younger Mississippian rocks were deposited (Merriam, 1955). The area was elevated following the deposition of early Mississippian rocks and a period of erosion followed. The exact geologic record during the Mississippian is somewhat indefinite because of the apparent instability of the region as a whole during this period. Lee (1940) recognized six unconformities during Mississippian time and post-Mississippian structural movements by way of removal of existing Mississippian sediments makes the record less clear.

The greatest period of uplift and structural movement for the Central Kansas Uplift and Cambridge Arch occurred at the end of Mississippian time. Post-Mississippian erosion removed all Mississippian rocks of post-Kinderhookian age and produced a pinchout of Mississippian rocks in the county.

During Pennsylvanian time the seas were depositing Morrowan and Atokan rocks to the south in the greater part of the Hugoton embayment. Near the end of Morrowan time the Sierra Grande Uplift, the Wet Mountains, and the Ancestral Colorado Mountains were elevated and served as a source of sediments for the area (Merriam, 1955). The deposition of the basal Pennsylvanian conglomerate marked the inundation by Desmoinesian seas. At the end of the Desmoinesian time the seas retreated forming an erosional surface. The Marmaton "chert" is thought by the writer to represent a detrital zone from the cherty upper Desmoinesian limestones.

The Missourian seas invaded the area forming sites for the deposition for the Lansing and Kansas City groups. The Hugoton embayment and Salina basin were filled and the Missourian deposits covered the Central Kansas Uplift and the Cambridge Arch. Seas had also nearly covered the source areas to the west. A relative rise or fall in sea level produced widespread advance or withdrawal of the seas. Post-Missourian erosion occurred and the Lansing-Kansas City group was subjected to widespread erosion. An isopachous map was constructed on the Lansing-Kansas City group to determine the extent of post-Missourian erosion. The uniformity of thickness made such a representation impractical and it is suggested that post-Missourian erosion was relatively brief with little structural readjustment.

The isopachous map of the Desmoinesian and Missourian thickness shows thickening of the interval toward the southwest corner of the county, indicating the development of the north extremity of the Hugoton embayment. The north terminus of the Rush Rib in township 8 and 9 south, range 21 west shows thinning, suggesting uplift. A thinning trend is noted in township 7 south and a slight structural readjustment may have been responsible.

Cyclic deposition continued during Virgilian time and shales and thin bedded limestones were deposited. The close of the Pennsylvanian was marked by uplift or withdrawal of the seas followed by a period of erosion.

The Permian (Wolfcampian) seas advanced and deposited a sequence of alternating limestones and shales unconformably upon the eroded Pennsylvanian rocks. The Wolfcampian seas were populated with an abundance of organic matter. The Leonardian series was dominated by evaporites indicating that the Leonardian sea was isolated from any large source of water. An extremely saline depositional environment developed and the Hutchinson salt member was deposited over the nearly level land surface as the Wichita Mountain system cut off the seas in Kansas from the Permian sea in Texas. The Hutchinson salt member was deposited over the southern and eastern part of the county and may indicate the limit of the evaporite sea in this area. Silt and sandy red beds make up the rest of the Leonardian as sluggish streams deposited over the nearly level land surface (Moore, 1949). The close of Permian time was marked by withdrawal of seas and an erosion surface developed, thus ending the Paleozoic Era.

## Mesozoic Era

The Morrison formation was deposited during the Jurassic times as western Kansas was tilted toward the subsiding Denver

Basin. Sluggish streams moving northwestward produced the clastic Morrison deposits which are marine in nature in the Denver Basin (Merriam, 1955).

The Cheyenne sandstone was deposited as a strand-line deposit in front of the northward advancing Cretaceous seas.

The Kiowa shale was deposited under marine conditions following deposition of the Cheyenne sandstone.

The Dakota group is thought to represent the shore line deposits of a shallow sea (Plummer and Romary, 1947). The seas then covered the area and the Graneros shale, Greenhorn limestone, and Niobrara group were deposited under marine conditions. The end of the Mesozoic was marked by the withdrawal of the Cretaceous seas and some tilting of the area toward the northwest. The closest date which has been assigned to this movement is post-Niobrara pre-Ogallala (Merriam and Atkinson, 1955). This period of unrest was synonymous with the Laramide of the west, and marked the close of the Mesozoic Era.

## Cenozoic Era

The rejuvenation of the Rocky Mountains created the background for the post-Cretaceous erosion and subsequent deposition of the Tertiary Ogallala formation. A long period of erosion followed the deposition of the Ogallala formation (Frye, et al., 1956). Fluvial and eolian deposits characterize the remainder of the Cenozoic Era. Western Kansas was tilted eastward sometime after deposition of the Ogallala formation and the area assumed its present configuration.

# STRUCTURE AND STRATIGRAPHY AND ITS RELATIONSHIP TO PETROLEUM ACCUMULATION

As shown in Figs. 7 and 8 (Appendix) the accumulation of petroleum is controlled by structural traps. However, production is also dependent upon other factors such as porosity and permeability. The presence of a structural high does not denote a producing field.

Often structural anomolies in the Lansing-Kansas City group are reflected in the lower units including the Arbuckle limestone. This indicates that the upper surfaces of these two units are not entirely erosional in character and compaction may have affected the structural attitude of the two surfaces. However, smaller irregularities in the surface of both the Arbuckle group and the Kansas City group give the appearance of being erosional in nature. The majority of recently discovered pools have been located on small areas with closure which have the appearance of being buried hills.

## Lansing-Kansas City Group

Regional dip is not apparent in the Lansing-Kansas City group. Elevations of about -1250 feet below sea level may be found in all four corners of the county. The structure seems to include two principal types: (1) Small basin areas, and (2) Adjacent domes or highs sometimes showing alignment. One of the most prominent basin structures is found in T. 8 and 9 S. and R. 24 and 25 west. The contours show the surface of the Lansing-Kansas City to be below -1350 below sea level. Adjacent to this basin are several closed highs. In the northeast corner of T. 8 S., R 24 W., the Nana and Penokee pools produce from areas with closures of 30 to 40 feet. In T. 7 S, R 25 E the Huntington and Blazier pools produce from areas of 20 to 30 feet of closure. Another basin is located north of and adjacent to the previously discussed pools. A trend of structural highs through T. 6 S, R 23 W to T. 7 S, R 24 W and the other in T. 6 S, R 21 and 22 W. In T. 10 S, R 23 W a structural high is bounded by structural depressions on the east and west. This high shows closures of 30 or more feet and the prolific Diebolt pool is located. Production in the Diebolt pool does not seem to occur below the -1280 feet contour interval.

