SUB-SURFACE GEOLOGY OF MCPHERSON COUNTY, KANSAS

by

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INTRODUCTION

Location

McPherson County, an area of 1,300 square miles, is in central Kansas, and includes townships 17, 18, 19, 20, and 21 south, and ranges 1, 2, 3, 4, and 5 west. The county is bounded by Saline County on the north, Rice County on the west, Harvey and Reno Counties on the south, and Marion County on the east.

Figure 1 shows the area covered by this investigation.

Topography

Hills of the Cretaceous escarpment with 100 to 200 feet of relief are present in the northwestern and central northeastern parts of the area, while the remaining part of the county is characterized by low relief of large areas.

The Smoky Hill river, and tributaries of the Arkansas, Cottonwood, and Smoky Hill rivers drain the county.

Previous Investigations

Very little literature has been published that has been concerned with only the McPherson County area. Hiestand (1933) described the Voshell field; in 1941, Bunte and Fortier described the Nikkel pool in McPherson and Harvey Counties. Lee (1949) constructed a cross section that extends approximately south to north through the center of the eastern half of the county.

Several regional studies have been published that described the McPherson County area. Lee (1939 and 1940) described structural and stratigraphic features of Mississippian rocks. Taylor (1946) described the Hunton limestone, the Maquoketa shale (1947_b), and the Viola limestone (1947_a). Lee, et al., (1948) described the stratigraphy and structure of the Salina basin.

Detailed accounts of oil and gas exploration in the county have been published by the Kansas State Geological Survey (Ver Wiebe and others, 1948, 1952, 1953, 1954).

Purpose of this Investigation

The purpose of this investigation is to provide a detailed study of the subsurface formations with emphasis on structure and the relation of petroleum accumulation to geologic structure.

Procedure

Structural contour maps and geologic cross sections have been prepared for the study of this problem.

The formation tops of the cross sections have been determined from electric and gamma ray logs, and Figure 8 shows a generalized stratigraphic section as depicted by an electric log. Microscopic examination of well samples has been made, where possible, for the lithologic description of the formations. Sample logs of the Kansas Sample Log Service, Kansas Geological Survey sample logs, driller logs, and scout tickets have provided additional information for the preparation of the geologic cross sections.

Scout information of Herndon Map Service was used to obtain location of wells and formation elevations in the preparation of the structural contour maps. The Herndon Map Service information has been checked and in many cases revised by information from other sources.

Stratigraphic correlation and rock unit names are those used by the Kansas Geological Survey.

HISTORY OF DEVELOPMENT

The first producing well in McPherson County was drilled in September, 1926, by Merriman, Reeves, and Shidel. The well was drilled on the Anderson farm in sec. 29, T. 18 S., R. 2 W., and completed as a gas well. The first oil production was found by the Mid-Kansas Oil Company in July, 1928, on the Larson farm in sec. 31, T. 18 S., R. 2 W. These wells opened the McPherson pool, and were completed in the "Chat" of depths slightly less than 3000 feet (Ver Wiebe, 1940).

The Ritz-Canton pool was opened by the McPherson Oil and Gas Company No. 1 Wedel in sec. 12, T. 20 S., R. 2 W., October, 1928. Gas was found in the Mississippian "chat," and this pool is now the largest oil producing area in McPherson County (Ver Wiebe _et al_., 1948).

The third McPherson County pool to be discovered was the Voshell which was found in August, 1929, and this discovery caused one of the most intensive drilling programs witnessed in Kansas. The Voshell is the largest of the five pools on the

Voshell anticline trend, and has been the second largest producing field in the county (total production) (Ver Wiebe et al., 1954).

The McPherson Oil and Gas Company discovered the fourth pool, the Chindberg, in November, 1929. The location of the discovery well was in sec. 18, T. 19 S., R. 2 W.

Thirty-two additional pools which are producing in 1955 have been discovered in the county since 1930. The most important of these are the Johnson pool, discovered in 1932, the Graber, in 1934, the Lindsborg, in 1938, and the Crowther, in 1942.

Figure 6 shows the names and locations of the McPherson County oil and gas pools.

STRATIGRAPHY

General Statement

The stratigraphic sequence present in McPherson County is represented graphically in Figure 8. The electric log for the Auto Ordnance Corporation Community No. 1-B is used to show relative positions of the formations from the Wellington shale to the base of the Viola limestone. The electric log for the Auto Ordnance Corporation No. 1 Melander is used to show stratigraphic sequence from the base of the Viola limestone to the pre-Cambrian granite; microscopic analysis has been made of the samples from the Auto Ordnance Corporation Community No. 1-B. The sedimentary rocks in McPherson County have an average thickness of approximately 4000 feet, and range from pre-Cambrian to Quaternary in age.

Pre-Cambrian and Arbuckle rocks have been penetrated by only three wells in McPherson County. These wells are the Sinclair Moorehouse No. 8, sec. 4, T. 21 S., R. 3 W., (Fig. 10, well No. 2); Auto Ordnance Corporation Melander No. 1, sec. 9, T. 17 S., R. 3 W. (Fig. 6); and Phillips Petroleum Company Tecter No. 3, sec. 10, T. 18 S., R. 1 W.

Samples could not be obtained of pre-Simpson rocks from any of these wells, and descriptions of these sediments have been adopted from Lee (1948), McQueen (1931), and Keroher and Kirby (1948).

Pre-Cambrian System

The top of pre-Cambrian rocks is reported only as granite from wells of McPherson County. It has been reported as pink granite from wells in adjacent counties.

The configuration of the pre-Cambrian surface in McPherson County and adjacent area is shown by Figure 2. The contours show that the area is in a synclinal basin between the Central Kansas uplift and the Nemaha Arch. This has been referred to as the pre-Roubidoux synclinal basin by Lee (1948), and is shown in Figure 10 of his report. Lee has found the pre-Roubidoux sediments missing in areas adjacent to the pre-Roubidoux syncline, and suggests that these pre-Roubidoux sediments originally had a broader distribution and were eroded from these areas in post-Roubidoux times.

Upper Cambrian System

Lamotte Sandstone. The Lamotte sandstone consists of yellow to white, coarse, subangular to rounded sand grains with arkosic material. The arkose is generally at the base and probably is frequently logged as granite wash. The sandstone becomes finer-grained in the upper part and grades into the overlying Bonneterre dolomite.

The Lamotte sandstone is 60 feet thick on the electric well log of the well in sec. 9, T. 17 S., R. 3 W. The Moorehouse well (sec. 4, T. 21 S., R. 3 W.) is reported (Keroher and Kirby, 1948) to have penetrated 45 feet of Lamotte sandstone. The Lamotte is present in the pre-Roubidoux syncline area in McPherson County, but is probably absent in surrounding territory outside the pre-Roubidoux syncline (Keroher and Kirby, 1948).

Bonneterre Dolomite. The Bonneterre dolomite is referred to as fine-grained, finely to coarsely crystalline, glauconitic dolomite with almost no chert, and locally brown in color.

The Bonneterre, like the Lamotte, reaches maximum thickness in the pre-Roubidoux syncline, and thins toward the east and the west. Thicknesses of 170 and 183 feet are reported for the Melander and the Moorehouse wells respectively.

Upper Cambrian - Lower Ordovician Systems

Arbuckle Group. The Arbuckle group consists of Late Cambrian and Early Ordovician deposits; its subdivision in Kansas are units that crop out in Missouri. The members of the group are, in ascending order, the Eminence dolomite, the Van Buren formation, the Gasconade dolomite, the Roubidoux formation, and the Cotter and Jefferson City dolomites. The Eminence is Cambrian and the others Ordovician.

The entire sequence of the Arbuckle group is present in McPherson County. The Eminence, Van Buren, and the Gasconade are probably limited to the area of the pre-Roubidoux syncline; the Roubidoux, the Cotter, and the Jefferson City are present over the entire area.

The Arbuckle group consists mainly of coarsely granular, cherty dolomite. The formations of the Arbuckle group are not easily separated in the subsurface, and have not been separated in this investigation. McQueen (1931), in his pioneer work on insoluble residues, has made a detailed description of these rock units in the subsurface.

The Arbuckle group has an average thickness of 375 feet in McPherson County. A thickness of 712 feet was reported in the Moorehouse well (sec. 4, T. 21 S., R. 3 W.). This is an abnormal thickness for the locality and the well was undoubtedly drilled through the reverse fault on the west of the Voshell anticline. A sample log examined in a Wichita oil company office revealed repetition of the Arbuckle beds.

Simpson Group. The Simpson group includes the St. Peter sandstone and slightly older rocks of Lower Ordovician age and the Platteville formation of Middle Ordovician age. They are in unconformable contact with the top of the Arbuckle group.

The Simpson group has a thickness of 50 to 100 feet, and is present throughout the area.

The lithology is quite variable, and no effort was made to separate the St. Peter from the Platteville. The St. Peter is characterized by rounded, frosted, quartz grains with variable amounts of green shale, while the Platteville consists of dolomite with dolomitic shale.

The Simpson group in the northern part of the area consists of dolomite in the upper part with sandstone and shale below (Fig. 9). The Simpson rocks in the southern part of the area, however, consist of sandstone and shale, with dolomite being present only in well No. 6 (Fig. 10). This suggests that the St. Peter sandstone increases in thickness towards the south and the Platteville dolomite is not present in this area.

Middle Ordovician - Upper Ordovician System

Viola Limestone. The Viola limestone of Middle Ordovician age lies above the Simpson group. The Viola thickens to the north and ranges from an average of 30 feet in the south to an average of 70 feet in the northern part of the county. Figure 11 shows the structure on top of the Viola.

The Viola limestone is gray to tan, calcareous, coarsely crystalline limestone, and becomes more dolomitic toward the southwest.

Taylor (1947_a) has divided the Viola of Central Kansas into six zones, only three of which are generally present in McPherson County. He has shown zone 4 to be present in the northern one-half of the county, and zones 5 and 6 to be present over all of the county. Zones 1 and 3 are present only to a small extent in the eastern part of the county, and zone 2 is not present in McPherson County (Taylor, 1947_a). He has numbered his zones in descending order.

Zone 6 is a lower cherty limestone or basal clastic member; zone 5 is a lower calcareous limestone member, and zone 4 is a middle cherty limestone member that contains specked chert mixed with tan, crystalline limestone (Taylor, 1947_a).

Lee (1948) classified the Viola into four zones, and also placed the limestone with the specked chert in the Viola limestone.

The limestones of zones 5 and 6 in Taylor's report are classified as Viola limestone in this report, while the cherty member (zone 4) is placed in the overlying Maquoketa shale. This dark specked chert has been recognized in the microscopic examination of samples from well Nos. 1, 2, 3, and 4, of Figure 9. A section of sandy, micaceous shale, 42 feet in thickness, was found to separate 10 feet of gray dolomite with specked chert from the underlying calcareous limestone in well No. 4 of Figure 9. This can also be observed on Figure 8. The dolomite with the specked chert, however, was found in contact with the underlying calcareous limestone in well No. 3 (Fig. 9), thus indicating a pinchout of the sandy, micaceous shale between these two wells. Samples have not been examined immediately west of well No. 4 (Fig. 9), but it is believed that the dolomite containing specked chert grades into contemporaneously deposited Maquoketa shale in this direction. Hence, the dolomite containing specked chert is considered to be a facies change of the Maquoketa shale, and placed within the Maquoketa formation.

Maquoketa Shale. The Maquoketa shale of Upper Ordovician age overlies the Viola limestone and is considered by Taylor (1947_b), (Fig. 1), Lee (1948), (Pl. 5), and Lee (1949) to be absent in a pre-Chattanooga erosion valley in the central part of the county. This pre-Chattanooga valley, as defined by Lee (1948), traverses the central part of the county in an east-west direction, and has a width of approximately 10 miles.

A greater lateral extent of the Maquoketa is attained by combining the specked chert dolomite with the Maquoketa, and the Maquoketa is possibly present throughout the county.

The Maquoketa and Chattanooga shales are in contact in the central and northwestern parts of the county because of removal of the Hunton limestone. Separation of these shales, where in contact, is difficult, and samples logged as Chattanooga may in reality be Maquoketa; this would give the Maquoketa formation greater distribution.

The Maquoketa is green to gray dolomitic shale, or cherty dolomite, with one lithology frequently grading laterally into the other. It has an average thickness of 50 feet and increases in thickness from west to east.

Silurian and Devonian Systems

The Hunton limestone, where present, overlies the Maquoketa shale in McPherson County, and is considered to be of Silurian and Devonian age. Separation of Silurian from Devonian is difficult in samples, and has not been done in this report. The Hunton is present in the southern and northeastern parts of the area, but has been removed by erosion in the pre-Chattanooga valley (Lee, 1948).

