THE SUBSURFACE GEOLOGY OF SMITH, JEWELL, MITCHELL, AND OSBORNE COUNTIES OF KANSAS, RELATED TO PETROLEUM ACCUMULATION

by

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INTRODUCTION

Purpose of Investigation

The purpose of this report is twofold:

1. to study the subsurface geology of Smith, Jewell, Mitchell, and Osborne Counties in Kansas and relate it to petroleum accumulation;
2. to determine the geologic factors that are unfavorable for the presence of oil in that area of the Salina Basin covered by this report.

Location and Physiography

The area covered by this investigation contains approximately 3440 square miles, comprising four counties which lie south of the Nebraska line and slightly west of the center of Kansas. The area is bordered on the north by the State of Nebraska, on the west by Phillips and Rooks Counties, on the south by Russell and Lincoln Counties and on the east by Republic, Cloud, and Ottawa Counties (Figure 1, Appendix).

The area lies in the high plain and dissected high plain sections of the Great Plains physiographic province. As the name suggests, a greater part of the land has been deeply dissected by stream valleys. Elevations range between 1300 feet in the Salt Creek and Solomon River Valleys in the south-eastern part of the area and 2100 feet on the top of divides that run from northwestern Smith County to southwestern Osborne County. The area is drained primarily by the Republican and Solomon Rivers and their tributaries. The southwestern corner of Mitchell County and the southern row of townships in Osborne County are drained by tributaries of the Saline River.

Previous Work

Previous work on the area includes reports on geology and ground water resources of individual counties. The geology of Mitchell and Osborne Counties was first studied by Laudes in 1930. A detailed report on geology and ground water resources of Mitchell County was published by Hodson in 1959. Leonard, 1952, reported on geology and ground water resources of the North Fork Solomon River in Mitchell, Osborne, Smith, and Phillips Counties.

Stratigraphy and structural development of the Salina basin was described by Leé in 1948 and again in 1956. Preliminary regional structural contour maps on tops of the Lausing group, Hunton and Arbuckle rocks in Kansas were published by Merriam and others in 1958, 1960, and 1961.

Reports explaining geology and ground water resources of the counties surrounding the area of this report were published by Frye and Leonard (1949), Fishel and Lohman (1948), Leonard and Berry (1961), Bayne and Walters (1959), and Berry (1952).

Construction material reports have been prepared for Mitchell County (Byrne, Johnson and Bergman, 1951), Osborne County (Walters and Drake, 1952), and Smith County (Byrne, Houston, and Mudge, 1948).

Procedure

In preparation for the study of this problem the following maps and sections were made:

1. Structural contour map on top of Lansing group (Plate I).
2. Structural contour map on top of Hunton Rocks, (Plate II).
3. Isopachous map between top of Mississippian and top of Lansing(Plate III)

4. Three sections of wells, a) North-south, b) east-west, c) northeast - southwest (Plate IV).

The lansing group was chosen to be mapped because of its significance as an oil producer in the area. The choice of Hunton Rocks was made, as there is a possibility of oil accumulation in the upper part, immediately below the unconformity.

The preliminary structure maps prepared by Merriam and others were used and modified. In recent years, particularly since the discovery of oil pools in Osborne County, increased drilling has provided the additional data. This data was used in modifying the older maps. The information used in the construction of these maps was obtained from the Herndon maps and the sample logs of the Kansas well log Bureau.

A relatively small contour interval of twenty feet was used for the Lansing group map because of good control in the vicinity of the Central Kansas Uplift. Hunton and Mississippian rocks are absent in this area. Since the few wells in the rest of the area do not furnish sufficient data, a fifty-foot contour interval was used instead of the twenty. The points of control used by Merriam and others in interpretation of preliminary structure on top of Lansing and Hunton were retained by the writer.

The stratigraphy and lithology were obtained by reviewing literature and by examining Kansas sample log service information.

Rock unit names used in the sections and the discussion of stratigraphy are those used by the Kansas Geological Survey.

STRATIGRAPHY

Precambrian Rocks

Precambrian rocks are not exposed in Kansas, but deep wells reveal that the basement rocks are mainly of igneous origin. The most often reported igneous rock is granite. Metamorphic rocks are also present and include quartizite, granite gneiss and schist. The Precambrian in one of the wells in northern Osborne County was encountered at a depth of 3700 feet and 160 feet of granite was penetrated. According to Lanc in 1930, the cuttings were composed chiefly of feldspar and angular quartz with a minor amount of hornblende and biotite.

Cambrian System

The Cambrian system is represented in Kansas only by rocks of late Cambrian age. There are three formations encountered in the sub-surface of Kansas. The Lamotte sandstone unconformably overlies much of the Precambrian surface in parts of eastern and western Kansas. However, it is absent from an extensive area in the central part of the State (Keroher and Kirby, 1948).