In T. 9 and 10 S, R 21 W small local closures of 20 to 30 feet are noted. The area covered by the Morel pool (Fig. 4. Appendix) is above the -1250 feet contour line. The Morel pool and the Coopell pool give the appearance of being structural highs lifted by tectonic elements rather than erosional elements. In T. 6 S., R. 21 W, Sections 1 and 2, a fault is shown. The uniformity of slope up to Sections 1 and 2 suggested faulting as a solution to the problem of sudden and local conjestion of contours. The proximity of the Cambridge Arch and the Central Kansas Uplift would suggest a mechanism for faulting in this area. The possibility of petroleum accumulation on the upthrown side similiar to that in Phillips County should not be discounted.

## Arbuckle Group

The surface of the Arbuckle group is influenced by regional features such as the Central Kansas Uplift and the Hugoton embayment (Fig. 2. Appendix) and regional dip from east to west is shown in (Fig. 7. Appendix). In analyzing the location of pools producing from the Arbuckle it was noted that there was no production from areas where structural contours were lower than -1650 feet below sea level. New production from the Arbuckle will probably be confined to local highs in R. 21 and 22 W. Closures of 100 feet or more were mapped in T. 8 S, R. 25 W which do not have any petroleum production from the Arbuckle group. The absence may be attributed to two causes, the first that the oil did migrate from the source beds at such low structural elevations and/or that the post-Arbuckle, pre-Mississippian beds overlapped the Arbuckle and prevented migration to this area from younger source beds.

A karst topography is shown in T. 8 and 9 S., R. 21 W. The possibility exists that the rest of the Arbuckle, if sufficient control were available for contouring, would show karst topography.

In T. 6 S, R. 21 and 22 W, the Arbuckle group has been locally removed by erosion. This would indicate that the group is thin in this area and the possibility of any large amount of production from the Arbuckle group is limited.

## HISTORY OF GRAHAM COUNTY OIL FIELDS

The first commercial oil production in Graham County was opened in April, 1938, by the discovery of the Morel pool in sec. 15, T. 9 S., R. 21 W (Ver Wiebe, 1940). The discovery well was rated at 2,100 barrels per day from the Arbuckle dolomite. Three other wells were drilled in 1938 but were all dry. In 1939, however, four important producers were discovered in sections, 10, 16, and 23 of the same township to expand the Morel pool and create renewed interest in drilling. All of these wells were completed in the Arbuckle dolomite. An Arbuckle test in sec. 11, T. S., R. 24 W. was plugged back and completed in the Lansing-Kansas City to produce 220 barrels per day and open the Penokee pool. (Ver Wiebe, 1941). This was the first Lansing-Kansas City production in the county and served as an impetus for exploration in areas seemingly barren of Arbuckle production.

By 1956, the number of pools had increased to 53 and production exceeded 4,800,000 barrels. During 1955, there were 17 pools discovered as Graham County led the state in the number of wildcat tests during the year with 42, (Ver Wiebe, 1956).

### Drilling and Producing Methods

With the exception of a few early wells drilling has been with the rotary method almost entirely. The portable rotary rig with a 94 foot mast is the most widely used type. In recent years, however, there has been a trend toward 122 foot or "triple" derricks.

The standard casing program calls for a surface string to be set from 150 to 300 feet. This casing is cemented to protect local water supplies. The size of hole below the casing string is 7 7/8 inches. Formation testing is done as the zones are penetrated. If a sufficient show is encountered, a 5 1/2 or 7 1/2 inch oil string is set and cemented through the pay. Following the cementing of the oil string, a cable tool rig is moved in and finishes completion of the well by drilling out the excess cement and cleaning out the hole. The wells in the Lansing-Kansas City and Arbuckle are usually acidized to stimulate production. Fracturing treatments have been applied but have not been too successful.

All of the wells in Graham County are pumped by the conventional plunger pump. There are no known formations in any locality which has sufficient bottom hole pressure to flow. Pipelines are scattered throughout the county and the producer has no trouble in selling crude oil.

## Water Disposal

All reservoirs are water drive and all fields require disposal methods. During the formative years, disposal of water was accomplished by evaporation from open pits. At present, the salt water disposal well is almost universally used. Most of these disposal wells are in the lower formations of the Kansas City and Arbuckle groups.

### Secondary Recovery

Secondary recovery is not used at present and because of the nature of the reservoirs and cost of drilling, does not appear desirable at the present time.

## DISCUSSIONS AND CONCLUSIONS

### Lansing-Kansas City Production

Figure 8 (Appendix) shows the relationship of oil accumulation to the Lansing-Kansas City structure. The Diebolt, Schmied, Schmied NE, Holley North, Huntington, Blazier, Penokee, Nana, Allodium, Harmony, Cooper, Red Line, and Faulkner pools show structural closure by closed contours. More than 30 feet of closure may be inferred for the Diebolt, Blazier, Nana, Penokee, Holley North, and Faulkner pools. Small closures of 10 to 20 feet are found on many of the smaller pools. Production in the Holley, Houston and Sand Creek pools does not seem to be governed by structural closures. Porosity traps may be responsible for these pools. Locally within the Holley pool small closures of 10 feet may be noted.

### Arbuckle Production

Figure 7 (Appendix) shows the relationship of oil accumulation to the Arbuckle structure. Structural highs in the eastern and southern parts of the county where the influence of the Central Kansas Uplift is noticed are most favorable for accumulation of petroleum in the Arbuckle. The Morel, Cooper, Smith-Denning, Laura and Noah pools all show closures of 25 to 50 feet. Some production is found on anticlinal noses around the margins of the large pools. Arbuckle production is notably absent where contours are below 1700 feet. The extent of pre-Pennsylvanian, post-Arbuckle beds may have some influence upon the accumulation of oil.

## Future Potential

Although the possibility of locating any large pools in the area is limited, a great many unexplored possibilities still exist.

A few wells in the Law pool are known to produce from the basal Pennsylvanian conglomerate and future production from this zone should not be discounted.

Locally, many small Lansing pools occur and future drilling to this group should discover many more. The development of pools such as the Holley pool where structure plays a secondary roll to porosity and permeability seems to be pre-eminent in the future.

New development in Arbuckle production may be confined to extensions of the developed pools. New pools may be developed in the extreme southeast corner of the county where there is a limited amount of unexplored acreage which lies relatively high on the Central Kansas Uplift.

The possibility of Reagan sandstone production such as that found in the Norton County oil field should not be discounted. Pre-Cambrian highs such as those found in the extreme northeast corner of the county offer a background for pinchout traps (Fig. 6. Appendix). The presence of an extreme local change in elevations, herein interpreted as a fault (Fig. 8. Appendix) in township 6 south, range 21 west lends even more attractiveness to the Reagan sandstone as a potential producer.

## ACKNOWLEDGMENTS

The writer is indebted to Dr. Henry V. Beck, Associate Professor of Geology, for his advice and suggestions while preparing this thesis, to Dr. Joseph R. Chelikowsky, Head of the Department of Geology and Geography, for the criticisms and suggestions while editing the thesis and to his wife, Betty Sandlin, for her assistance in preparing this thesis.