The Hunton ranges from 0 to 100 feet thickness in the northeastern area, and 0 to 50 feet thickness in the southern area.

The Hunton limestone consists of gray to tan, crystalline, dolomitic or calcareous limestone. Chert and/or sand are sometimes present.

Mississippian or Devonian Systems

The shale sequence between the Mississippian and the Devonian or Ordovician limestones in McPherson County is named the Chattanooga shale. It is of either Mississippian or Devonian age. The Misener sandstone member at the base of the Chattanooga is only locally present in the county. It is probable that the Chattanooga and Misener are of Devonian age.

The Chattanooga shale is in unconformable contact with the underlying Viola, Maquoketa, and Hunton formations.

The Chattanooga is present throughout the county, and ranges from 80 to 275 feet in thickness. The Chattanooga attains maximum thickness in the pre-Chattanooga valley where these shales fill this erosional valley.

The Chattanooga is gray or greenish, fissle, shale containing lentils of limestone, and often becomes black and spore-bearing at the base. A bed of black shale with sub-rounded to rounded quartz grains was found to lie at the base of the

Chattanooga in the Community No. 1-B well.

The Misener sandstone member is present only in the western part of the county, and reaches a maximum thickness of 30 to 40 feet in the southeastern part of the county.

The Misener is a white to gray, medium to coarse grained, friable, phosphatic sandstone.

Mississippian System

The Mississippian limestone can be separated into two general zones, a lower one that consists of unweathered limestones and dolomites, and an upper weathered zone consisting chiefly of residual chert and red clay. Chert can be present throughout both zones, but a non-cherty limestone or dolomite is often present at the base of the lower zone.

The thickness of the Missippian rocks, because of erosion subsequent to anticlinal folding, is extremely variable (Figs. 9 and 10), and ranges from a minimum of 50 feet on the crests of folds to a maximum of 350 feet on the flanks and in the basins (Lee, 1939). The Mississippian rocks underlie the Pennsylvanian sediments with angular unconformity.

The lower zone is commonly white to gray, limestone or dolomite, and is frequently known as the "Mississippian lime".

The upper zone is often called the "Mississippian chat," and consists of either unconsolidated or cemented chert fragments, or chert fragments embedded in red clay. The weathered zone is considered to be a basal conglomerate of the Pennsylvanian period by many authors, and Moore (1926) was the first to describe it as such. However, this has been included in the Mississippian section because no attempt was made in this investigation to divide these sediments, and they are shown as one section in Figures 8, 9, and 10. Figure 12 shows the configuration of the upper surface of this section.

Lee (1940, 1948) has divided the Mississippian limestone section into three series in McPherson County. These are, in ascending order, the Kinderhookian, the Osagian, and the Meramecian. He has analyzed the lithologic nature of these series, and divided each into formations.

Kinderhookian series consists of the underlying Sedalia dolomite in contact with the Chattanooga shale and overlain by the Gilmore City limestone.

Osagian series consists of, in ascending order, the Reeds Spring limestone, the Burlington limestone, and the Keokuk limestone.

Meramecian series consists of the underlying "Warsaw" limestone overlain by the Spergen limestone.

Pennsylvanian System

The Pennsylvanian rocks, overlying the Pennsylvanian basal conglomerate, are divided into three series in McPherson County. They are, in ascending order, the Desmoinesian, the Missourian, and the Virgilian.

Desmoinesian Series. The Desmoinesian series is divided into the "Cherokee" group below and the Marmaton group above. This series is 190 to 250 feet in thickness over all of the area, except to the northwest where it averages 300 feet in thickness.

"Cherokee" Group. The "Cherokee" group extends from the top of the Pennsylvanian basal conglomerate to the base of the Fort Scott limestone. The group is in unconformable contact with the underlying Mississippian limestone but is essentially conformable with the overlying Marmaton group.

The "Cherokee" commonly consists of varicolored and gray shale and ranges from a 40 to a 100 foot thickness in the east to an average thickness of 170 feet in the west. Occasionally, thin non-persistent limestone is present in very minor amounts.

Marmaton Group. The Marmaton group consists of thin limestone alternating with gray shale, and is quite constant in thickness with an average of 150 feet. The limestones are quite similar, lithologically, to each other, and are usually gray, fine to medium crystalline, dense limestone. Outside of the Fort Scott limestone, the group is not divided into units in this investigation.

The Fort Scott limestone makes an excellent marker in the subsurface for the base of the Marmaton, and can readily be picked from an electric log. It is commonly gray, medium crystalline, dense limestone and ranges from 10 to 20 feet in thickness.

Missourian Series. The Missourian series is divided into three groups in McPherson County. These are, in ascending order, the Pleasanton group, the Kansas City group, and the Lansing group.

The thickness of the series is quite uniform throughout the county, with slight thinning to the north. The average thickness in the north is 370 feet, while the average thickness in the south is 420 feet.

The Pedee group is the youngest group of the Missourian series in the state of Kansas, but has been eroded in the subsurface of McPherson County during the hiatus between the Virgilian and the Missourian series.

Pleasanton Group. The Pleasanton group extends from the top of the Marmaton group to the base of the Hertha limestone, and its thickness is usually from 10 to 20 feet. Lee (1948) stated that the thickness of the interval is controlled by erosional relief at its base and also by regional warping of the pre-Pleasanton surface.

The Pleasanton usually consists of gray, silty shale in McPherson County.

Kansas City Group. The Kansas City group extends from the base of the Hertha limestone to the base of the Plattsburg limestone, and has an average thickness of 300 feet. The interval consists predominately of limestone with minor amounts of shale facies of varying thickness present. Although the limestone beds are shown very well by an electric log, caution is needed in their use for correlation as many of these limestones grade into contemporaneously deposited shale. These limestones are, in ascending order, the Hertha limestone, the Swope limestone, the Dennis limestone, the Drum limestone, the Iola limestone, and the Wyandotte limestone.

The Hertha limestone makes an excellent marker in the subsurface for the base of the Kansas City group and can readily be "picked" from an electric log. The Hertha is commonly gray, finely crystalline limestone and has an average thickness of 10 feet.

The Swope limestone is usually about 20 feet thick, but can be much thinner or even absent because of gradation into contemporaneously deposited shale. It commonly consists of gray to tan, finely oölitic, medium crystalline limestone.

The Dennis limestone has an average thickness of 20 to 30 feet, and is usually gray to tan, coarsely oölitic, coarsely crystalline limestone.

The Drum limestone consists of tan, finely crystalline limestone and has an average thickness of 10 feet.

The Iola limestone has an average thickness of 15 feet and consists of gray, finely crystalline limestone that was found to contain chert in one well.

The Wyandotte limestone is a white limestone that is sometimes oölitic. The thickness of Wyandotte, from 50 to 70 feet, makes it an excellent marker for subsurface correlation.

Lansing Group. The Lansing group extends from the base of the Plattsburg limestone to the top of the Stanton limestone, and has an average thickness of 95 feet. Lithologically, the Lansing is much like the Kansas City. It consists predominately of limestones with several shales of varying thickness and the limestones grade into contemporaneously deposited shale.

The interval consists of the Plattsburg limestone at the base and the Stanton limestone at the top, and it is in unconformable contact with the overlying Douglas group.

The <u>Plattsburg limestone</u> consists of gray, medium to coarsely crystalline, dense limestone which is sometimes cherty and oölitic, and gray shale which sometimes separates two limestone beds. It has an average thickness of 15 feet.

The <u>Stanton limestone</u> in outcrops is a sequence of three limestones alternating with two shale members (Moore, 1951). However, it is usually two limestones separated by a shale or all limestone in the subsurface of McPherson County, and has an average thickness of 30 feet. The Stanton is white limestone that is generally either cherty or oölitic, but may contain neither chert or oölites.

Although the top of the Stanton is often easily recognized and commonly listed in scout reports, it has been frequently misplaced in the past, and the "tops" listed by scout reports do not provide a dependable datum for close contouring in McPherson County.

<u>Virgilian Series</u>. The Virgilian series is divided into three groups in McPherson County. These are, in ascending order, the Douglas group, the Shawnee group, and the Wabaunsee group.

Douglas Group. The Douglas group consists of red and gray shale, one thin limestone, and a thick section of sandstone. It has an average thickness of 200 feet and is separated into two units: the Haskell limestone, and the Ireland sandstone.

The <u>Haskell limestone</u> is generally about 30 feet above the top of the Stanton and consists of brown, finely crystalline limestone or limey shale. It has an average thickness of 15 feet.

The Ireland sandstone is in the upper part of the Douglas group, and ranges in thickness from 40 to 180 feet. It consists of gray, fine-grained, well-sorted, sub-angular to sub-rounded, silty sandstone and becomes coarser and micaceous at its base.

Shawnee Group. The Shawnee group consists of limestone, shale and some sandstone, and has an average thickness of 350 feet. It extends from the base of the Oread limestone to the top of the Topeka limestone.

The group is divided into four thick limestone formations that are usually revealed by an electric log. These are, in ascending order, the Oread limestone, the Clay Creek limestone, the Lecompton limestone, the Deer Creek limestone, and the Topeka limestone. The lithology of the limestone is quite variable, and the limestone is oölitic and cherty.

Wabaunsee Group. The Wabaunsee group extends from the top of the Topeka limestone to the base of the Indian Cave sandstone member of the Towle shale, and the Indian Cave sandstone is considered to be the lowermost Permian deposit. The thickness of the group varies considerably because of the pronounced unconformity at its top and the minor disconformity at its base. The Wabaunsee group is a sequence of alternating limestones and shales with some sandstone, and most of the limestones are relatively thin. The group has been divided into many limestone formations, but only three of the limestone formations were recognized on an electric log. These are, in ascending order, the Howard limestone, the Happy Hollow limestone, and the Tarkio limestone.

Permian System

The Permian rocks, overlying the Wabaunsee group, of the Pennsylvanian system, are divided into two series in the subsurface of the area. These are the Wolfcampian and the overlying Leonardian.

Wolfcampian Series. The Wolfcampian series is divided into three groups. These are, in ascending order, the Admire group, the Council Grove group, and the Chase group. The series ranges from an average thickness of 235 feet in the north to 300 feet in the south.

Admire Group. The Admire group has a variable thickness because of the unconformity separating the Pennsylvanian and Permian rocks. The sequence consists predominately of shale with some sandstone and some relatively thin limestone. Subsurface correlation of the limestones in the Admire group is difficult and none can be easily recognized on an electric log.

Council Grove Group. The Council Grove group extends from the base of the Foraker limestone to the base of the Wreford limestone and has an average thickness of 300 feet. The sequence consists of alternating beds of limestone and red, varicolored shale. The group has been divided into seven limestone formations, all of which were recognized on electric logs. These are, in ascending order, the Foraker limestone, the Red Eagle limestone, the Grenola limestone, the Beattie limestone, the Bader limestone, the Crouse limestone, and the Funston limestone.

Chase Group. The Chase group extends from the base of the Wreford limestone to the top of the Nolans limestone and ranges in thickness from 350 to 375 feet. The sequence consists of alternating formations of limestone and shale, with much of the limestone containing chert.

The sequence has been divided into four limestone formations and all of these were recognized on electric logs. They are, in ascending order, the Wreford limestone, the Barneston limestone, the Winfield limestone, and the Nolans limestone.

The Barneston limestone, with an average thickness of 100 feet makes an excellent marker for subsurface correlation and is easily recognized on an electric log. The Barneston is also easily recognized in samples with the non-cherty Fort Riley limestone member at the top and the very cherty Florence limestone member at the base.

Leonardian Series. The Leonardian series is represented in the subsurface of McPherson County by the Sumner group which is undifferentiated in this investigation. The Sumner group has a variable thickness and is a sequence of evaporites and shales.

The cross sections of Kellet (1932) shows the thick Hutchinson salt member, of the Wellington formation, of the Sumner group, present in the western one-third of the county, but absent in the eastern two-thirds. The salt was originally present throughout the subsurface of the county, but has been removed by leaching associated with settling and deformation of the overlying beds.

Cretaceous, Teritary and Quaternary Systems

Tertiary and Quaternary sand, clay, and gravel overlie the consolidated Permian rocks throughout most of the county. Cretaceous rocks, represented by the Kiowa shale formation, overlie Permian sediments in the northwestern and northeastern parts of the county.

GEOLOGIC HISTORY

Publications by Lee (1948, 1949) and Figures 9, 10, and 12 were used as regional sources of information relative to the geologic history of McPherson County.