The Bonneterre dolomite is underlain by the Lamotte sandstone. It overlaps onto the Precambrian granite where Lamotte sandstone is absent. It consists of coarsely crystalline to dense fine grained glauconitic dolomite. Green dolocastic shale is common in the upper part. The thickness of the Bonneterre dolomite varies from a few feet in southeast Mitchell County to about 90 feet in northwest Smith County.

No eminence sediments are known in the area. Their absence may be the result of non-deposition over the central uplift area, or of post eminence removal by erosion.

Ordovician System

Arbuckle Group: The Arbuckle group consists of early Ordovician and late Cambrian deposits. The two formations in the group are; the Roubidoux formation and undifferential Jefferson City and Cotter dolomites.

The Roubidoux overlaps upon the Bonneterre dolomite. In Smith County, Jewell County, the northern parts of the counties below them, it was exposed and thinned by post St. Peter erosion and in places it was entirely removed. It is generally white, very coarsely crystalline dolomite containing much fine bright angular sand. The thickness varies from a few feet to 200 feet.

The Jefferson City - Cotter sequence which overlies Roubidoux is absent where the area was exposed to Post-Cotter erosion. The thickness of the formation increases from 0 feet in the north to about 125 feet in the south. The Jefferson City - Cotter consists mainly of coarsely granular cherty dolomite, with an abundance of oolitic chert in the upper part and tripolitic chert in the lower part of the sequence.

The thickness of the Arbuckle group as a whole increases from 200 feet in the north to 500 feet in the south.

Simpson Group: Rocks of Simpson age may be divided into the St. Peter sandstone and the Platteville formation. The St. Peter sandstone, the lower part of the interval, consists of three zones. The upper and lower zones are composed of sandstone having rounded and frosted sand grains. The middle zone has green clay shale containing sand grains and glauconite.

The Platteville formation, the upper part of the Simpson, consists of beds of shale, dolomite, limestone, sandstone, and sandy shale in variable sequences.

The thickness of the Simpson Group is about 100 feet on the Nebraska - Kansas line and thins southward on the flanks of the Central Kansas Uplift.

Viola Group: The Viola limestone overlying rocks of Simpson age consists of dolomite and limestone containing some cherty beds characterized by black flecks and spicular and tube like fragments of microorganisms (Moore and others, 1951). The Viola is absent on the Central Kansas Uplift. The thickness varies from a beveled edge on the flanks of the uplift to about 200 feet in northern Jewell County.

Maquoketa Shale: The Maquoketa Shale (upper Ordovician) is gray-green to gray, silty dolomitic shale and gray, fine granular silty dolomite. It is absent in a greater part of the Osborne County, the western border of Smith County, and the southwestern corner of Mitchell County. The range of thickness is 30 t0 95 feet.

Silurian-Devinian Rocks

Rocks predominantly limestone and dolomite, of Devonian and Silurian age lie unconformably below the Mississippian and over Ordovician rocks. In places they overlap different Ordovician formations, but in general, their structure and distribution accords more closely with Ordovician than with Mississippian rocks. These commonly undifferentiated rocks are known as Hunton (Jewell and Merriam, 1959). The Hunton is absent in parts of Smith and Osborne Counties, but was encountered in many wells at different depths in rest of the area (Table 1, Appendix). Plate II shows the structure on top of Hunton rocks in the area.

Mississippian or Devonian System

The shale sequence between Mississippian and Devonian limestone in this area is divided into two formations, Chattanooga Shale underlying Boise Shale. The Chattanooga is in unconformable contact with the underlying Viola, Maquoketa, and Hunton rocks. It is gray or greenish, fissile shale containing pyrite and lentils of limestone, and often is black and spore bearing at the base.

The Boise Shale has red and brown ironstone oolites, and red shale at the base. The maximum thickness of Chattanooga and Boise Shale is about 60 feet in eastern Mitchell and Jewell Counties. There is a thinning towards the west where it is absent on the eastern flanks of the Central Kansas Uplift.

Mississippian System

Kinderhookian Series: The formation at the base of Kinderhookian is called Sedalia Dolomite. It is buff to brown, locally gray non-cherty or sparsely cherty dolomite. Sedalia Dolomite, is overlain by Gilmore City Limestone, which is oolitic in part, with soft chalky matrix.

Osagian Series: The St. Joe Limestone at the bottom of the series, is non-cherty or sparsely cherty, dark gray to gray, argillaceous limestone of finely crystalline texture. Reeds Spring Limestone overlying St. Joe Limestone, is cherty. The chert is bluish to bluish gray, transluscent to semi-transluscent. Undivided Keokuk and Burlington limestones at the top of the Osagian Series are in two zones. The lower zone has an abundance of chert, mainly white, opaque, microscopically massive. A little quartz is also present. The upper zone is cherty, and includes in some zones microfossil embedded in chalcendony.