## LITERATURE CITED

Bass, N. W.
Geologic structure of the Dakota sandstone of Western Kansas. Am. Assoc. Petrol. Geol. Bull., Vol. 9, No. 6, 1926, 1022-1023 pp.

Darton, N. H.
Preliminary report on the Geology and underground water resources of the central Great Plains., U. S. Geol. Survey Prof. Paper 32, 1905, 299 p.

Darton, N. H.
The structure of parts of the Central Great Plains, U. S. Geol. Survey Bull. 691, 1918, 1-26 pp.

Frye, J. C., A. B. Leonard and Ada Swineford
Stratigraphy of the Ogallal formation of northern Kansas, State Geol. Survey of Kansas Bull. 118, 1956, 92 p.

Keroher, R. P. and J. J. Kirby
Upper Cambrian and Lower Ordovician rocks in Kansas, State Geol. Survey of Kansas Bull. 72, 1948, 140 p.

Koester, E. A.
Geology of Central Kansas Uplift. Am. Assoc. Petrol. Geol. Bull., Vol. 19, 1935, 1405-1426 pp.

Landis, K. K. and R. P. Keroher
Mineral resources of Phillips county. State Geol. Survey of Kansas Bull. 41, 1942, 279-312 pp.

Lee, Wallace
Relation of thickness of Mississippian limestones in central and eastern Kansas to oil and gas deposits. State Geol. Survey of Kansas Bull. 26, 1939, 42 p.

Lee, Wallace
Stratigraphy and structural development of the Salina Basin area. State Geol. Survey of Kansas Bull. 121, 1956, 165 p.

McCoy, A. W.
Tectonic history of the Denver Basin. Am. Assoc. Petrol. Geologists Bull. Vol. 37, 1953, 1873-1893 pp.

Merriam, D. F.
Jurassic rocks in Kansas. Am. Assoc. Petrol. Geologists Bull. Vol. 39, 1955, 31-47 pp.

Merriam, D. F.
Structural development of the Hugoton embayment. Proc. 4th Subsurface Symposium, Univ. of Oklahoma, Norman, 1955, 81-97 pp.

Merriam, D. F. and W. R. Atkinson
Tectonic history of the Cambridge Arch in Kansas. Kansas Geol. Survey Oil and Gas Investi. No. 13, Maps and Cross secs., 1955, 28 p.

Merriam, D. F. and E. D. Goebel
The geology of the Norton oil field, Norton county, Kansas. State Geol. Survey of Kansas Bull. 1954, 109 pt 2, 19 p.

Moore, R. C., et al.
The Kansas rock column. State Geol. Survey of Kansas Bull. 89, 1951, 132 p.

Plummer, N. V. and J. F. Romary
Kansas clay, Dakota formation. State Geol. Survey of Kansas Bull. 67, 1947, 241 p.

Prescott, G. R. ✓
The geology and ground water resources of Graham county. State Geol. Survey of Kansas Bull. 110, 1955, 98 p.

Swineford, Ada
Cemented sandstones of the Dakota and Kiowa formations in Kansas. State Geol. Survey of Kansas Bull. 70, 1947, 53-104 pp.

Twenhofel, W. H.
Significance of some of the surface structures of central and western Kansas. Am. Assoc. of Petrol. Geologists Bull., Vol. 9, No. 7, 1925, 1061-1070 pp.

Ver Wiebe, W. A.
Exploration for oil and gas in western Kansas during 1939. State Geol. Survey of Kansas Bull. 28, 1940, 106 p.

Ver Wiebe, W. A.
Exploration for oil and gas in western Kansas during 1940. State Geol. Survey of Kansas Bull. 36, 1941, 109 p.

Ver Wiebe, W. A.
Oil and gas developments in Kansas during 1955. State Geol. Survey of Kansas Bull. 122, 1956, 248 p.

# APPENDIX

Table 2. Exact locations of points used in Fig. 5.

| Points | Location | Section | Township | Range |
|---|---|---|---|---|
| 1 | NE, NE, NE | 16 | 10S | 25W |
| 2 | NE, NE, NE | 12 | 8S | 25W |
| 3 | NE, NE, NE | 32 | 7S | 23W |
| 4 | NW, NW, SW | 2 | 10S | 23W |
| 5 | NE, NW, NE | 9 | 6S | 22W |
| 6 | NE, NE, NE | 4 | 6S | 21W |
| 7 | NW, NW, SE | 22 | 8S | 21W |

Table 1. Oil production in Graham County, Kansas to January 1, 1955

| Pool and location of Discovery Well | Discovery Year | Area Acres | Depth Feet | Producing Zone | No. Wells | Production, bbl. 1954 | Production, bbl. Cumulative |
|---|---|---|---|---|---|---|---|
| Alda 15-7-22W | 1944 | 700 | 3,518 | Lans.-K.C. | 3 | 9,902 | 73,029 |
| Allodium 19-6-25W | 1955 | 80 | 3,740 | Lans.-K.C. | 2 | 6,987 | 6,987 |
| Blazier 21-7-25W | 1955 | 480 | 3,785 | Lans.-K.C. | 8 | 13,802 | 13,802 |
| Brush Creek 4-9-23W | 1955 | 80 | 3,769 | Lans.-K.C. | 4 | 18,092 | 18,092 |
| Cooper 11-10-21W | 1950 | 4,980 | 3,528<br>3,841 | Lans.-K.C.<br>Arbuckle | 121 | 851,396 | 4,827,234 |
| Cooper North 33-9-21W | 1953 | 300 | 3,905 | Arbuckle | 10 | 69,300 | 95,973 |
| Crocker 18-10-21W | 1951 | 40 | 3,916 | Arbuckle | 1 | 1,281 | 20,421 |
| Diebolt 33-10-23W | 1953 | 1,460 | 3,779 | Lans.-K.C. | 1 | 552,538 | 703,316 |
| Dorman 30-10-24W | 1952 | 40 | 3,921 | Lans.-K.C. | 1 | 2,872 | 15,155 |
| Dorman West 25-10-24W | 1955 | 40 | 3,954 | Lans.-K.C. | 1 | 3,764 | 3,764 |

Table 1. (Cont'd.)

| Pool and location of Discovery Well | Discovery Year | Area Acres | Depth Feet | Producing Zone | No. Wells | Production, bbl. 1954 | Cumulative |
|---|---|---|---|---|---|---|---|
| Elrick 15-10-25W | 1955 | 160 | 3,931 | Lans.-K.C. | 1 | 2,206 | 2,206 |
| Fargo 26-9-22W | 1950 | Combined with Ironclad | | | | | |
| Fargo West 34-9-22W | 1951 | 80 | 3,755 | Lans.-K.C. | 2 | 733 | 3,734 |
| Faulkner 27-10-23W | 1945 | 160 | 3,629<br>3,844 | Lans.-K.C.<br>Marmaton | 5 | 7,596 | 206,389 |
| Gettysburg 7-8-23W | 1941 | 80 | 3,725 | Lans.-K.C. | 2 | 3,962 | 70,709 |
| Glen Dale 23-9-24W | 1955 | 80 | 3,993 | Lans.-K.C. | 1 | 2,474 | 2,474 |
| Happy 21-10-23W | 1954 | Combined with Diebolt | | | | | |
| Harmony 32-7-22W | 1951 | 700 | 3,597<br>3,776 | Lans.-K.C.<br>Arbuckle | 9 | 38,423 | 190,180 |
| Highland 20-8-22W | 1951 | 40 | 3,616 | Lans.-K.C. | 1 | 1,825 | 12,242 |
| Holley 3-9-24W | 1954 | 2,000 | 3,900 | Lans.-K.C. | 50 | 233,372 | 235,825 |