Four major periods of folding have occurred in this particular area since pre-Cambrian time. These are, in chronological order: (1) pre-St. Peter, (2) post-Arbuckle to pre-Mississippian, (3) post-Mississippian to pre-Marmaton with diminished activity through Pennsylvanian and Permian time, and (4) post-Cretaceous.

The upper Cambrian sea extended over all of McPherson County and ranged from a shallow sea in which the Lamotte sandstone was deposited, to a fairly deep sea in which the Arbuckle sediments were deposited. This fairly deep sea extended into lower Ordovician time, and an exact time line is difficult to draw between the two periods. Erosion followed Arbuckle deposition so that post-Arbuckle sediments were laid down on an erosional topography.

The depositional environment following the Arbuckle erosional period varied from a shallow fluctuating sea in which the Simpson group was deposited to a fairly deep sea in which the Viola and the Maquoketa sediments were laid down.

This fairly deep sea extended into Silurian and Devonian time, and the Hunton limestone was deposited in conformable contact with the underlying Maquoketa shale.

Prior to Chattanooga deposition, the McPherson County area was slightly uplifted and subjected to extensive erosion. The pre-Chattanooga valley was formed at this time, and this valley cut through the Hunton and into the Maquoketa rocks with an outlier of Hunton and Maquoketa rocks being formed south of the valley.

The Chattanooga shale was deposited unconformably on older truncated formations in either Lower Mississippian or Upper Devonian time. This was followed by a thick section of Mississippian cherty limestone being deposited in essentially conformable contact with the underlying Chattanooga shale.

The cherty Mississippian limestone was uplifted and eroded in post-Mississippian, pre-Marmaton time, and the basal Pennsylvanian deposit of weathered chert was formed at this time.

A marine sedimentation environment prevailed during the remaining part of the Pennsylvanian period, and fossiliferous limestone interbedded with shale and some sandstone was deposited. Diminished structural movement during the period is represented by minor unconformities appearing at the close of each series.

The marine sedimentation continued into Permian time, with interbedded marine limestone and shales being deposited until the end of the Wolfcampian time.

Following the end of the Wolfcampian time, the seas withdrew to the south and a sequence of non-marine evaporites was deposited during Leonardian time.

The area was probably above sea level during Triassic and Jurassic time, and a major portion of a thick Permian salt bed was removed by leaching. The Kiowa shale was probably deposited over the entire county in lower Cretaceous time, but has since been eroded over much of the county.

Tertiary and Quaternary sediments are found on the surface and are represented by alluvial and eolian deposits in the stream valleys.

STRUCTURE

General Statement

Structural contour maps have been made of the Viola and Mississippian horizons (Figs. 11 and 12), and reference to these should be made in reading the material on subsurface structure. Figure 3 shows the relative concentration of wells used in contouring the Viola surface, and Figure 4 shows the concentration of wells used in constructing the Mississippian surface.

Cross sections, extending approximately east-west, have been made of the interval from the top of the Lansing group to the pre-Cambrian surface, and these show the structural conditions within the area.

Figure 6 shows the locations of the oil pools in McPherson County and will be helpful reference in reading the material on subsurface structure.

Geologically, the area occupies a central position and is either flanked by or included in many of the major structures in the state. It is also traversed by several of the more prominent minor structures within the state of Kansas. Pre-Mississippian regional structures, pertaining to the area, are shown on Figure 5, and Figure 6 depicts post-Mississippian regional structures. Figure 5 is a location map of these structures.

Sub-surface Structure of McPherson County

The sub-surface structure of McPherson County consists of regional dip interrupted by anticlinal structure and associated faulting.

The sub-surface structure of McPherson County can be divided into two areas which show marked contrast with each other.

The eastern one-half of the county is an area characterized by relatively high elevations and regional Ozark monoclinal dip to the west which is interrupted by anticlinal folds of small vertical magnitude. This regional monoclinal dip is shown by wells 5, 6, and 7 of Figure 9, and by wells 3, 4, 5, and 6 of Figure 10. Wells 4, 5, and 6 of Figure 10 reveal the structure of the Graber pool, which is a typical example of the anticlinal folds in the eastern part of the area. This area is sharply contrasted in the centers of T. 21 S., R. 3 W., and T. 20 S., R. 3 W., where the Voshell anticline and a narrow asymetrical, adjacent syncline show intense folding. These features represent some of the most sharply folded structure in the state of Kansas.

The general structure of the western one-half of the county is a regional syncline, and is characterized by relatively low elevations. The northern part of this area has some anticlinal structure, while the southern part is almost completely dominated by the Conway syncline. Wells 1, 2, 3, 4, and 5 of Figure 9 and well 1 of Figure 10 show the monoclinal dip in this area. Wells 3, 4, and 5 of Figure 9 show the structure of the Lindsborg pool, which is the most prominent anticline in the western half of the county.

The most important period of folding in McPherson County occurred during pre-Marmaton, post-Mississippian time and has formed most of the anticlinal structure in the area. The Nemaha anticline was formed at this time along a narrow linear north-east, south-west trending fold. A majority of the anticline folds in McPherson County show a north-east, south-west elongation and are considered to be associated with the Nemaha. The Lindsborg pool, the Voshell trend, the Halstead-Graber trend and several other anticlinal folds are good examples of this.

Koester (1935) observed a trend of pre-Mississippian warping that extends in a northwest-southeast direction from the Wilson dome in Russell County through the Ritz-Canton and McPherson fields in McPherson County to the Burns dome in Butler

County, and named this the Wilson-Burns element.

This structural element was not easily recognized in the sub-surface mapping, but it may exist and be obscured in many places by the more dominant pre-Marmaton, post-Mississippian folding. The contrast between the dome-shaped, northwest-southeast elongated McPherson County structure and the linear-shaped, northeast-southwest elongated structures of the Voshell, Johnson, and Chindberg pools, all located on the Voshell trend, is cited as evidence of the existence of the Wilson-Burns element. The contrast between the broad, dome-shaped Ritz-Canton field and the long, linear-shaped Voshell trend is also evidence for this element. Hiestand (1933) has stated: "Broad domes are observed at the intersection of structural trends of approximately equal magnitude and the shapes of structures are usually criteria to indicate the nature of the mechanics involved." Therefore, the Ritz-Canton and McPherson structures were possibly folds elongated in a northwest-southeast direction in pre-Mississippian time that were developed into dome-shaped structures by pre-Marmaton, post-Mississippian folding.

The pre-Roubidoux syncline (Lee, 1948) reflects pre-St. Peter folding in McPherson County and the synclinal structure is shown by Figure 2. Figure 2 has been adapted from Mettner (1935) with new information added, and shows the topography of the pre-Cambrian surface in McPherson County and adjacent area. The trend of the syncline is shown by Figure 5.

Nearly all of the sediments in McPherson County have been tilted to the west by the Prairie Plains homocline during post-Cretaceous time (Lee, 1948).

The most striking structural feature in the county is the Voshell anticlinal trend and its associated faulting. The Voshell trends slightly east of north and extends from the lower center of T. 21 S., R. 3 W. to the southwest corner of T. 18 S., R. 2 W., a distance of approximately 21 miles. Located on the trend of the Voshell in McPherson County are the northern end of the Hollow-Nikkel pool, the Voshell pool, the Johnson and Johnson south pools, the Chindberg pool, and the McPherson pool. Some geologists have considered the Reuben and Bonaville pools to be accumulations of petroleum trapped by faulting and extended both the fault and the anticlinal trend to the Saline County border. The Reuben and Bonaville pools are not considered to be accumulations of petroleum trapped by faulting in this investigation because of lack of fault evidence, and the area north of the McPherson pool (southwest corner of T. 18 S., R. 2 W.) has been contoured without a fault.

Barwick (1928) suggested that the Voshell is a southern extension of the Abilene anticline, while Lee, et al., (1948) have stated that the two probably are not connected, despite the fact that they are approximately in the same trend. McClellan (1937) published an official pool map which showed the trend of the Abilene anticline to enter McPherson County at the southeast corner of T. 17 S., R. 1 W., and extend southward through the Graber pool.

This investigation does not support a northward extension of the Voshell trend to the Abilene anticline, and prominent anticlinal features were not found north of the McPherson pool. The Voshell trend appears to be terminated by a northwest, southeast trending fault and syncline on the north side of the McPherson structure.

The Fanska (in Marion County), the Crowther, the Paden, the eastern side of the Ritz-Canton, (T. 19 S., R. 1 W.), and the Graber pool structures show a northeast, southwest trend and this trend is considered to be the most probable southern extension of the Abilene anticline. This trend is not clearly evident in the vicinity of the Ritz-Canton pool (T. 19 S., R. 1 W.), but has been possibly obscured by pre-Marmaton, post-Mississippian folding of pre-Mississippian structure.

The Abilene anticline can be traced on the surface from Riley County to the town of Abilene (Lee, 1948), where it becomes lost in the sub-surface. The area between the town of Abilene and the northeastern corner of McPherson County is outside the scope of this investigation, and literature that detailed the sub-surface structure of this area could not be found. A sub-surface investigation of this area would possibly reveal the southward trend of the Abilene anticline and locate favorable structure for future petroleum exploration. The trend and the proposed southern extension of the Abilene anticline are shown in Figure 6.

The Voshell "trend" consists of a series of anticlinal folds, or domes, that are faulted on the west and plunge to the south. Figure 10 is a cross section that extends across the Voshell pool of the anticlinal trend, and well No. 2 is a well in the Voshell field. The folding and faulting in the Voshell trend are considered to have occurred simultaneously, and are considered to be pre-Marmaton, and post-Mississippian in age.

The Voshell trend is intersected by a reverse fault that is approximately parallel to the anticlinal axis; the fault is located about one-fourth of a mile to the west of the anticlinal axis. The fault has a maximum throw of 350 feet and the throw has been found to increase progressively with depth.

Definite evidence of the Voshell faulting exists in four different wells. These are (1) the Independent Oil Company well in the NE¼, NE¼, SW¼, of sec. 9, T. 21 S., R. 3 W., where repetition of the Viola and slickensides were reported; (2) the Sinclair Oil Company well in the center of the east line of the SE¼, of sec. 28, T. 20S., R. 3W., where repetition of the Simpson has been found; (3) the Sinclair Oil Company well in the SW¼, NW¼, NE¼, of sec. 4, T. 21 S., R. 3 W., where repetition of the Arbuckle has been found; and (4) the Dickey Oil Company well in the SE¼, SW¼, NW¼ of sec. 13, T. 19 S., R. 3 W., where repetition of the Mississippian has been found.

The formations in a well located in the SW¼, SE¼, SW¼ of sec. 20, T. 18 S., R. 2 W., were found to be much lower than in nearby wells, and a northwest, southeast trending fault has been placed at the north end of the McPherson structure. The differences in elevation caused an abnormal dip, and the area has been contoured as faulted, although the criterion of steep dip is not considered to be definite evidence of a fault.

The Conway sincline was named by Koester (1935) and defined as, "The low area west of the McPherson anticline, or Voshell trend, that is evident in western McPherson County and northeastern Reno County." This syncline was evident in Figures 11 and 12 of this investigation as extending through the center of the southwestern part of the county in a north-south direction and dividing the westward (Ozark dome) dip from the eastward (Central Kansas uplift) dip, (Fig. 5).

The Conway syncline is clearly defined in the southwestern part of the county, and may extend through the synclinal area in the center of the northwestern part of the county. Clark, et al., (1948), however, have shown a long, curving synclinal trough that traverses the northeastern part of Reno County and the southeastern part of Ellsworth County in a northwest direction. They did not mention the Conway syncline by name, but suggested that this was a northern extension of the Conway.

Since either of these synclinal areas could be an extension of the Conway syncline, only the well defined synclinal area in the southwestern part of the county is considered to be the Conway syncline (Fig. 6).

Lee (1939) has shown that a close relationship exists between the thickness of the Mississippian limestones and the geologic structural features in McPherson County, and he has used this criterion to delineate a low, arch-like structure that trends east-west across the central part of McPherson County and separates the Sedwick and Salina basins (Lee, et al. 1948, Pl. 8). Barwick (1928), p. 179, referred to this structure as a saddle between the Chautauqua arch and the Barton arch, and considered it the southern boundry of the Salina basin. Barwick's Barton arch is now generally known as the Central Kansas uplift. The trend of this unnamed, arch-like structure is shown by the dotted line drawn between the Sedwick and Salina basins on Figure 6.

OIL AND GAS PRODUCING ZONES

Most of the following oil and gas production data has been obtained from the State Geological Survey of Kansas Bulletin No. 107, Oil and Gas Developments in Kansas During 1953, Ver Wiebe, et al., 1954.