Meramecian Series: Meramecian Series consists of two formations; Warsaw Limestone overlain by Spergen Limestone. Warsaw Limestone is cherty, opaque, partly gray, and partly dark; broken micro-organisms and spicules are present. Spergen Limestone is granular at the topand silty dolomitic at the base. It is non-cherty or sparsely cherty and may include traces of microfossils.

Mississippian Limestone is about 250 feet thick in southern Mitchell County. There is a thinning towards the northwest, and it is absent on the western border of Smith and Osborne Counties.

Pennsylvanian System

Basal Pennsylvanian Deposits: Erosion at and near the end of Mississippian and during early Pennsylvanian time reduced the Mississippian surface to a peneplain as crests of anticlines were truncated, leaving a greater thickness of Mississippian deposits preserved in synclines. The surface was deeply weathered and solution features developed locally (Merriam, 1961). The weathered chert that has remained in places in the Mississippian limestone, is of course Mississippian in age, and the chert that was reworked by Cherokee sea is classed as detrital deposits of Pennsylvanian age. These deposits are called Pennsylvanian Basal Conglomerate in the area and being highly porous, are good reservoirs for oil. Some of the oil produced in Osborne County comes from these deposits.

The Pennsylvanian rocks overlying the Pennsylvanian basal conglomerate are divided into three series; the Demsoinesian, the Missourian, and the Virgilian.

<u>Desmoinesian Series</u>: The Desmoinesian Series is divided into the Cherokee Group below and the Marmaton Group above.

Cherokee Group: The Cherokee is essentially conformable with the overlying Marmaton Group and consists predominantly of shale, but there are few limestone beds. The formation thins to the west very markedly with a thickness of about 300 feet in Mitchell County wells to about 100 feet or less in Western Osborne County.

Marmaton Group: The Marmaton group consists of a series of limestone and variously colored shale beds. Fusilinids and Ostracods are quite abundant and an occasional small brachipod is also found. The Marmaton ranges from 260 feet to 400 feet, gradually thinning to the west.

<u>Missourian Series</u>: The Missourian series is separated from the Desmoinesian series by an unconformity and a faunal break. It is divided into three groups; the Pleasanton Group, the Kansas City Group, and the Lansing Group. Pedee is the youngest group of the Missourian series in Kansas, but it is not present in the subsurface of the counties under study because of erosion during the hiatus between the Virgilian and the Missourian Series.

Pleasanton Group: The Pleasanton Group consists of sandstone, shale and limestone beds. Its thickness is usually from ten to thirty feet. The thickness of the interval is controlled by erosional relief at its base and also by regional warping of the Pre-Pleasanton surface (Lee, 1948).

Kansas City and Lansing Groups: This thick limestone formation below the Wabaunsee, Shawnee, Douglas group is fairly uniform in thickness but gradually thins towards the west. It is clearly defined in all wells and is an excellent marker. The Kansas City and Lansing Groups together range from 200 to 300 feet in average thickness.

In the center of the Salina Basin in Section 5, T.5S, R.10W, the electric log of the Carter Exploration well revealed the following sequence of the Kansas City Group (Lee, 1956). It is in descending order; Bonner Springs Shale, Wyandotte Limestone, Lane Shale, Iola Limestone, Cherryvale Shale, Dennis Limestone, Galesburg Shale, and Swope Limestone.

Hertha Limestone which is an excellent marker for the base of the Kansas City Group, is probably absent from much of the Salina Basin area where the Swope Limestone seems to be the basal formation.

Lansing Group is very similar to Kansas City Group in lithology. It consists predominantly of limestone with several shale beds of varying thicknesses. The three formations of the Lansing Group in descending order are: Plattsburg Limestone, Vilas Shale, Stanton Limestone.

Virgilian Series: The Virgilian Series is divided into three groups. They are in ascending sequence; Douglas, Shawnee, and Wabaunsee. This upper division of the Pennsylvanian is a thick series of limestones and shales ranging from 560 feet to 1,020 feet in thickness.

Douglas Group: The Douglas Group consists of two formations, Stranger Formation overlain by Lawrence Shale. The Stranger Formation consits of yellowish gray shale and sandstone and includes one or two limestones members in the upper part. Lawrence Shale consists chiefly of blue-gray and yellowish shale. An unconformity of considerable erosional relief separates the Stranger Formation and the Lawrence Shale (Lee, 1956).

Shawnee Group: The Shawnee Group is a group of alternating beds of shale and limestone. The formations in ascending order are; Oread Limestone, Tecumseh Shale, Deer Creek Limestone, Calhoun Shale, and Topeka Limestone. All the limestones are oolitic and cherty at some points in the subsurface and include one or several members containing fusilines. The thickness of the Shawnee Group in section 10, T5S, R.10W, is 244 feet.