Table 1. (Cont'd)

| Pool and location of Discovery Well | Discovery Year | Area Acres | Depth Feet | Producing Zone | No. Wells | Production, bbl. 1955 | Production, bbl. Cumulative |
|---|---|---|---|---|---|---|---|
| Holley North 29-8-24W | 1955 | 40 | 3,897 | Lans.-K.C. | 1 | 648 | 648 |
| Holley Northwest 32-8-25W | 1955 | Combined with Holley | | | | | |
| Holley West 36-8-25W | 1955 | 640 | 3,924 | Lans.-K.C. | 7 | 7,884 | 7,884 |
| Hoof 9-10-23W | 1954 | 640 | 3,865 | Lans.-K.C. | 21 | 142,881 | 144,524 |
| Hoof West 8-10-23W | 1955 | 40 | 3,903 | Lans.-K.C. | 3 | 8,781 | 8,781 |
| Houston 9-6-22W | 1947 | | 3,506 | Lans.-K.C. | 1 | no runs | 19,516 |
| Huntington 7-7-25W | 1955 | 40 | 3,832 | Lans.-K.C. | 1 | 5,952 | 5,952 |
| Ironclad 23-9-22W | 1950 | 1,000 | 3,756 | Lans.-K.C. | 17 | 86,475 | 342,363 |
| Laura 30-10-20W | 1950 | 1,200 | 3,706 | Arbuckle | 18 | 156,495 | 336,166 |
| Law 34-9-23W | 1951 | 900 | 3,922 | Lans.-K.C.<br>Penn. congl. | 14<br>2 | 105,161<br>12,640 | 656,229 |

Table 1. (Cont'd)

| Pool and Location of Discovery Well | Discovery Year | Area Acres | Depth Feet | Producing Zone | No. Wells | Production, bbl. 1955 | Cumulative |
|---|---|---|---|---|---|---|---|
| Law Southeast 12-10-23W | 1955 | 500 | 3,869<br>4,088 | Lans.-K.C.<br>Penn. congl. | 12 | 38,747 | 38,747 |
| Mickleson 27-8-22W | 1952 | 120 | 3,502<br>3,759 | Lans.-K.C.<br>Arbuckle | 3 | 18,006 | 49,589 |
| Mildrexter 12-9-23W | 1955 | 80 | 3,814 | Lans.-K.C. | 1 | 2,218 | 2,218 |
| Morel 15-9-21W | 1938 | 7,000 | 3,712 | "Sooy" | 217 | 1,472,364 | 19,797,750 |
| Morel East 12-9-21W | 1949 | 300 | 3,729 | Arbuckle | 5 | 31,433 | 313,639 |
| Morel North 3-9-21W | 1955 | 80 | 3,667 | Penn. congl. | 1 | 2,800 | 2,800 |
| Morel Northwest 7-9-21W | 1953 | Combined with Morel | | | | | |
| Morlan 23-10-21W | 1949 | 400 | 3,778 | Arbuckle | 11 | 54,379 | 427,455 |
| Muilenburg 1-10-21W | 1949 | 80 | 3,839 | Arbuckle | 2 | 3,375 | 29,673 |
| Nana 4-8-24W | 1953 | 700 | 3,738 | Lans.-K.C. | 26 | 197,641 | 296,803 |

Table 1. (Cont'd)

| Pool and Location of Discovery Well | Discovery Year | Area Acres | Depth Feet | Producing Zone | No. Wells | Production, bbl. 1955 | Production, bbl. Cumulative |
|---|---|---|---|---|---|---|---|
| Noah<br>27-10-21W | 1953 | 320 | 3,651<br>3,786 | Lans.-K.C.<br>Arbuckle | 3<br>9 | 11,194<br>43,652 | 163,361 |
| Penokee<br>11-8-24W | 1940 | 130 | 3,750 | Lans.-K.C. | 5 | 15,134 | 249,982 |
| Prairie Glen<br>25-10-23W | 1954 | 40 | 3,596 | Lans.-K.C. | 3 | 21,103 | 21,772 |
| Prairie Glen Southeast<br>21-10-22W | 1955 | 80 | 3,594 | Lans.-K.C. | 4 | 9,974 | 9,974 |
| Red Line<br>32-9-22W | 1955 | 640 | 3,776 | Lans.-K.C. | 4 | 8,001 | 8,001 |
| Red Line North<br>20-9-22W | 1955 | 40 | 3,676 | Lans.-K.C. | 1 | 2,358 | 2,358 |
| Sand Creek<br>27-8-21W | 1954 | 320 | 3,387<br>3,578 | Lans.-K.C.<br>Arbuckle | 1<br>1 | 321<br>4,408 | 5,318 |
| Schmied<br>21-8-25W | 1952 | 1,280 | 3,740 | Lans.-K.C. | 28 | 228,632 | 463,425 |
| Schnebly<br>8-8-22W | 1952 | 80 | 3,507 | Lans.-K.C. | 5 | 18,222 | 36,001 |
| Shiloh<br>1-9-25W | 1951 | 40 | 4,013 | Lans.-K.C. | 2 | 8,426 | 40,121 |

Table 1. (Concl.)

| Pool and Location of Discovery Well | Discovery Year | Area Acres | Depth Feet | Producing Zone | No. Wells | Production, bbl. 1955 | Cumulative |
|---|---|---|---|---|---|---|---|
| Smith-Denning 5-10-21W | 1950 | 900 | 3,530 | Lans.-K.C. | 17 | 77,712 | 511,405 |
| Spaulding 1-11-21W | 1953 | 160 | 3,573 | Lans.-K.C. | 4 | 18,927 | 18,927 |
| Van 14-9-22W | 1954 | 40 | 3,580<br>3,871 | Lans.-K.C.<br>Arbuckle | 2 | 12,693 | 14,492 |
| White Southwest 35-10-21W | 1953 | 500 | 3,539 | Lans.-K.C. | 24 | 221,601 | 375,663 |
| Wild Horse Creek 16-9-22W | 1950 | | 3,944 | Arbuckle | | no runs | 10,095 |
| Worcester 23-7-22W | 1951 | 40 | 3,792 | Arbuckle | 1 | 400 | 11,701 |