Most petroleum production in McPherson County has been obtained from pre-Pennsylvanian sediments, and the Mississippian limestone and "chat" are the most prolific producing horizons. Petroleum is produced from only Mississippian beds in 21 of the 37 oil pools and the Mississippian is one of the producing horizons in an additional seven of these oil pools. The Viola limestone is the next largest producer of petroleum in the area, and petroleum has been obtained from the Simpson group, the Maquoketa dolomite, the Hunton limestone, the Misener sandstone, and the Lansing-Kansas City limestones. Petroleum was formerly produced from the Arbuckle limestone in the Voshell pool, but this zone is no longer productive. Figure 11 shows the pools where production has been obtained from the Viola limestone, and areas of productive Mississippian sediments have been delineated on Figure 12.

Sandstone of the Simpson group is productive in the following pools: Bonaville, Reuben, Roxbury, Lindsborg, and Lindsborg South. The Hunton limestone is the producing horizon in the Graber and Nickkel pools, while the Misener sandstone has been found productive in the Graber and formerly in the Voshell pool.

The Kansas Geological Survey and others believe that the Viola limestone is the reservoir rock of the Lindsborg pool. However, since the productive interval is the specked chert zone, the Lindsborg pool probably produces from the Maquoketa dolomite. Elsewhere, the production from the Viola is probably in a lower zone (Taylor, 1947_a), and is Viola production.

Lee (1939) stated that the producing zones in Mississippian rocks are dependent on the porosity of the limestone and appear to be independent of the stratigraphic formations. Folding of the Mississippian rocks brought the various formations of the Mississippian to the surface and subjected them to weathering and leaching, thus forming secondary porosity. Consequently, the productive horizons of the Mississippian limestone occur at various depths below the surface of the Mississippian. Oil production from the zone of weathered chert ("chat") has been found at or near the top of the Mississippian rocks, while lower production from porous zones has been found 100 feet or more below the top of the Mississippian surface (Lee, 1939).

Petroleum is produced from various oölitic limestones of the Kansas City and Lansing groups, and this is referred to as Lansing-Kansas City production.

Accumulation of oil in the Simpson group is obtained from the uppermost sandstone in the group, and accumulation in the Viola, the Maquoketa, the Misener, and the Hunton is found at the uppermost part of the formations.

The Mississippian sediments contain the largest amounts of natural gas in McPherson County, and gas is produced from the Mississippian limestone or "chat" in the five gas pools shown on Figure 12. The Viola limestone and the Lansing-Kansas City limestones are productive of gas in the McPherson pool. Gas has been produced from other pools in the past which are no longer productive.

RELATION OF PETROLEUM ACCUMULATION TO GEOLOGIC STRUCTURE

Production in McPherson County is chiefly from anticlines and most of the accumulation is controlled by structure. All but nine of the individual pools in McPherson County appear to be controlled by structure, although extensive pool studies were not made and only a few of the pools have been described in the literature.

The Nikkel pool is a good example of the stratigraphic type of pools in the area, and has been described (Bunte and Fortier, 1941) as being a faulted anticline closed on the north by the pinchout of the Hunton limestone. Other examples of stratigraphic accumulation are shown by the Lively, the Windom, and the Georob pools on Figure 12, where closure is not depicted by the outlines of the pools.

Most of the anticlinal structures in McPherson County are relatively small and have 50 feet or less of closure. This is strongly contrasted by the pools of the Voshell trend where the Voshell pool was found to have 325 feet of closure and all of the other pools located on the trend have 100 or more feet of closure.

A slight westward shifting of structural axis progressive with depth was generally observed throughout the county. This is most pronounced in the Lindsborg pool, and can be seen by a comparison of Figure 11 with Figure 12. The shift of axis in the Lindsborg pool, between the Mississippian and the Viola limestones, is approximately one mile to the west.

It was observed that most of the pre-Marmaton, post-Mississippian structures became more acutely folded progressively with depth. The Lindsborg pool is a good example of this with 50 feet of closure present on the Viola horizon (Fig. 11) as compared to no closure being present on the Mississippian (Fig. 12).

AREAS FOR FUTURE EXPLORATION

Several areas have been delineated by the work of this investigation that appear to be highly favorable for future exploration.

A long, narrow anticlinal fold with approximately 25 feet of closure is present near the center of T. 17 S., R. 4 W., on Figure 11. This area is almost completely untested, and future exploration may find commercial quantities of petroleum along this structure. The Continental Oil Company No 1 Mattson well in sec. 8, T. 17 S., R. 4 W., had a show of oil in the Maquoketa dolomite, but the water ratio was too high when perforations were made (Ver Wiebe, et al., 1952). This anticlinal structure is shown by wells 1, 2, and 3 in Figure 9, and also revealed by Figure 11.

A small dome with 25 feet of closure and a northwest-southeast elongation has been contoured in the central part of T. 18 S., R. 4 W., on Figure 11. Although this structure has been somewhat tested, future exploration may still discover a new pool in this area. Shows of oil were found in the Victor Drilling Company No. 1 Swanson well in sec. 21, T. 18 S., R. 4 W., in the Viola limestone and the Simpson sandstone (Ver Wiebe, et al., 1953). The northwest-southeast elongation and the obscurity of this feature on the Mississippian map (Fig. 12) suggest that the fold is associated with the Wilson-Burns trend of the pre-Mississippian folding.

A pronounced structural nose that plunges southeast is evident in the western part of T. 17 S., R. 5 W., on Figure 11. Although drilling, to date, has not revealed closure in this area, there is considerable structural relief that should warrant further exploration. The elongation, geographic location, and loss of relief on the Mississippian surface suggest that this structure is associated with pre-Mississippian Wilson-Burns warping.

Another area for future exploration was observed in the northwestern part of T. 21 S., R. 2 W., where a broad structural nose is present on Figure 11, and 25 feet of closure is present on Figure 12. This area should warrant further exploration despite the fact that several tests have failed to find production.

Further possibilities for future exploration exist along the area of the pre-Chattanooga valley where the Chattanooga shale, well established as a source rock, is in contact with the Hunton, the Viola, and the Maquoketa reservoir rocks. Excellent possibilities exist along the edges of this area for stratigraphic type traps along the pinchout areas of the Hunton limestone and the Maquoketa dolomite.

SUMMARY OF FINDINGS

A nearly-normal stratigraphic sequence of marine sediments is encountered in the sub-surface of McPherson County that ranges from pre-Cambrian to Quaternary in age, and averages 4000 feet in thickness. An upper zone of Viola limestone has been considered to be a facies change of the Maquoketa shale, and placed within the Maquoketa formation.

Northeast-southwest trending post-Mississippian, pre-Marmaton folding created most of the anticlinal structure, but northwest-southeast trending pre-Mississippian folding is evident, and is considered to be a contributing factor to the tectonic framework of the area.

The sub-surface structure of McPherson County consists of regional dip interrupted by anticlinal structure and associated faulting. The anticlinal structures are not intensely folded except in the Voshell trend where anticlinal folds show intensive folding and faulting.

The Voshell trend is a series of anticlinal folds, or domes, that are faulted on the west and plunge to the south. A reverse fault, with a throw of approximately 350 feet, is located one-quarter of a mile to the west from the anticlinal axis of the trend. The trend is terminated by a northwest-southeast trending fault, and does not extend beyond the northern limits of the McPherson pool structure.

A line entering the northeastern corner of the county, and continuing southward through the Graber pool, is considered to be the probable southern trend of the Abilene anticline.

The oil and gas production of McPherson County is almost entirely obtained from pre-Pennsylvanian sediments, and most of the petroleum accumulation is controlled by anticlinal structure. The folding and faulting has been found to increase progressively with depth, and a slight westward shifting of structural axis progressive with depth has been observed.

Excellent possibilities for future exploration exist in the following areas of anticlinal structure: (1) near the center of T. 17 S., R. 4 W., (2) central part of T. 18 S., R. 4 W., (3) western part of T. 17 S., R. 5 W., and (4) northwestern part of T. 21 S., R. 2 W.