Wabaunsee Group: The Wabaunsee Group conformably overlies the Shawnee and comprises a sequence of alternating limestones and shales. Shale is the principal deposit, but it contains thin interbedded limestone and local sandstone lenses. None of the shales have any particular outstanding characteristics that make them readily identifiable (Merriam, 1959). Most of the Wabaunsee Limestones are light gray to brownish, slightly crystalline and fusilinid bearing.

Permian System

Permian rocks in this area are divided into two Stage, the upper one is called the Cimarron and the lower one Gearyan.

Gearyan Stage: The Gearyan Stage is divided in to the following groups listed in ascending order; Admire, Council Grove, and Chase.

Admire Group: This group, exclusive of the basal sandstone, consists dominantly of shale, some of which is sandy. The limestone beds, although persistent, are thin and lack unique lithologic features that might identify them in the subsurface. The thickness of the Admire Group ranges from about 100 to 400 feet.

Council Grove Group: The Council Grove Group consists of equal proportions of shale, a large part of which is red, and of limestone much of which is impure and shaly. A sequence of formations of the Council Grove Group recognized in Meyers No. 1. Cen. NE¼, SW¼, Sec. 10, T5S, R.11W, in ascending order is: Foraker Limestone, Johnson Shale, Red Eagle Limestone, Roca Shale, Grenola Limestone, Eskridge Shale, Beattie Limestone, Stearns Shale, Bader Limestone, Easly Creek Shale, Crouse Limestone, Blue Rapids Shale, Funston Limestone, and Speiser Shale. The total thickness of the group is about 600 feet.

Chase Group: The Chase Group consists of a sequence of alternating beds of thick limestone and shale. Some of the limestone formations have calcareous shale members in them. The shales are vari-colored, red, and green predominating in some formation. The limestones are cherty. The Herington Limestone, a buff to gray dolomitic limestone marks the top of the group, and the Wreford Limestone, a cherty limestone, characteristic of this group, occurs at the bottom. The average thickness of the Chase Group in this area is 250 feet.

Cimarron Stage: Cimarron Stage is divided into the Nippewalla Group above and the Sumner Group below.

Sumner Group: The Sumner Group includes in ascending order; Wellington Formation, Ninnescah Shale, and Stone Corral Dolomite.

Lee in 1956, for convenience divided the Wellington formation into three members, the anhydrite beds at the bottom, the salt beds or Hutchinson Salt Member in the middle, and an unnamed member at the top comprising the middle "gray beds," "red beds," and "upper gray beds" of VerWiebes; clasification. The anhydrite beds consists of a sequence of gray shales alternating with anhydrite beds. The Hutchinson Salt Member is an evaporite zone consisting of salt (Halite) with beds and laminae of anhydrite. It is present only in the southern half of Osborne County and a part of northwestern Mitchell County. The beds range from a feather edge of 300 feet in thickness. The top member of the Wellington Formation consists of gray and red shale with little or no anhydrite. The Ninnescah Shale consists predominantly of red shale with minor amounts of gray shale, and thin beds of impure limestone and calcareous sand. The thickness of the Ninnescah Shale in a well located in southeastern Smith County is 200 feet. Stone Corral Dolomite, the youngest deposits of Sumner County, consists of dolomite and anhydrite. The ratio of dolomite to anhydrite varies from place to place. Maximum thickness of the stone corral dolomite is about 100 feet in Osborne County, It is absent in parts of northern Smith County.

Nippewalla Group: All formations, except the Harper Sandstone lying at the bottom of the group, were eroded from the area during the hiatus preceeding Cretaceous deposition. Harper Sandstone consists chiefly of red sandstone members broken by thin beds of red shale.

Triassic, Jurassic, and Cretaceous Systems

All rocks of Triassic and Jurassic age are absent in the area under discussion.

Rocks of Cretaceous age are divided into two series: Comanchean overlain by Gulfian.

Comanchean Series: The Comanchean Series is comprised of Cheyenne Sandstone underlain by Kiowa Shale. The Cheyenne Sandstone consists of buff to light gray sandstone with small amounts of shale and siltstone. The Kiowa Shale consists of gray to black thinly laminated shale, interbedded with thin lenticular bodies of white siltstone and sandstone. Shell fragments and carbonaceous material are common.

Gulfian Series: The Gulfian Series is divided into five formations. They are in ascending order; Dakota Formation, Graneros Shale, Greenhorn Limestone, Carilie Shale and Niobrara Formation.

Dakota Formation: The Dakota Formation consists of clay, gray, white, and buff shale, lenticular sandstone, and beds of lime cemented sandstone; lignite and siderite pellets are common. The average thickness is 200 feet.