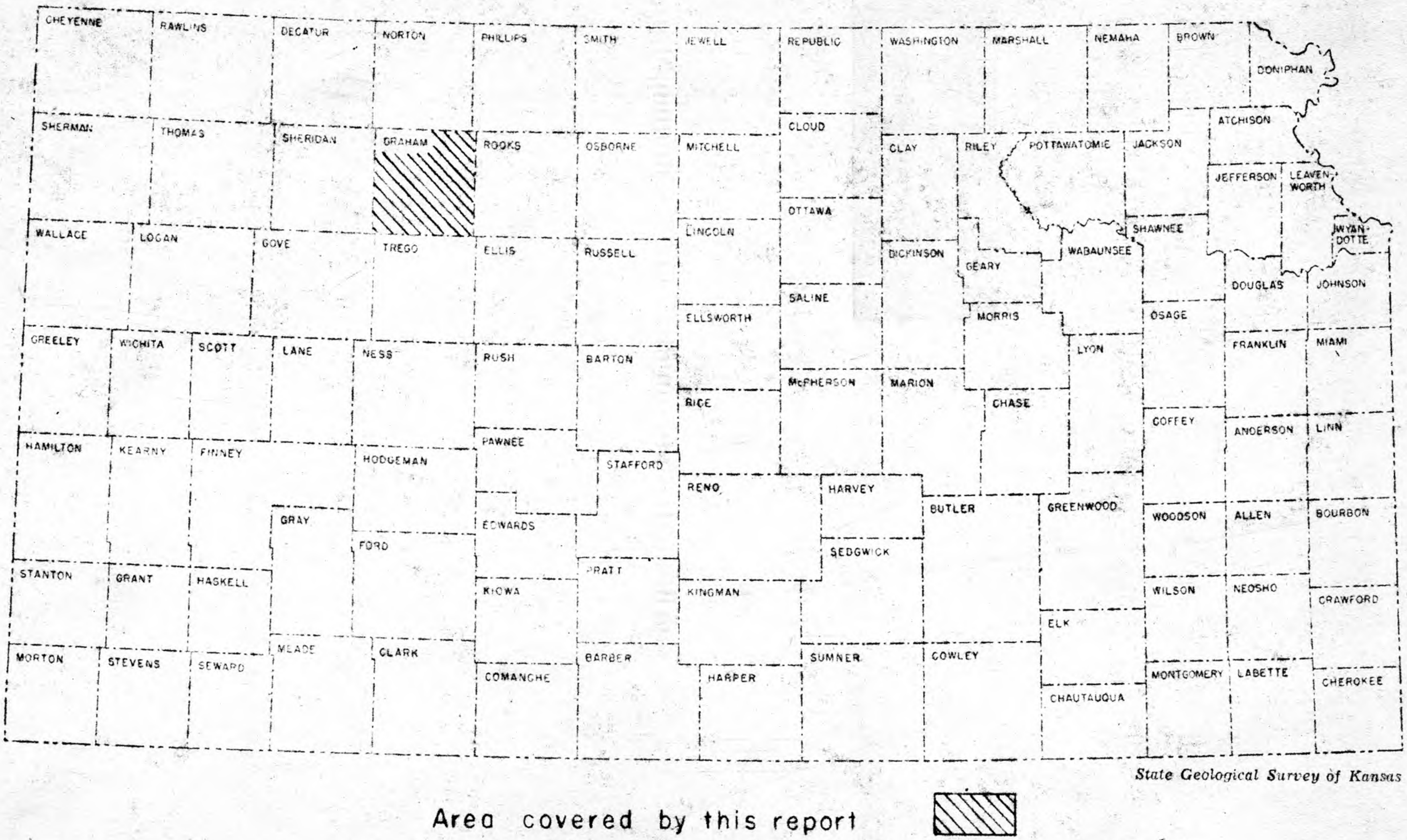



Fig. 1. Location of area covered by this report

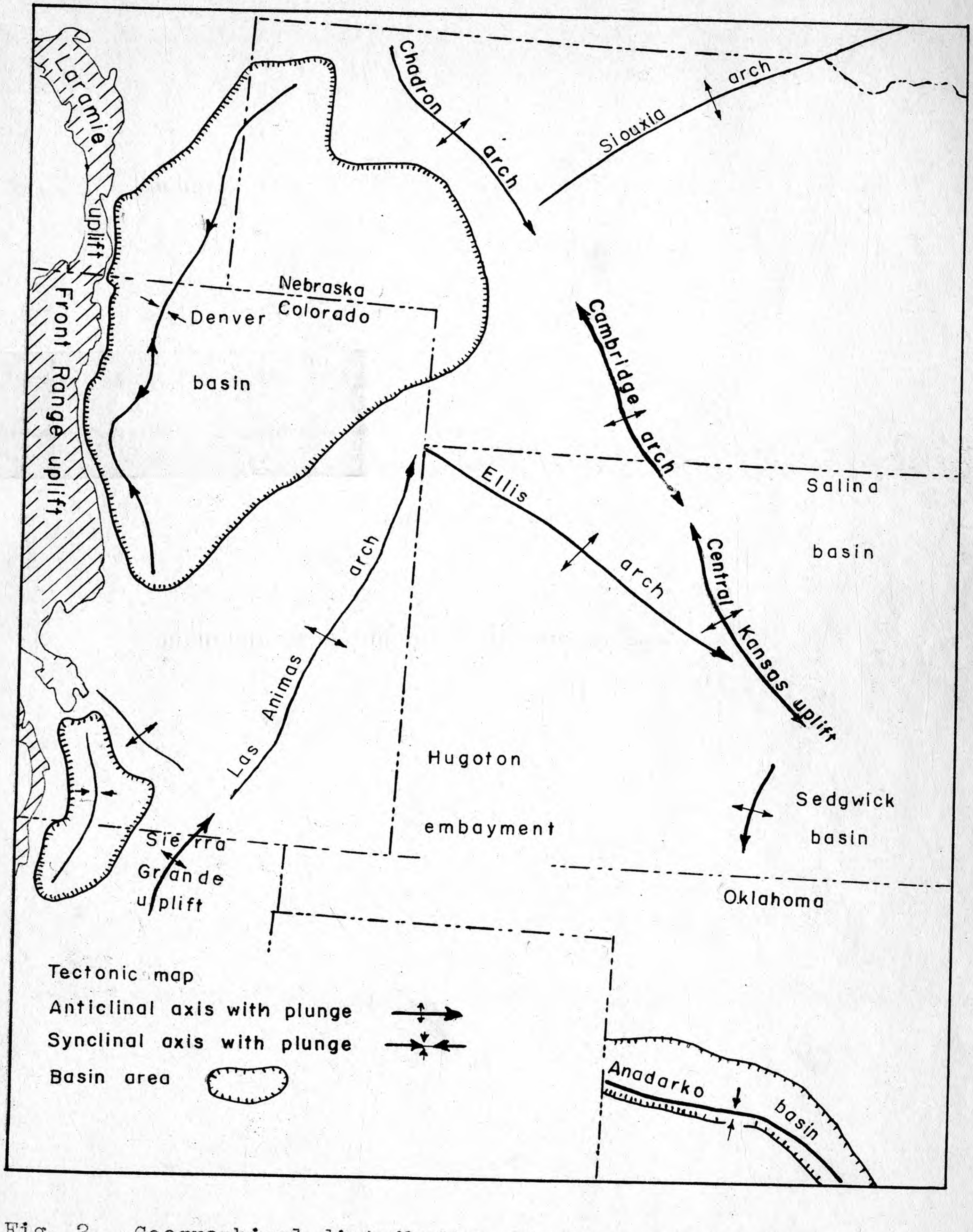



Fig. 2. Geographical distribution of major structures.