ACKNOWLEDGMENTS

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APPENDIX

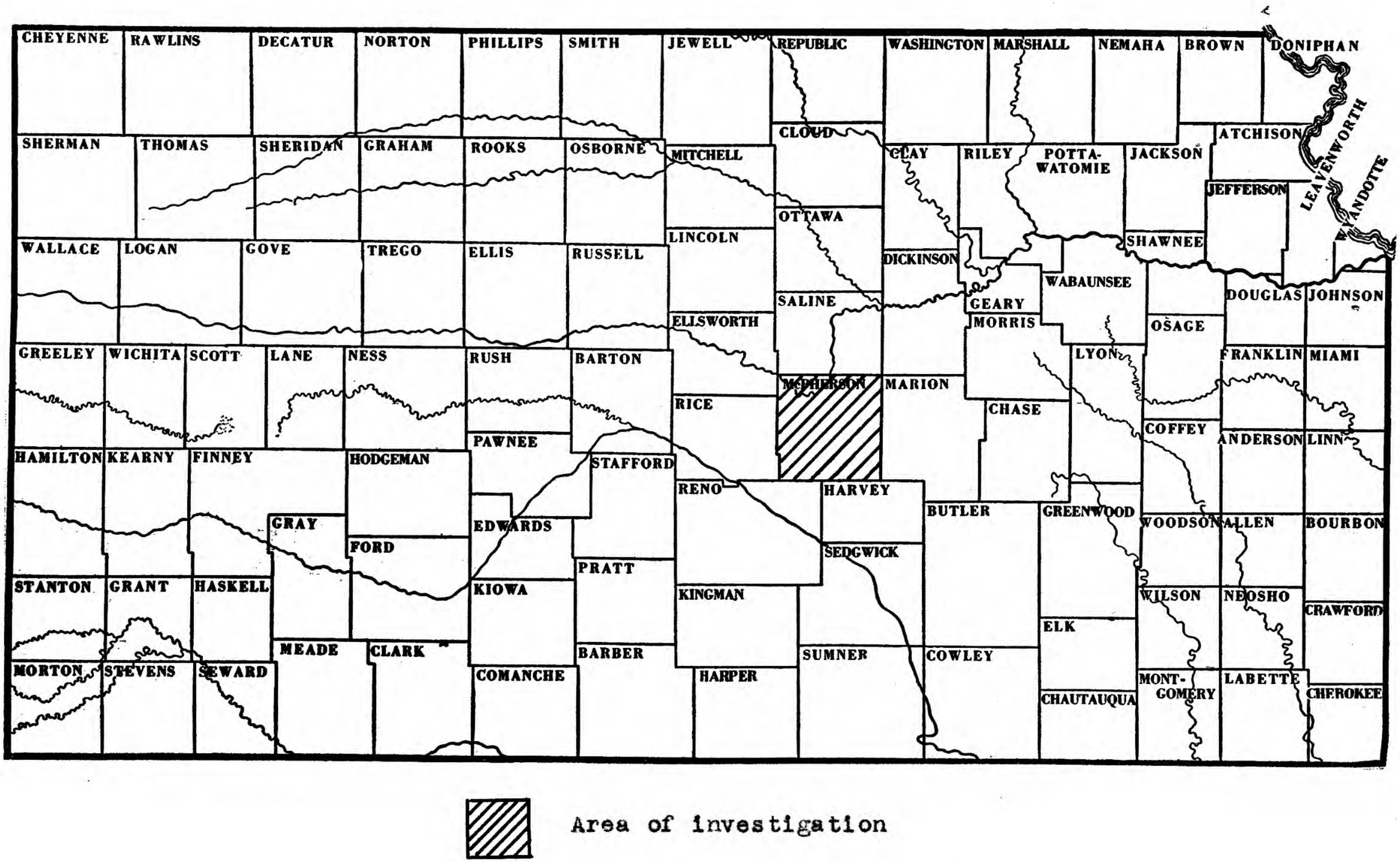


Fig. 1. Index map of Kansas showing the location of McPherson County

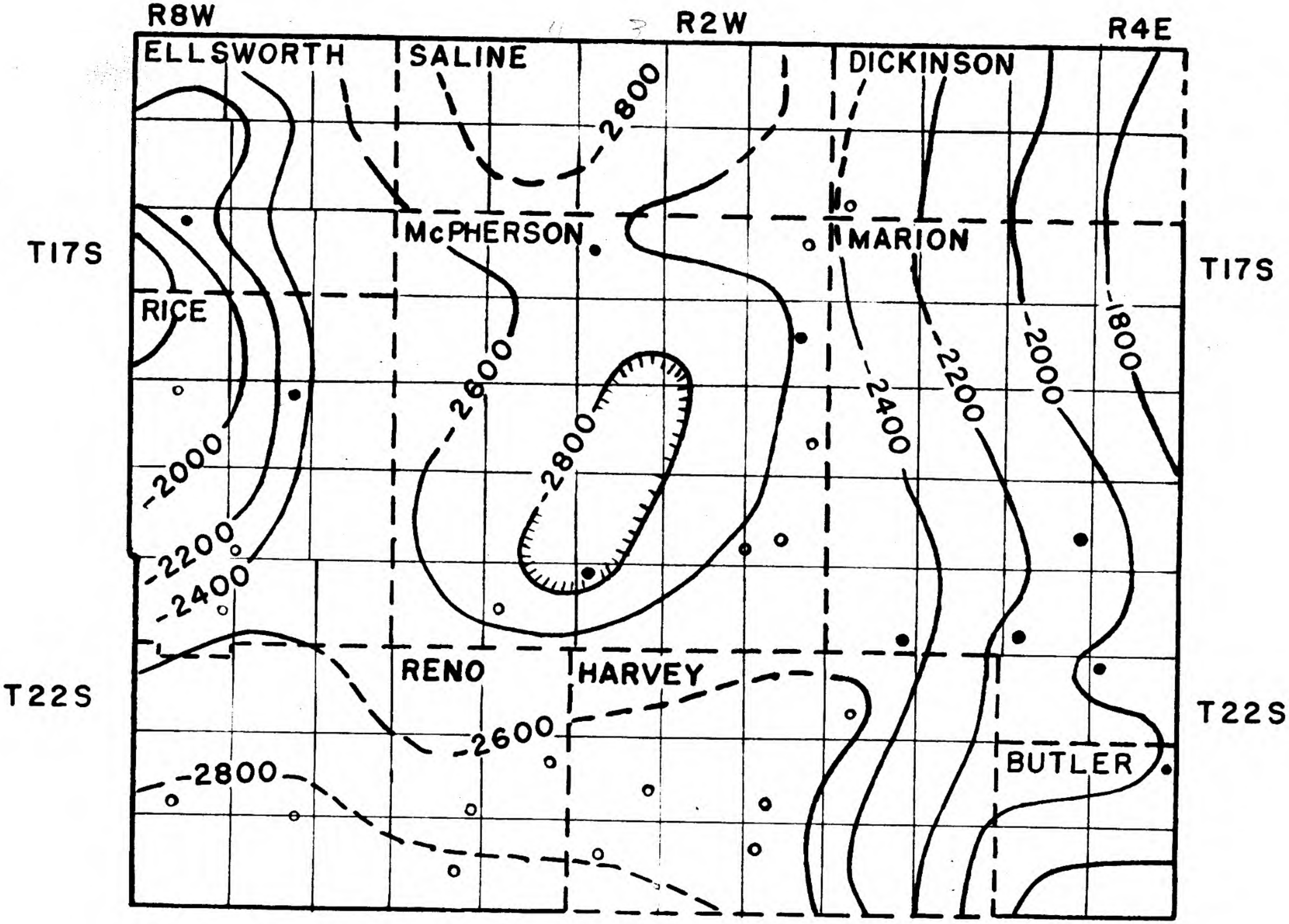


Fig. 2 Structure contours on the Pre-Cambrian surface Central Kansas area

• Well reaching Pre-Cambrian surface

○ Deep well not reaching Pre-Cambrian surface

Datum- Sea level Contour interval - 200'

Adapted from Mettner

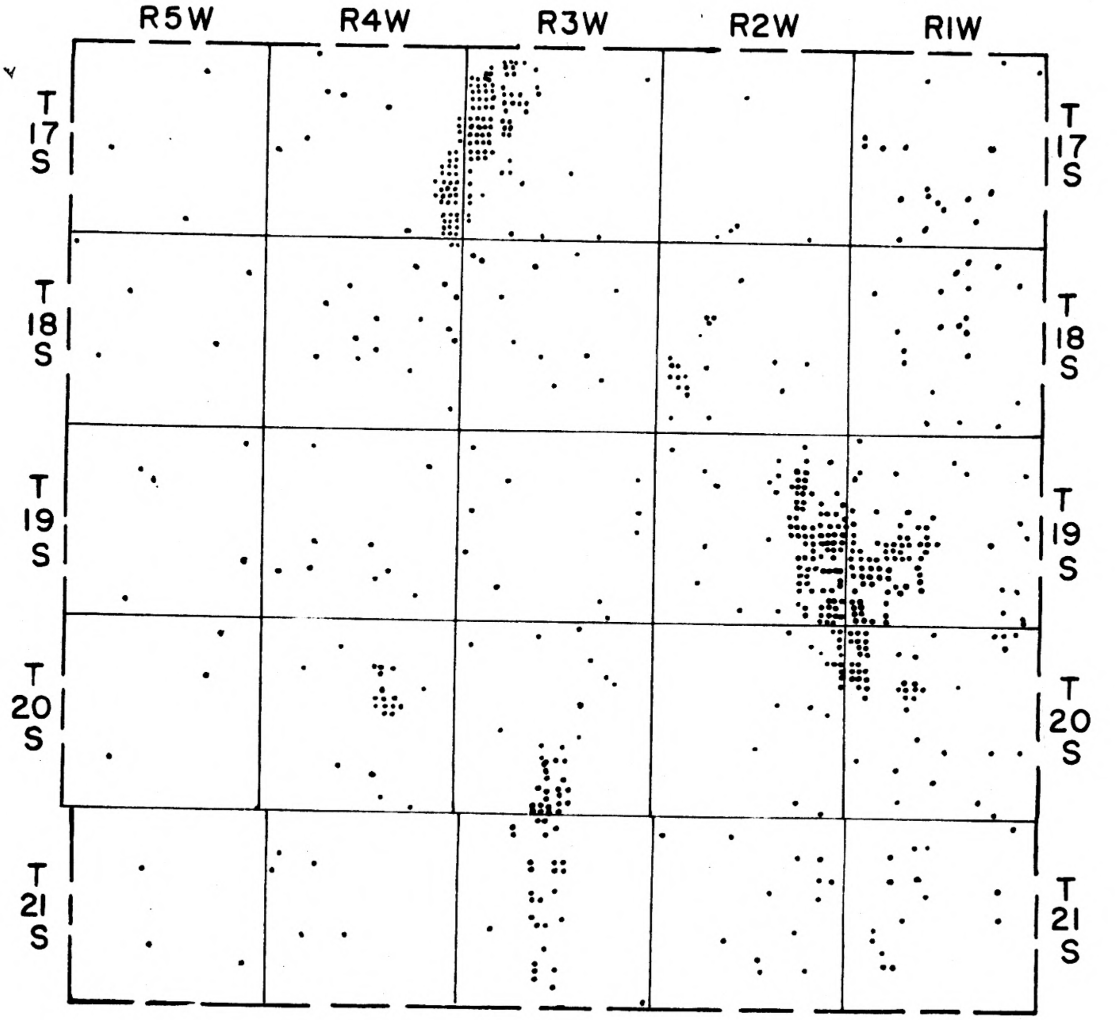


Fig. 3 Wells drilled to the Viola limestone

• – Oil well

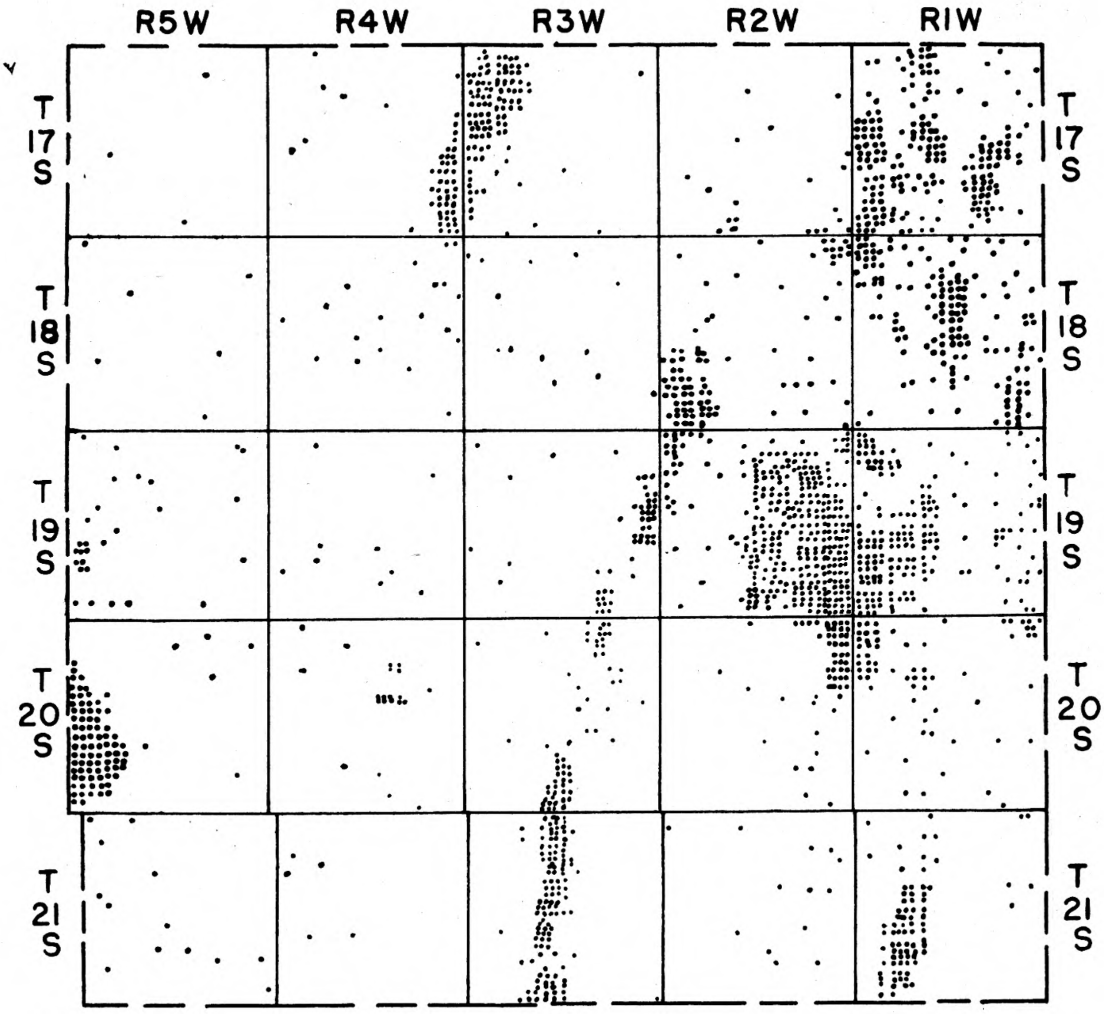
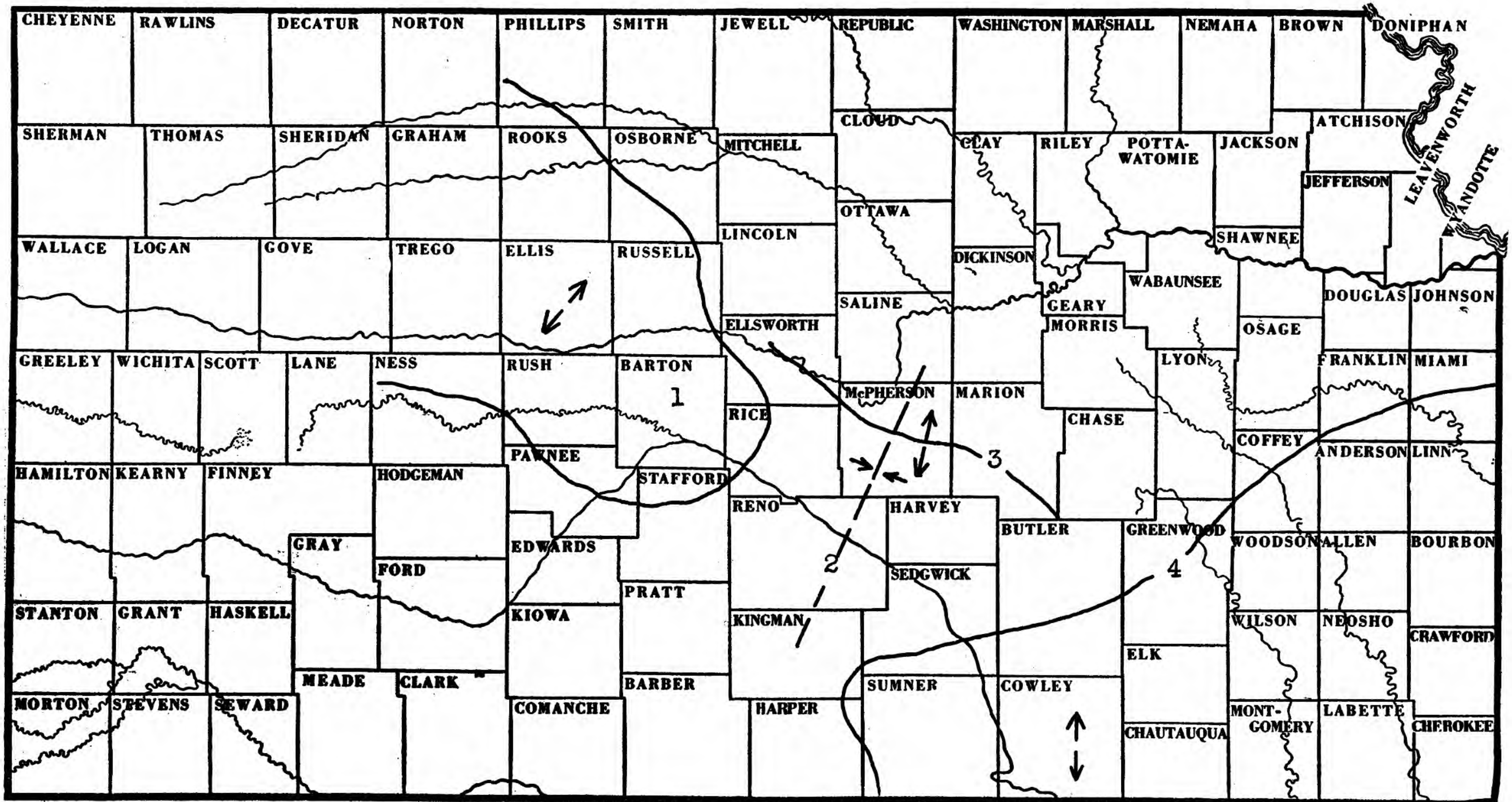