Graneros Shale: The Graneros Shale consists of gray to black shale.

The shale contains selenite crystals, lenticular sandstone and ironstone. The average thickness of this formation is only thirty feet.

Greenhorn Limestone; This formation consists of gray chalky shale alternating with thin chalky limestones in upper part and thin petroliferous limestone in base. The average thickness is about 85 feet.

Carlile Shale: The Carlile Shale is gray in color and contains thin lenses of fine grained sandstone at the top. Thin limestone and bentonite beds are common in the base. The average thickness of the formation is 300 feet.

Niobrara Formation: This formation is at the top of the series and in unconformable contact with the overlying deposits of Paleogene and Neogene age. The Niobrara consists of chalk and chalky shale. It contains fifty feet of chalky limestone at the base (Fort Hays Limestone Members). The thickness of the formation averages about 600 feet.

Paleogene and Neogene System

Paleogene and Neogene deposits occur throughout most of the area. Rocks of Pliocene and early Pleistocene age, consisting of alluvial deposits of sand, silt, and clay overlie the consolidated Permian and Cretaceous rocks. Neogene deposits of Pleistocene and recent age are also present. Sand, gravel, silt, and clay as much as 200 feet thick occur in the area.

STRUCTURE

Major Pre-Mississippian Regional Structures

Ancestral Central Kansas Uplift: The Ancestral Central Kansas Uplift is the early Paleozoic development of the Central Kansas Uplift, to which Moore and Jewett (1942), gave the name "Ellis Arch."

Central Kansas Arch: The Central Kansas Arch is a broad, compound geanticlinal uplift in the form of an open arc convex towards the south. It includes the ancestral Central Kansas Uplift and Chautauqua Arch.

Chautauqua Arch: This name was suggested by Barwich (1928) for the Pre-Mississippian extension of the Ozark Uplift along the Kansas-Oklahoma line (Figure 2, Appendix). It was a broad uparched feature stretching westward on which the Cherokee basin later developed.

North Kansas Basin: The North Kansas Basin is a large downward area north of the Chautauqua Arch and east of the Ancestral Central Kansas Uplift. The basin began to develope after St. Peter time, and differential downwarping allowed accumulation of Pre-Mississippian strata. There was a prolonged period of erosion in late Mississippian time. In Post-Mississippian time, the North Kansas Basin was divided into the Salina Basin and the Forest City Basin by the formation of the Nemaha Anticline.

Ozark Monocline: The "Ozark Monocline" was first named by Rich (1933) who described the structure as "one of the principal structural features revealed by the Pre-Mississippian areal geology, comprising the eastern part of the state where the pre-Chattanooga dip was primarily west-northward into the North Kansas basin." The Monocline which is the northwestern flank of the Chautauqua Arch, has a gentle dip westward, broken by a number of local domes.

Southwest Kansas Basin: The ancestral Central Kansas Uplift separates the Southwest Kansas Basin from the North Kansas Basin. In the Post-Mississippian the same feature was called the Hugoton Embayment.

All major Pre-Mississippian Structures in Kansas are shown in Figure 2.

Post-Mississippian Regional Structure

Bourbon Arch: Slightly north of the Pre-Mississippian Chautaqua Arch, a later but narrower arch rose in early Pennsylvanian time. This shallow platform like structure separates the Forest City Basin on the north from the Cherokee Basin on the south.

Cambridge Arch: This arch, also called the Darton's Arch, is a large northwest trending anticline in western Kansas extending northward into Nebraska. It is on the same trend as the Central Kansas Uplift, the Chadron Arch of Nebraska and the Chautauqua Arch, all of which form an accurate trend of up-arched features. The Salina Basin flanks the structure on the east and a part of the arch lies in the northwest corner of Smith County. The northern end of the Hugoton embayment limits the western side and a structural saddle separates it from the Central Kansas Uplift which is to the southeast. Surface rocks along the Cambridge Arch are Tertiary and Cretaceous.

Central Kansas Uplift: The Central Kansas Uplift (also called the "Barton Arch" or "Russell Arch") is a major Post-Mississippian Pre-Demoinesian structural feature in Central Kansas (Morgan, 1932). Generally, recognized as the largest single feature in Kansas, it is a northwest trending structure which separates the Hugoton embayment on the west from the Salina and Sedgwick Basins on the east. There is a great deal of subsurface information available in this area. There are many wells which extend to the basement rocks. On the crest of the structure, Precambrian rocks are overlain

Missing
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The main development of the embayment took place in Palozoic rocks and is not expressed in younger beds. It plunges gently to the south with an accompanying thickening of the sedimentary rocks.