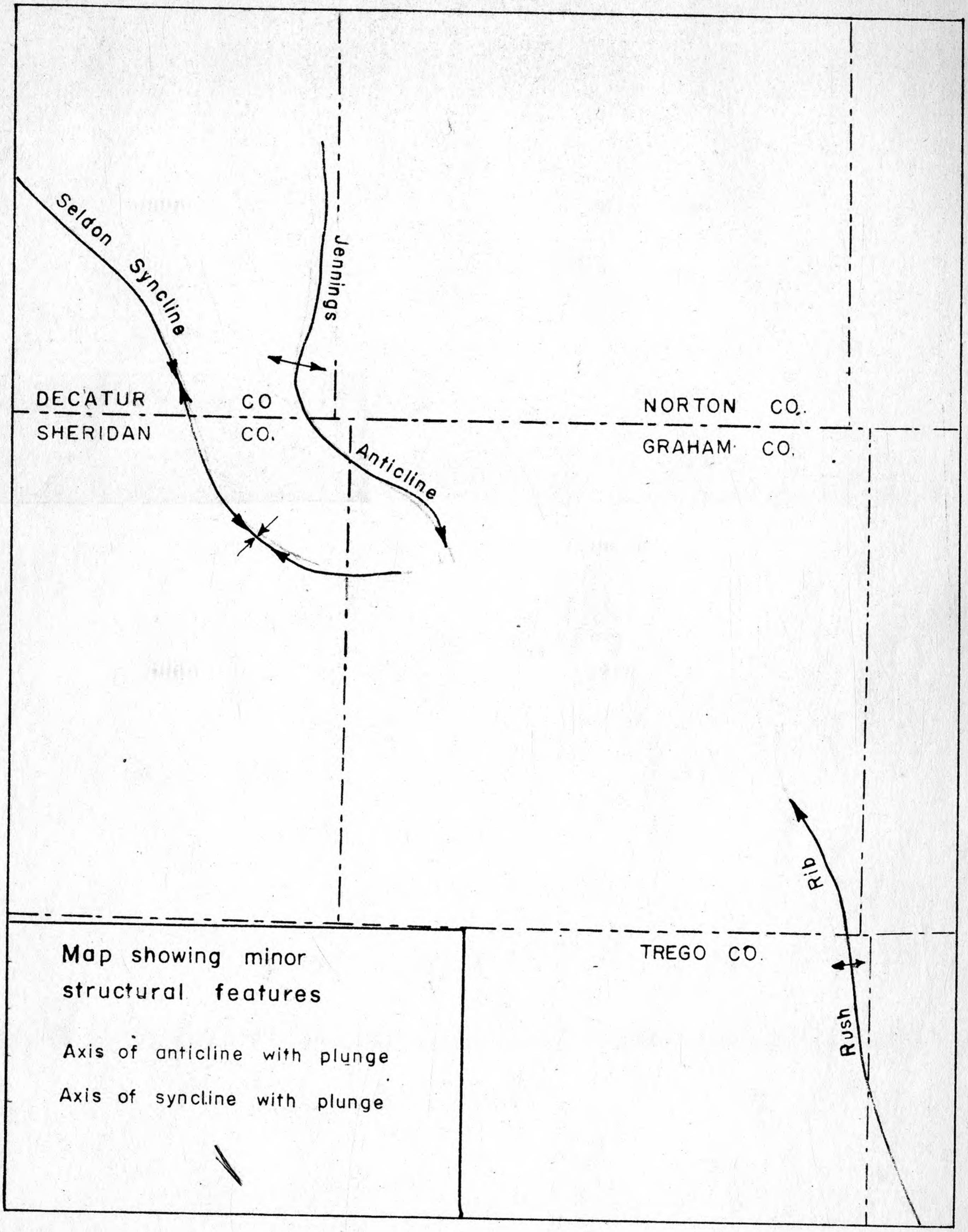



Fig. 3. Map of Graham County showing minor structural features.