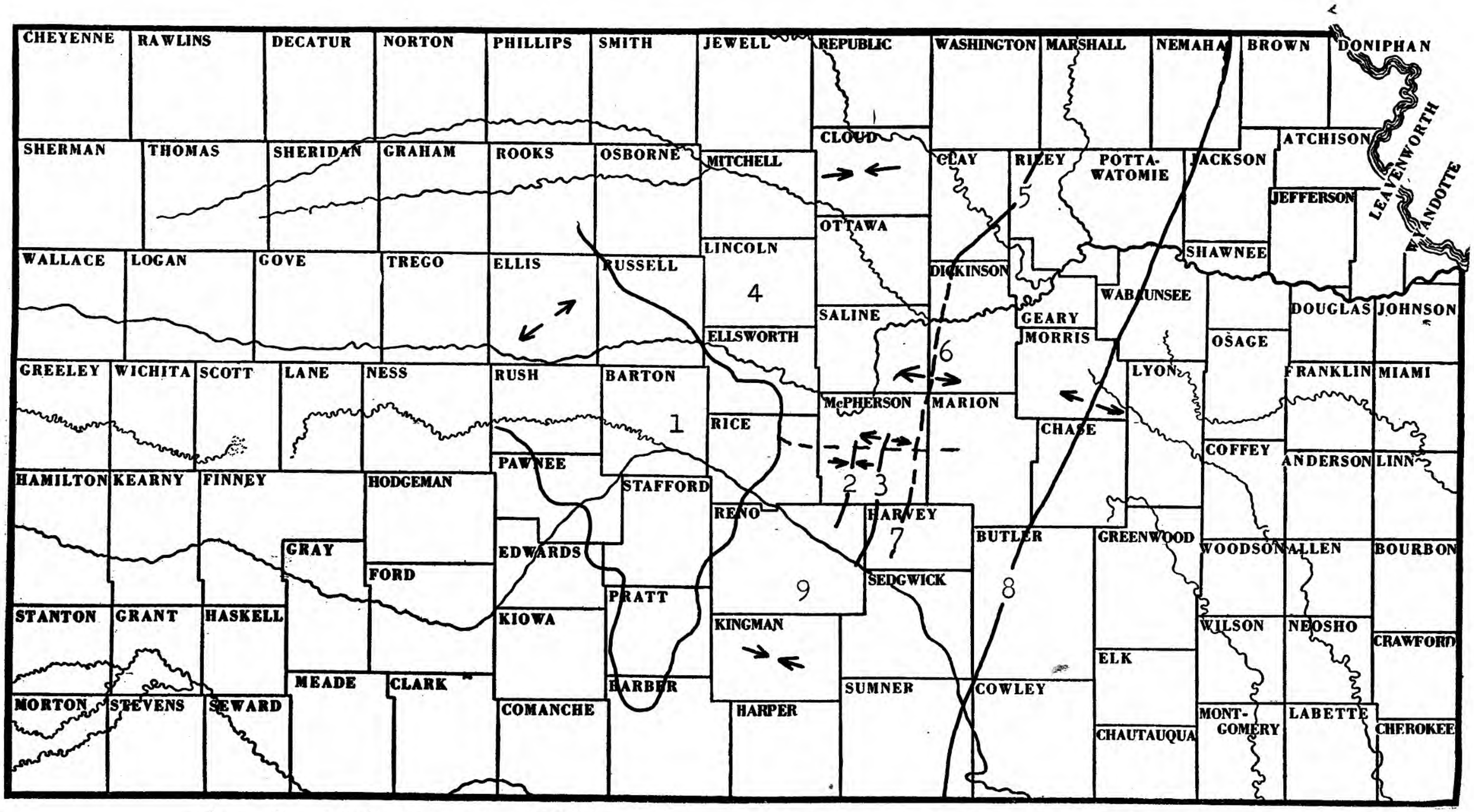
Fig. 4 Wells drilled to the Mississippian rocks

• — Oil well



1. Central Kansas uplift
2. Pre-Roubidoux syncline
3. Wilson-Burns element
4. Chautauqua arch

Fig. 5. Pre-Mississippian regional structure



1. Central Kansas uplift
2. Conway syncline
3. Voshell trend
4. Salina basin
5. Abilene anticline
6. Possible extension of Abilene anticline
7. Halstead-Graber trend
8. Nemaha anticline
9. Sedgwick basin

Fig. 6. Post-Mississippian regional structures

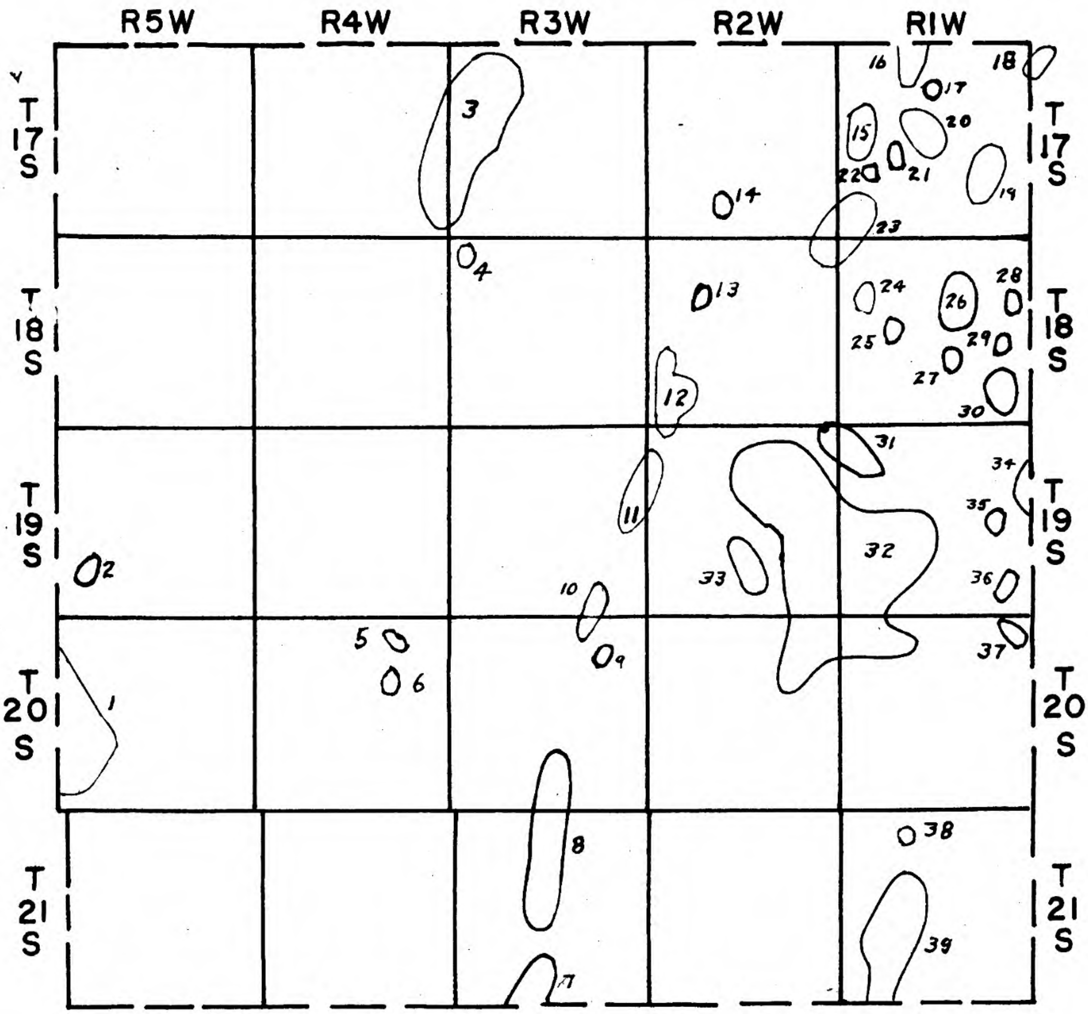


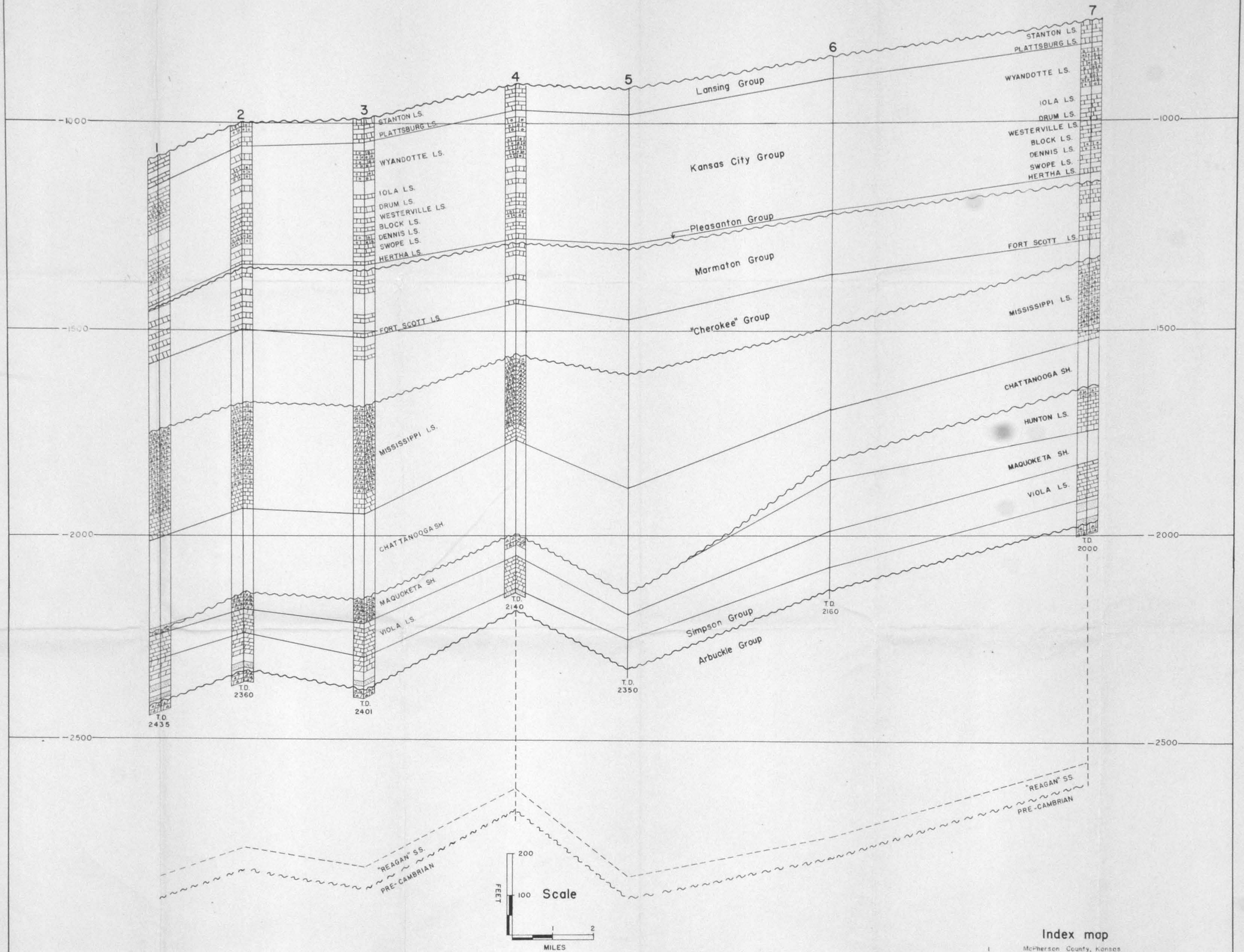
Fig. 7 Oil and gas pools, McPherson County, Kansas