Nemaha Anticline: The Nemaha Anticline is the most prominent Post-Mississippian structural feature of Kansas. Extending into Nebraska on the north and Oklahoma on the south, the structure crosses Kansas from Nemaha County to Sumner County. The north-south trending anticline separates the Forest City and Cherokee Basins on the east from the Salina and Sedgwick Basins on the west. It is sometimes called, the "granite ridge" because the Precambrian crystalline rocks are at comparatively shallow depths along the axis of the uplift. This ridge plunges towards the south and reaches greater depths near the Oklahoma border. Merriam (1961) described the structural geology of Nemaha Anticline as follows:

> "Pre-Pennsylvanian strata are upturned, truncated, and overstepped by Pennsylvanian sediments along the flanks, and the Pennsylvanian beds rest on rocks as old as Precambrian on the crest of the structure. During the early part of the Pennsylvanian, the granite was exposed as a low ridge or chain of hills, which shed arkosic sediments into the adjoining basins."

<u>Pratt Anticline</u>: The Pratt Anticline, a broad southward plunging nose, is the smallest major structure within Kansas. It separates the Sedgwick Basin on the east from the Hugoton Embayment on the west. The section in this province includes sedimentary rocks of Cambro - Ordovician, Mississippian and Permo-Pennsylvanian age. Pennsylvanian beds overlie Ordovician rocks, where Mississippian rocks are absent.

Salina Basin: The Salina Basin is especially important to this study as much of the area under investigation lies within it. The second largest basin in Kansas, it is actually the southern end of the larger Central Nebraska Basin. It is bounded by the Cambridge Arch and the Central Kansas Uplift on the west, the Nemaha Anticline on the east and an indistinct unnamed saddle on the south. The axis of this Post-Mississippian syncline trends northwest and plunges northward into the deeper part of the basin in Nebraska. Lee, Leatherock, and Botinelly, 1948, described the following five principal periods of deformation or folding:

1) Late Cambrian to early Orodvician;
2) St. Peter to Mississippian;
3) Mississippian to Permian;
4) Post-Permian and Pre-Cretaceous;
5) Post-Cretaceous.

Sedimentary rocks present in the basin include units of Ordovician, Siluro - Devonian , Mississippian, Permo-Pennsylvanian, Jurassic, Cretaceous, and Teritary age.

Sedgwick Basin: One of the major structural provinces of Kansas, the Sedgwick Basin is enclosed by the Nemaha Anticline on the east, the Pratt Anticline on the west, and an indistinct saddle on the north which separates it from the Salina Basin. Plunging towards the south, it merges into the Anadarko Basin of Oklahoma. There is a thickening of the strata southward, from the shelf-like area into the deeper part of the Anadarko Basin. Sedimentary rocks in the basin range from Cambrian to Tertiary in age.

All major Post-Mississippian structures are shown in Figure 3 (Appendix).

Minor Structures

Only those minor structures that are in the area of investigation, (Figure 4, Appendix) are discussed here.

Agra Anticline: Agra Anticline is a northeast-southwest trending local feature in the Cambridge Arch. It passes through the northwestern corner of Smith County and extends into neighboring Phillips County.

Fairport-Natoma Anticline: The name Fairport-Natoma is applied to an anticline discovered by V. H. McNutt in Russell and Osborne Counties. This fold appears to be in general alignment with the Pfeifer anticline of Ellis and Russell Counties. Steeper on the west flank, it is measurable on outcroping rocks on the Barton Arch. According to Rubey and Bass (1925), "Minor domes and depressions occur on top of the anticlinal axis and in the synclines." Oil and gas have been found in such domes of Russell County.

Salt Creek (Twins) Structures; Two domes forming an amoeboid structure in southern Mitchell County have been called the "Salt Creek Twins." Closure of the west dome is about 50 feet, and of the east dome about 80 feet (Figure 5, Appendix). The structures are believed by Landes and Ockerman (1933), to be due to Cretaceous deposition conformable to the uneven surface on eroded Permian rocks. The productive oil formations in central and western Kansas are older than the Cretaceous so that these are valueless in oil prospecting.

Tipton Anticline: Tipton Anticline is a rather pronounced northward plunging anticlinal fold in western Mitchell County. It is discernible in outcroping Cretaceous rocks (Jewett, 1951).

GEOLOGIC HISTORY

Precambrian Surface

The oldest rocks known in subsurface of the area are the Precambrian crystalline rocks upon which later rocks were deposited. The Precambrian region was probably a broad undulating plain underlain by granite and other crystalline rocks. A long period of erosion in early Cambrian time reduced the land surface to a relatively level plain.