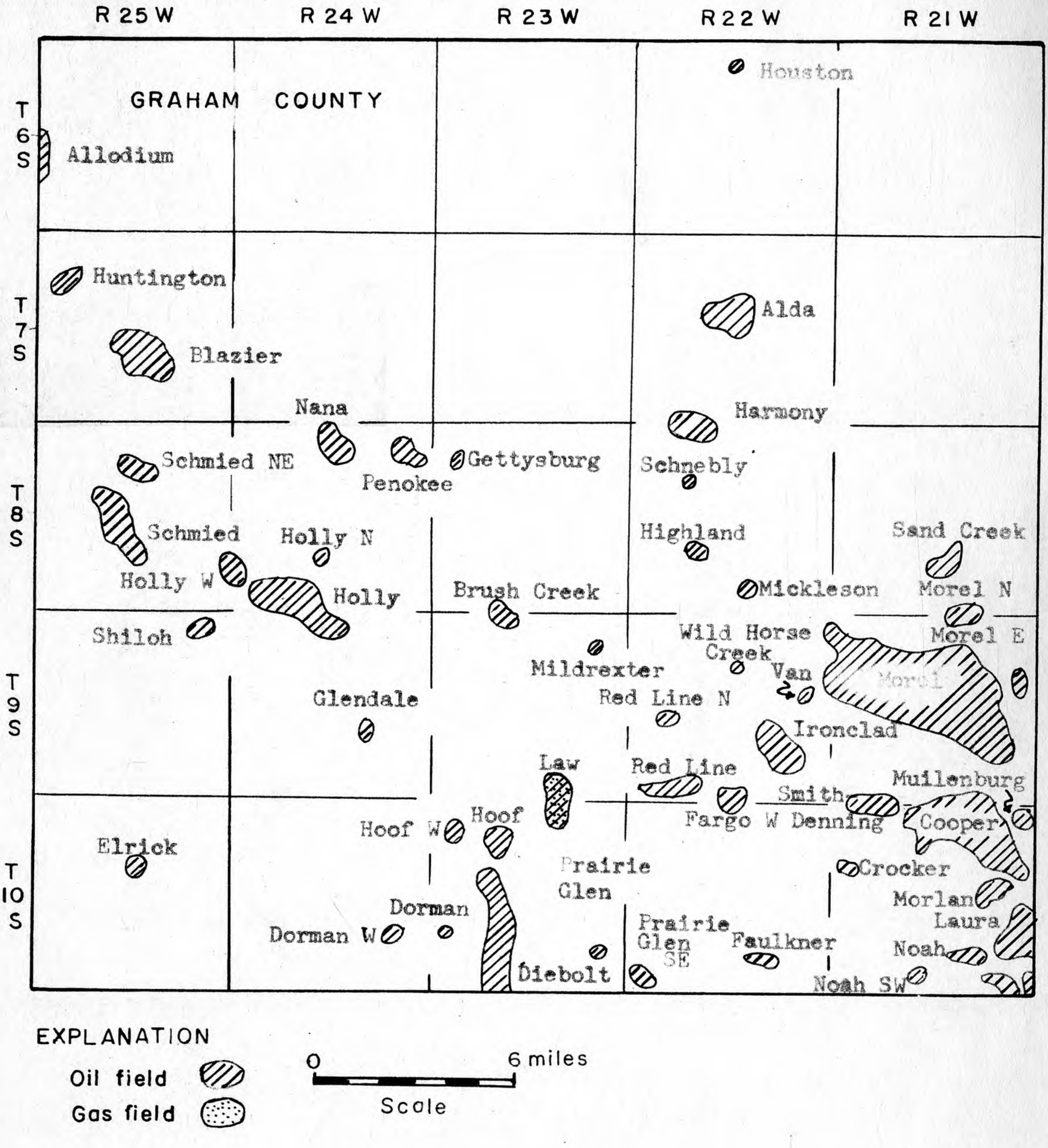



Fig. 4. Map of Graham County showing the location of producing oil and gas pools

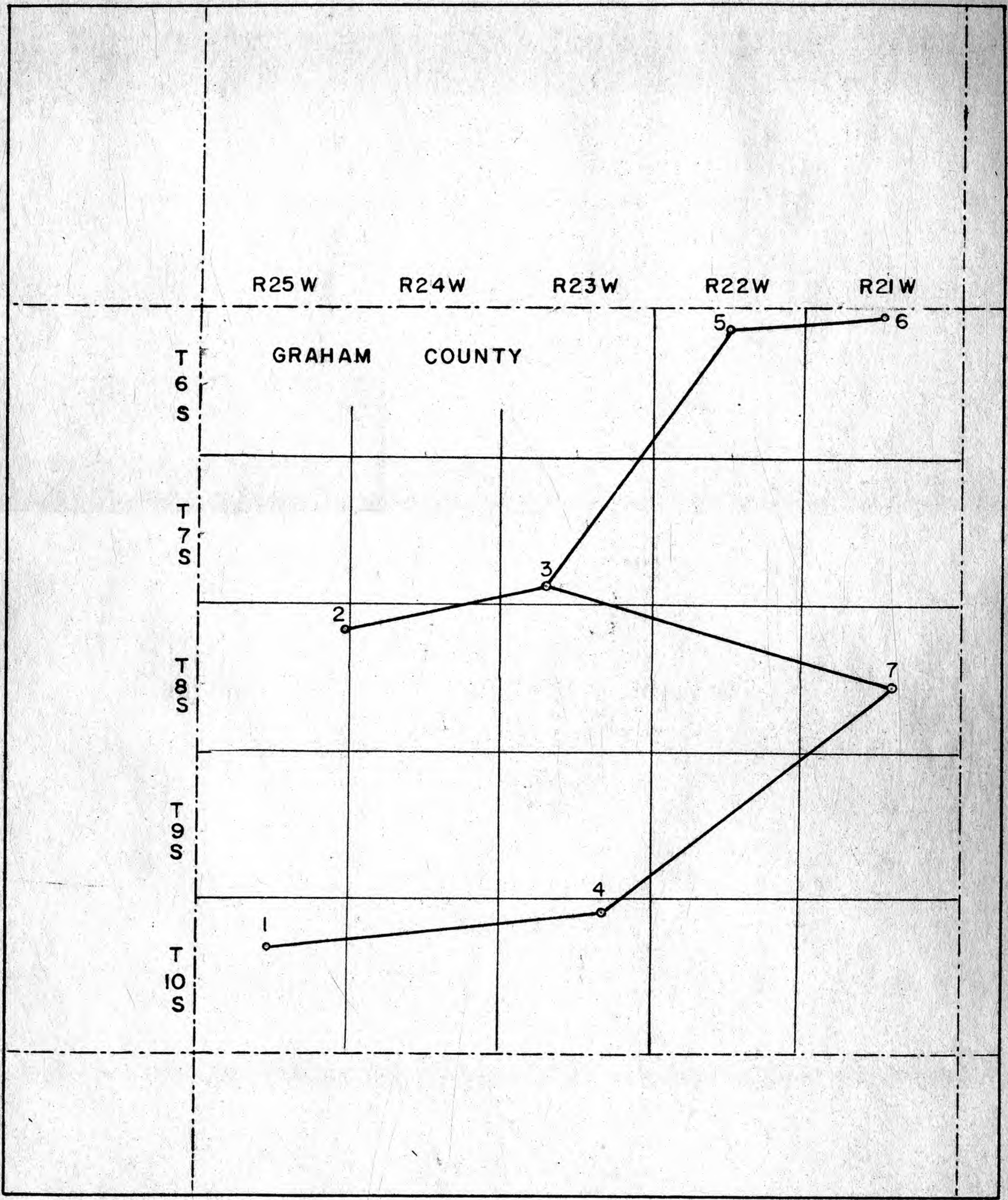
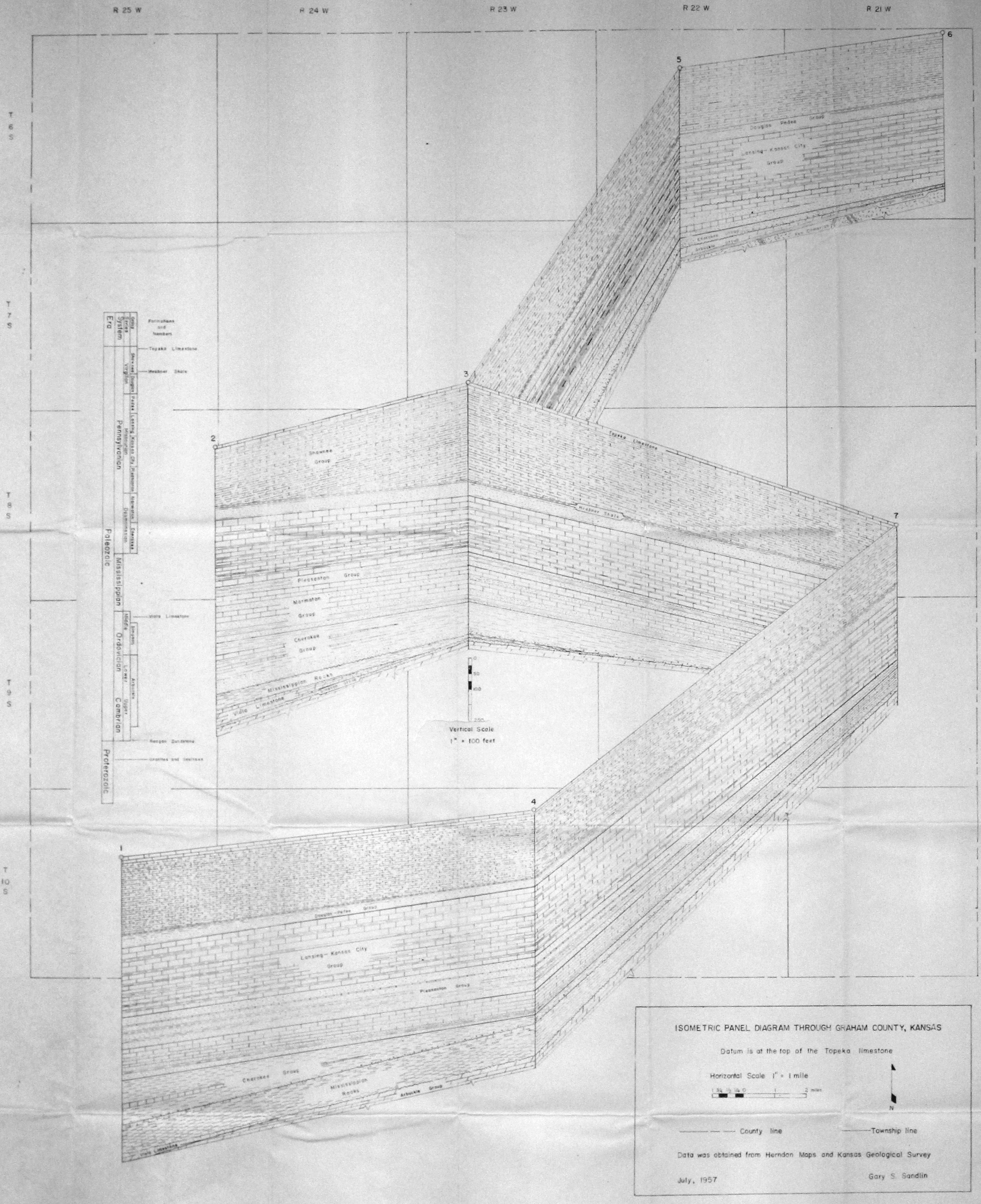