1. Bornholdt
2. Windom
3. Lindsborg
4. Lindsborg S.
5. Groveland
6. Groveland S.
7. Hallow-Nikkel
8. Voshell
9. Johnson S.
10. Johnson
11. Chindberg
12. McPherson
13. Reuben
14. Bonaville
15. Roxbury
16. Gypsum Creek
17. Gypsum Creek S.
18. Franska
19. Crowther
20. Henne
21. Roxbury S. E.
22. Roxbury S.
23. Georob
24. Burk
25. Maxwell
26. Paden
27. Paden S.
28. Battle Hill N.
29. Battle Hill
30. Canton N
31. Jenday
32. Ritz-Canton
33. Lively
34. Doles Park
35. Coons
36. Bitikofer N.
37. Bitikofer
38. Graber N.
39. Graber

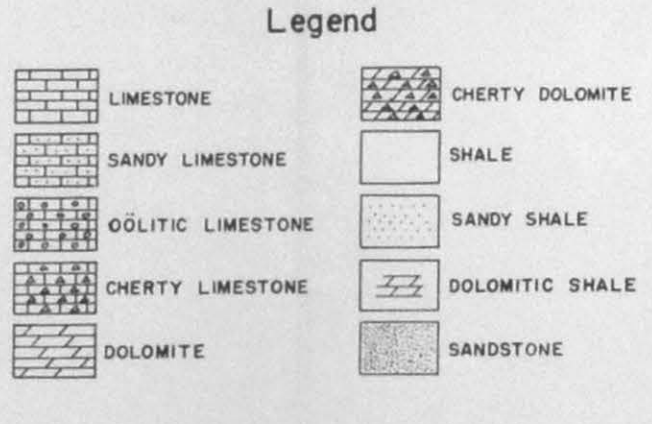
FIGURES 8 TO 12 INCLUSIVE

(in accompanying plate box)

Stratigraphic sequence of rocks penetrated
McPherson County, Kansas

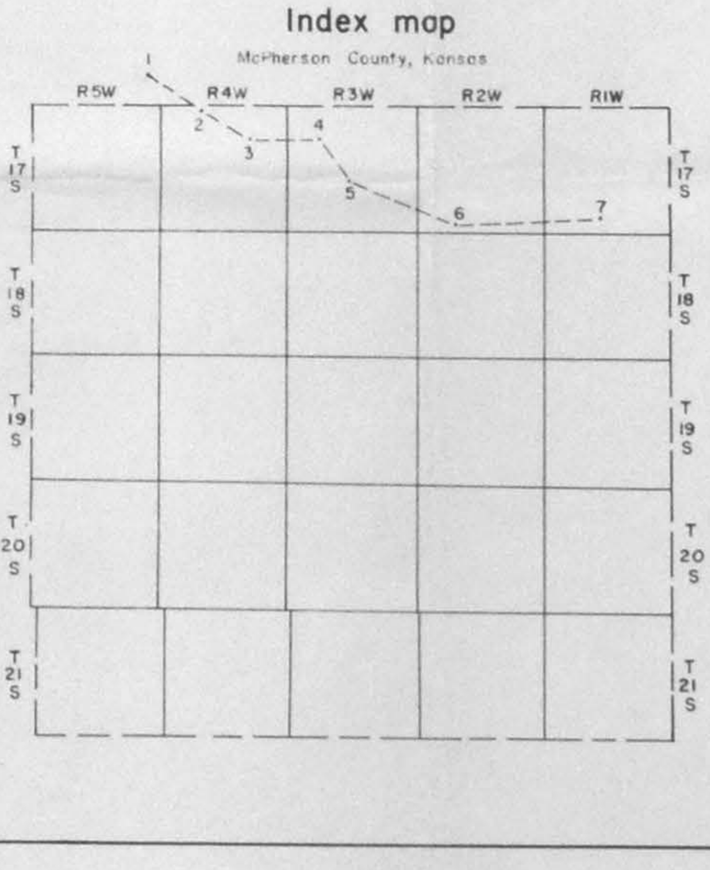


DATUM - SEA LEVEL

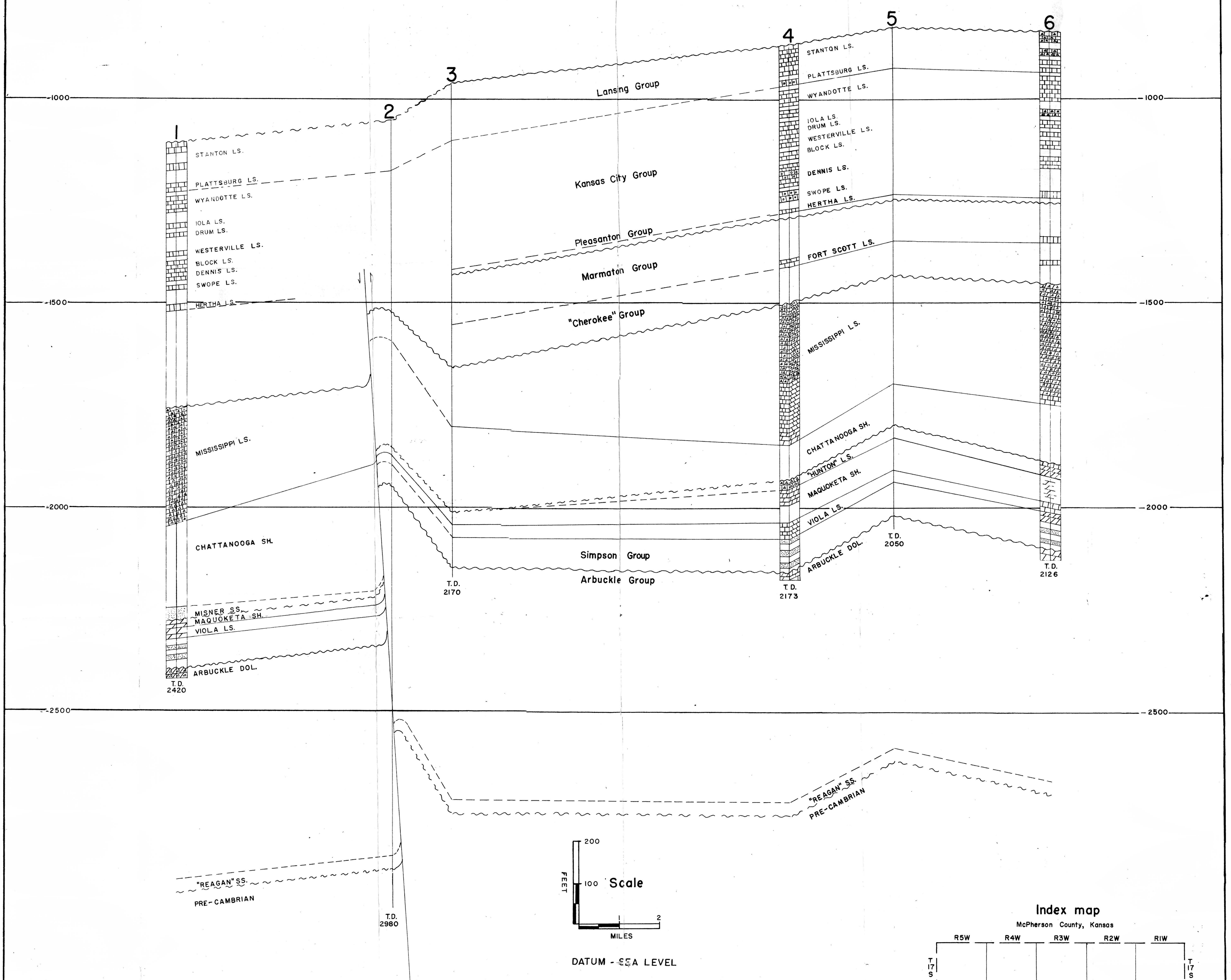


List of wells

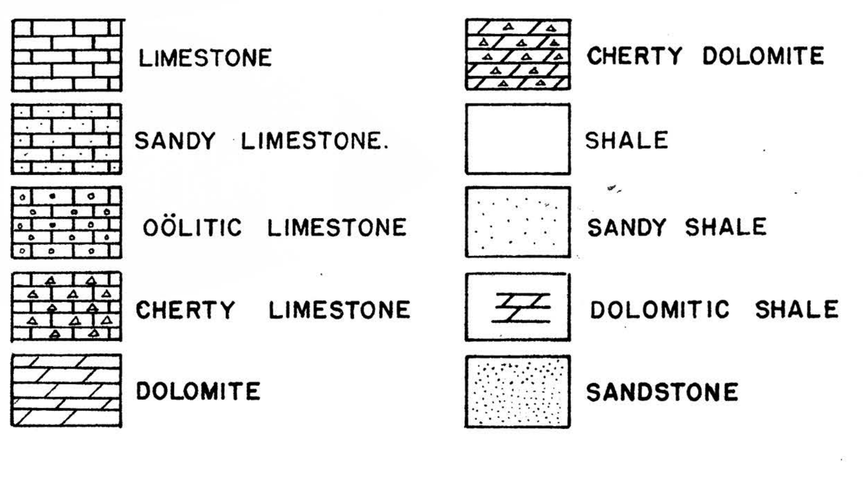
COMPANY	FARM NAME AND WELL NO.	LOCATION	ELEVATION IN FEET ABOVE SEA LEVEL	SOURCE OF DATA
1. Republic Natural Gas Co.	Hawkinson No. 1	SE,SE,SE 25-16-5W	1498	Electric log, Sample log
2. E. W. Carey	Lundquist No. 1	NW,NW,NE 5-17-4W	1549	Electric log, Sample log
3. Hanco Oil and Gas Co.	Dalstein No. 1	SE,SW,SE 10-17-4W	1525	Sample log, Drillers log
4. Auto Ordanance Corp.	Community No. 1-B	SW,NW,SE 8-17-3W	1336	Electric log, Sample analysis
5. Globe Oil and Refg.	Anderson No. 1	SW,SW,SW 22-17-3W	1364	Electric log
6. National Associated Oil Co.	Malm No. 1	SW,SE,SE 32-17-2W	1488	Electric log
7. Shell Oil Co.	Johnson No. 1	SW,SW,NW 33-17-1W	1352	Sample log, Drillers log