Paleozoic Era

The area was submerged beneath the sea in late Cambrian or early Ordovician times and was repeatedly inundated by epicontinental seas and subjected to subaereal erosion, which resulted in deposits of sandstone, limestone, dolomite, and shale separated by many hiatuses. More limestone was deposited through the Devonian period. Then the land rose above the sea and erosion occurred. A period of folding began in Mississippian time during which marked Orogenic movements took place. The Nemaha mountains and the Barton Arch were pushed up and the Salina Basin was formed between them. Much of the Devonian and Ordovician rocks were eroded away before the Mississippian sea finally covered the area. Two typical deposits of this sea are; a gray to black shale at the base and thick cherty limestone at the top. Uplifting and folding occurred again at the end of the Mississippian time. Pre-Pennsylvanian erosion removed nearly all the Paleozoic rocks from the central Kansas uplift and beveled parts of the rocks on its flanks. In Mitchell County an estimated total of 1,200 feet of Cambrian, Ordovician, Silurian, Devonian, and Mississippian rocks remained at the beginning of Pennsylvanian time (Hodson, 1959). During most of Pennsylvanian and early Permian times, the floor of the Salina Basin stood close to sea level.

The presence of unconformities between the various Pennsylvanian formations suggests that the sea oscialated back and forth on its western border (Ockerman and Landes, 1930). There is no unconformity found between Pennsylvanian and Permian. These periods are distinguished by the red beds deposited during the Permian. The principal deposits of early Permian were alternating beds of gray shale and limestone. Chemical precipitates of anhydrite, salt, and gypsum were deposited next as the shallow bodies of water evaporated in the arid climate. The salt series thin to the east and north and are not found in the subsurface in the eastern and northern parts of Mitchell County. The non-marine red beds, composed of sandstone, shale, siltstone, and evaporites, record a late Permian interval of deposition.

Mesozoic Era

A long period of erosion followed the withdrawal of the Permian sea. The sea covered the eroded surface of Permian rocks near close of early Cretaceous time. Shales, sandstone, and a few limestones were deposited over the hills and valleys. At the beginning of late Cretaceous time the area became land locked and fresh water sediments of Dakota age were deposited. The sea again covered the land thd thick sections of upper Cretaceous shale, chalk, and limestone were deposited. This is the Greenhorn Formation which forms the near surface rocks in part of the area. At the close of the Cretaceous time the sea withdrew from the plains region and a continental environment has existed since that time (Leonard, 1952).

Cenozoic Era

In early Tertiary time the Rocky Mountains province to the west uplifted considerably. Streams flowing eastward from the Rockies carried heavy loads of sediments which were deposited over thousands of square miles, forming the Great Plains. The Tertiary rivers finally diminished in size and deposition ceased. The streams draining the area began to deepen and widen their valleys so that most of the Tertiary and some of the Cretaceous rocks were removed. Streams from the Rocky Mountains crossed the western and central Kansas and began to aggrade their channels and deposited large quantities of alluvial material in their valleys. As the streams valleys became filled, the streams spread across the bed rock divides, shifted laterally and developed an extensive alluvial plain of sand, gravel, clay, and silt (Ogallala formation) that merged in the west with the erosional surface in the Rocky Mountain region (Frye, 1945). The major streams rejuvenated and finally reached the downward limit to which they could erode and commenced to deposit alluvium in the form of flood plains at a level that was but temporary and then later deepened the valleys forming a terrace. This process of erosion and deposition still continues.

History of Drilling

Oil and gas seepages in Smith County were reported by Moore and Haynes in 1917. About that time the reports of oil in shallow water wells generated considerable interest. These occurences had been known then for a considerable while, and in 1916 to 1918, much of the land about Athol, in the western part of the County, and near Bellaire, in the central part, was leased for development. A few tests wells were drilled, but no oil was discovered.

Prospecting for oil and gas in Mitchell County and Osborne County started in the nineteen twenties. Nineteen wells were drilled to depths ranging from 2,200 feet to 4,860 feet. Seven of the nineteen wells reported shows of oil or gas. The Beeler No. 1, in NE¼, NE¼, Sec. 10, T9S, R8W, reported a show of oil at a depth of 3,335 feet. The Turner No. 1, in NE cor. NE¼, Sec. 10, T7S, R12W, had a show of gas at a depth of 2,777 feet., and the Carlin No. 1. SW cor NE¼, Sec. 19, T8S, R13W, had an oil show in thick sand between 2,670 and 2,736 feet. A good show of oil at a depth of 2,840 feet was reported by the Dorman No. 1. in SW¼, SN¼, Sec. 20, T10S., R 15W, but the producing sand was only 3½ feet thick. The Preuter No. 1 in SW¼ SE¼, Sec. 30 T9S, R15W, had shows of gas, oil, and a mixture of both at different depths. However, no oil or gas could be extracted from the wells on a commercial scale.

Since that time wildcat wells have been drilled from time to time (Table 1, Appendix), but so far no oil pools have been discovered in Smith, Jewell, and Mitchell Counties. The three oil pools discovered is Osborne County are discussed under the heading of "Oil Production."