Fig. 5. Map of Graham County showing location of wells used in Fig. 6.

FIGURES 6 TO 9 INCLUSIVE

(in accompanying plate box)


R 25 W
R 24 W
R 23 W
R 22 W
R 21 W
T 6 S
T 7 S
T 8 S
T 9 S
T 10 S
Era
System
Series
Group
Formations and Members
Topeka Limestone
Heebner Shale
Virgilian
Shawnee
Douglas
Missourian
Pedee
Lansing
Kansas City
Pleasanton
Desmoinesian
Marmaton
Cherokee
Pennsylvanian
Paleozoic
Mississippian
Middle
Simpson
Viola Limestone
Ordovician
Lower
Arbuckle
Cambrian
Upper
Reagan Sandstone
Proterozoic
Granites and Schists
Shawnee Group
Pleasanton Group
Marmaton Group
Cherokee Group
Mississippian Rocks
Viola Limestone
Topeka Limestone
Heebner Shale
Douglas Pedee Group
Lansing-Kansas City Group
Pleasanton Group
Cherokee Group
Mississippian Rocks
Arbuckle Group
Vertical Scale
1" = 100 feet
ISOMETRIC PANEL DIAGRAM THROUGH GRAHAM COUNTY, KANSAS
Datum is at the top of the Topeka limestone
Horizontal Scale 1" = 1 mile
2 miles
N
County line
Township line
Data was obtained from Herndon Maps and Kansas Geological Survey
July, 1957
Gary S. Sandlin


STRUCTURE CONTOURS ON TOP OF ARBUCKLE GROUP

GRAHAM COUNTY, KANSAS

County Line

Township Line

Contour Line

Contour Interval = 25 feet

Scale 1" = 1 mile

0 1/2 1 2 3

Scale

N

By

Gary S. Sandlin

1957


STRUCTURE CONTOURS ON TOP OF LANSING-KANSAS CITY GROUP

GRAHAM COUNTY, KANSAS

County Line

Township Line

Contour Line

Contour Interval = 10 feet

Scale 1" = 1 mile

By

Gary S. Sandlin

1957

0 1/2 1 2 3

Scale

N


ISOPACHOUS MAP SHOWING THE THICKNESS FROM THE TOP OF THE LANSING-KANSAS CITY GROUP TO THE TOP OF THE BASAL PENNSYLVANIAN CONGLOMERATE, GRAHAM COUNTY, KANSAS

by

Gary [illegible] Sondik

1957

Contour Interval = 25 feet

Area of greatest thickness

County Line

Township Line

Scale 1" = 1 mile

0 1/2 1 2 3 miles

N

# SUBSURFACE GEOLOGY OF GRAHAM COUNTY, KANSAS

by

Gary Stuart Sandlin

B. S., Kansas State College
of Agriculture and Applied Science, 1955

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AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1957

Graham County covers 25 townships in northwestern Kansas. The purpose of this investigation was to determine the relationship of the subsurface structure, stratigraphy, and the geologic history of Graham County to the accumulation of petroleum. Structure maps, isopachous maps, and a panel diagram were constructed to show the relationship of petroleum accumulation to the Paleozoic rocks. Rock units present in northwestern Kansas range in age from pre-Cambrian to Quaternary, but Silurian, Devonian and Triassic rocks are absent.

Structurally, Graham County is located on the northwestern terminus of the Central Kansas Uplift, on the southwestern terminus of the Cambridge Arch, and partly within the northeastern extension of the Hugoton embayment. Three minor structures extend into Graham County, the Jennings anticline in the northwestern corner, the Seldon syncline in the west-central part, and the Rush Rib in the southeastern corner.

Geologic history indicates that erosional zones developed in post-Arbuckle and post-Missourian times are potential oil reservoirs. Oil accumulation associated with structural closures are found in the Arbuckle group and the Lansing group. Potential producing zones are the Reagan sandstone, the basal Pennsylvanian conglomerate, and the Marmaton group. Major oil production is obtained from the Lansing-Kansas City group and the Arbuckle group.

By 1956 the number of pools in Graham County had risen to 53 as exploration activity continued to increase. There were 17 new pools discovered in Graham County as the county led the state in the number of pools discovered.

Although the drilling activity has continued to increase, the possibility of discovering major pools in the county is limited. The future potential of the county is probably limited to the discovery of small pools with small structural closures and to stratigraphic traps in the Reagan sandstone and lower Pennsylvanian rocks.