Subsurface geological cross section



Legend

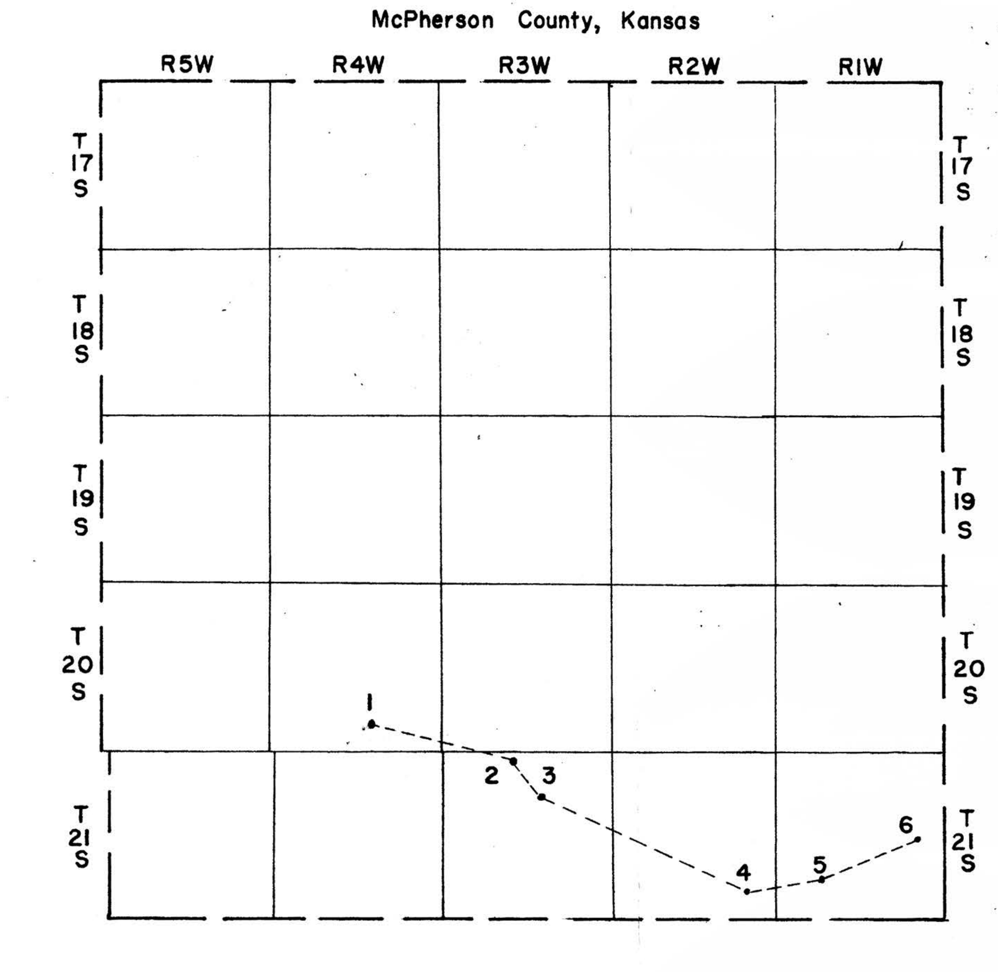


List of wells

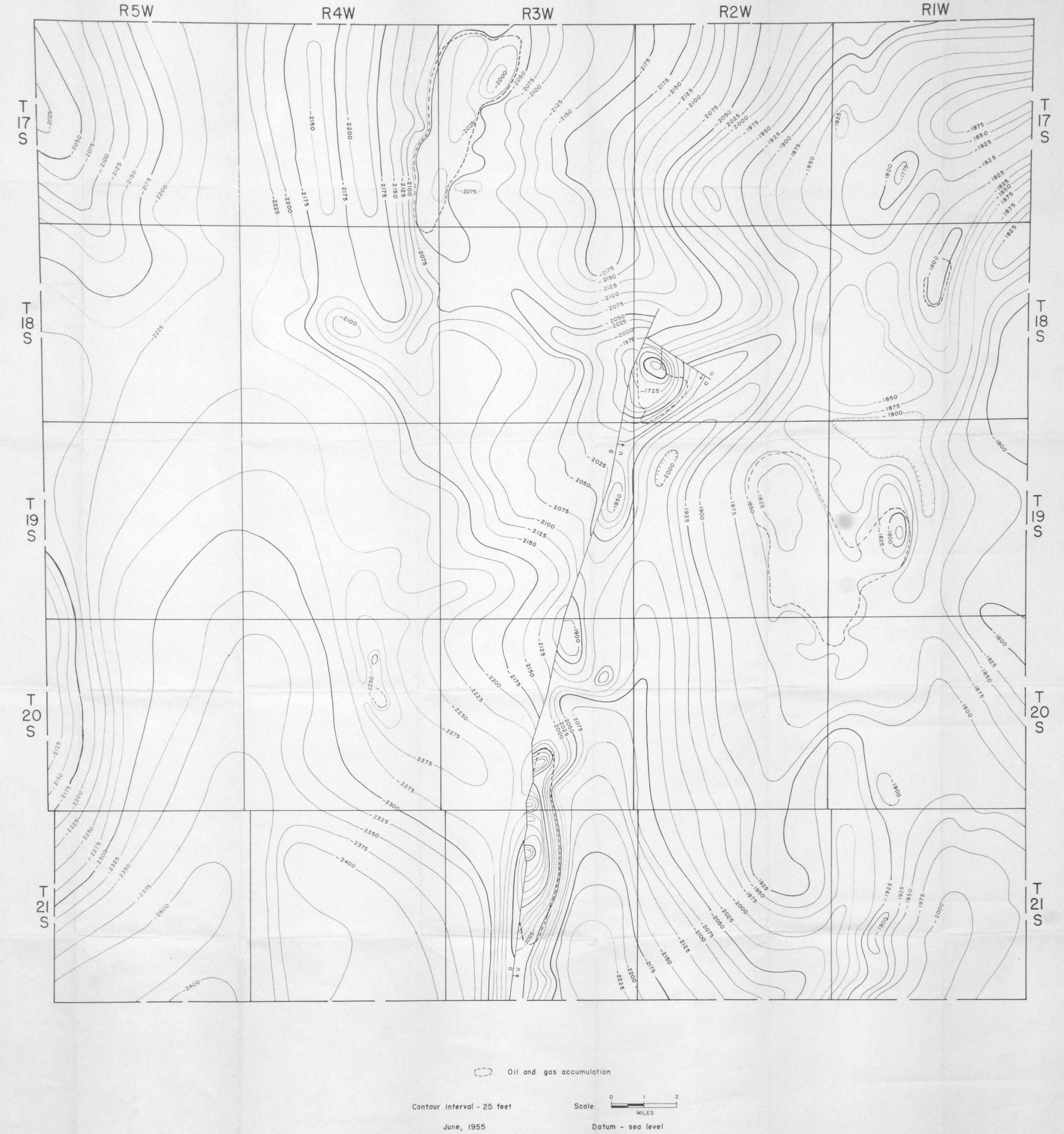
COMPANY	FARM NAME AND WELL NO.	LOCATION	ELEVATION IN FEET ABOVE SEA LEVEL	SOURCE OF DATA
1. Anschutz and Pack	Mitchell No. 1	SW, SW, SE 27-20-4W	1465	Electric log Sample log
2. Sinclair Oil and Gas Co.	Moorehouse No. 8	SW, NW, NE 4-21-3W	1453	Drillers log
3. Gypsy Oil Co.	Stucky No. 1	SW, SE, NW 10-21-3W	1449	Drillers log
4. Kiowa Drilling Co.	Renser No. 1	SE, SE, SE 26-21-2W	1487	Sample log
5. Continental Oil Co.	Houser No. 1	NE, SE, SW 29-21-1W	1483	Electric log
6. Penguin Petroleum Co.	Regier No. 1	NE, NE, NE 23-21-1W	1525	Electric log Sample log

Index map

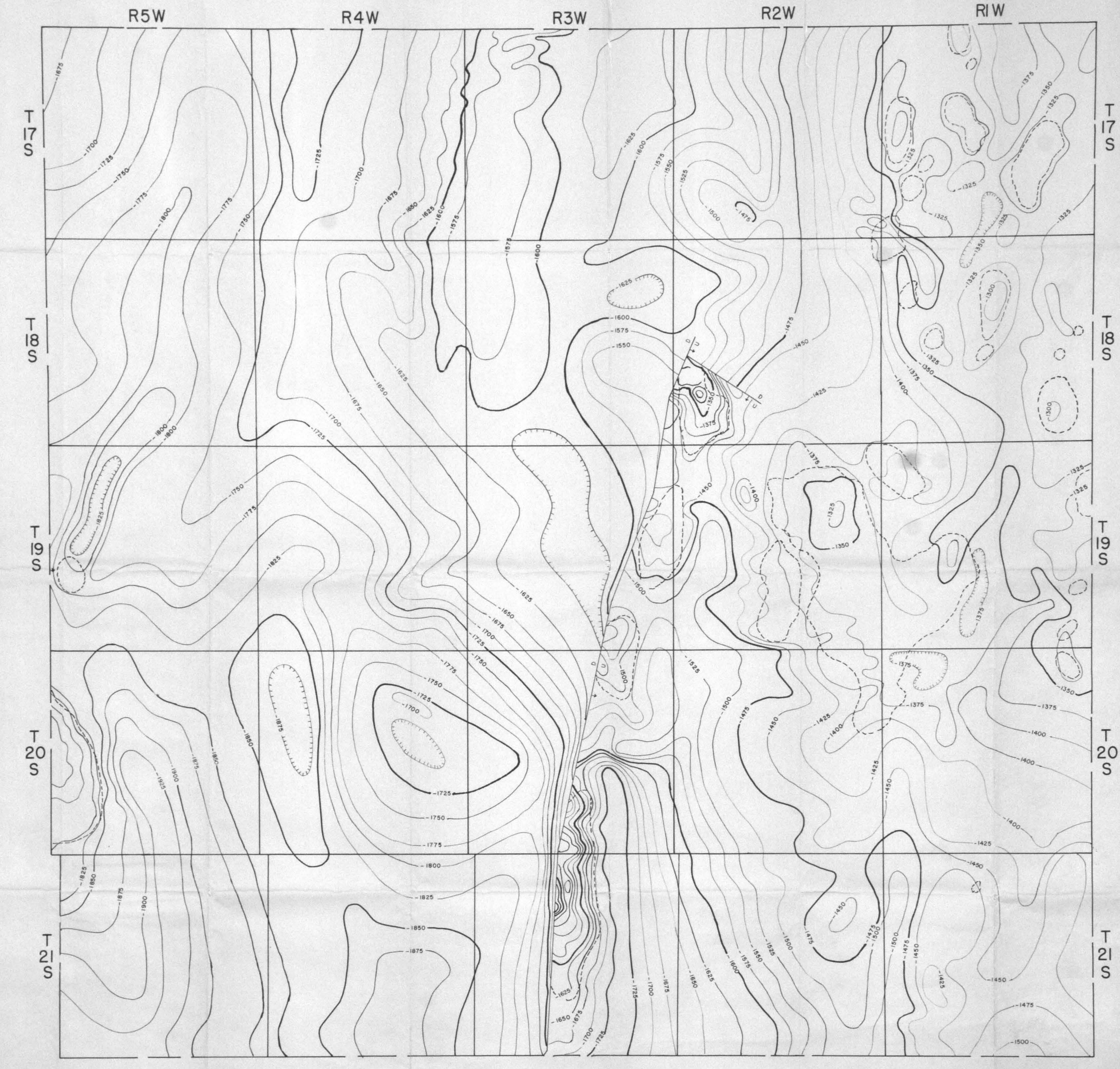
McPherson County, Kansas



Subsurface geological cross section



Structure contours on top of the Viola limestone
McPherson County, Kansas



Oil and gas accumulation

Contour interval - 25 feet

Scale 0 1 2 MILES

June, 1955

Datum - sea level

Structure contours on top of the Mississippian rocks
McPherson County, Kansas

SUB-SURFACE GEOLOGY OF MCPHERSON COUNTY, KANSAS

by

DALE ROMAINE OLSON

B. S., Kansas State College
of Agriculture and Applied Science, 1951

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

1956

This study was undertaken to obtain a semi-regional picture of the sub-surface structure and the relation of structure to petroleum accumulation in McPherson County, Kansas.

Detailed structural maps of the Mississippian and Viola formations and cross sections depicting the stratigraphic sequence from the pre-Cambrian granite to the top of the Stanton limestone have been constructed for the study of this problem. Information from sample logs, drillers' logs, electric and gamma ray logs, and sub-surface scout reports has been used to construct the structure maps and cross sections.

The stratigraphic sequence of marine sediments encountered in McPherson County ranges from pre-Cambrian to Quaternary in age, and averages 4,000 feet in thickness. An upper zone of the Viola limestone has been considered to be a facies change of the Maquoketa shale, and placed within the Maquoketa formation.

Most of the folds in the sub-surface of McPherson County are post-Mississippian, pre-Marmaton in age, and trend in a northeast, southwest direction. Pre-Mississippian folds trending sorthwest-southeast are evident, however, and are considered to be a contributing factor to the tectonic framework of the area.

The most prominent structural feature in McPherson County is the Voshell trend of anticlinal folding and associated faulting. Structural closure up to 350 feet is present along this trend, and the fault has been found to have a throw of 350 feet.

Most of the petroleum accumulation is (1) controlled by anticlinal structure, and (2) found in pre-Pennsylvanian sediments. The folding and faulting has been found to increase progressively with depth, and a slight westward shifting of structural axis progressive with depth has been observed.

The locations of four areas of anticlinal structure favorable for future exploration have been given, and further exploration possibilities exist along the trend of the pre-Chattanooga valley.

McPherson County has promising possibilities for future exploration, and new petroleum accumulations of commercial size may be discovered.