Oil Production

Oil production in the area is limited to the southwestern corner of Osborne County (Figure 5, appendix), which lies on the east flank of the petroleum-rich central Kansas Uplift. Barton and Russell Counties also lie on this important structural feature, and contain parts of four of the largest producing fields in Kansas. The northern end of the Fairport pool of Russell County is about a mile from southwestern Osborne County. Likewise, the eastern edge of the Laton field in Rooks County is about a mile from the western boundary of Osborne County. Many wells have been drilled in southwestern Osborne County because of the high production of the south and west.

Until 1951, drilling had not discovered any commercial oil or gas fields. The year 1952 marks the discovery of Ruggles pool. The 640 acres covered by this pool is located in 23-10-15W. Twelve wells were drilled to produce oil from three zones in Shawnee, Lansing, Kansas City, and Pennsylvanian Conglomerate, all of Pennsylvanian age. An additional well in 1959 brought the total number of producing wells to thirteen. All of these wells have been producing consistently with a cummulative production of 803,835 bbls. at the end of 1962.

Production was confined to Ruggles until 1957, when Ruggles south was discovered. It is located in sec. 27, T10S, R15W, and comprises an area of forty acres. Only one well in this pool produces oil from the Lansing, Kansas City Group, reaching a zone 3,038 feet deep. A cummulative total of 17,580 bbls. of oil has been produced up to 1963.

Worley pool is the latest one, discovered in 1959, and has an area of forty acres in sec. 33, T10S, R15W. The only well drilled in this area reaches a producing zone 3,408 feet deep in Pennsylvanian Conglomerate. By the end of 1959, this well had produced 1963 bbls. Since then, production has not been reported.

The oil production in Osborne County is shown in Table 2, Appendix.

DISCUSSION AND CONCLUSION

Oil is produced from Pennsylvanian deposits in small anticlinal structures of local extent in southwestern Osborne County. The possibility of new discoveries is very likely in this area. More important is the possibility of Arbuckle pools, as a large part of production to the south- and west is from this group of rocks.

The possibility of Arbuckle and Lansing, Kansas City pools in parts of Smith County is strong as many pools in neighboring Phillips County pro- cuce from these deposits. It is the writer's belief that the possibility of oil accumulation in this county could be for two reasons,

1) Anticlinal accumulation,
2) Accumulation by wedgeout of the reservoir rock on the flanks of the uplift.

The Agra anticline in T15, R15W is the most favorable structure for future development in the area. It is a northerly trending anticline almost paralleling the Cambridge Arch. Although not very well defined on Plate I, it can be picked out easily.

The wedging out of the rocks on the eastern flanks of the Cambridge Arch may be the cause of oil accumulation. The conditions are favorable for stratigraphic traps, along the belts of overlap and beveling, where the beveled edges of the rocks are porous and structurally closed. An example of accumulation of oil beneath unconformities is the Kraft Prusa field of Barton County which lies on the south limb of the uplift.

The source of oil for the seeps in Smith County is probably from the formations of Pennsylvanian age. It is possible that the oil from the Pennsylvanian sediments first migrated vertically up along joints and faults to the Cretaceous sediments. Then it migrated laterally along the bedding planes to the neighboring areas leaving traces of oil in Cretaceous sediments of Smith County in the form of seeps. The presence of oil in commercial quantities is a possibility without the presence of seeps. The presence of seeps strengthens the possibility (Landes and Jewell, 1939).

The Paleogeologic map is of immeasurable value to the petroleum geologist in search for stratigraphic traps. The areal geology of the area in the past is shown in Figure 7 and 8 of the Appendix (adapted from Lee,1956). Figure 7 is a Pre-Mississippian paleogeologic map showing sedging out of Simpson, Maquoketa, and Hunton rocks. Figure 8 gives a clear picture of the areal geology at the end of Mississippian. Wedging out Maquoketa shale and Hunton rocks cannot be seen here as they are overlapped by Devonian and Mississippian sediments. Stratigraphic traps are more difficult to find than structural traps and therefore, it requires a lot of exploration in that area of the basin which is worth testing yet almost neglected. The wedgeout type of trap is largely confined to the sedimentary basin rims and the more important areas that should be tested for oil are along the beveled edges of different formations that wedgeout against Central Kansas Uplift. The situation may be an inclined permeable stratum which has been truncated and the eroded edge sealed by a covering of relatively impervious material. Sealing on a bald headed structure is usually brought about by the blanketing effect of the overlapping younger sediments, which may lead to the formation of a stratigraphic trap. At the southwestern corner of the Osborne County the "bald head," the core of the truncated anticline, is Arbuckle limestone of Cambro-Ordovician age. This eroded anticline is overlain unconformably by Pennsylvanian formations.

The chances of oil accumulation are high in the porous Arbuckle limestone at the top of the anticline beneath the unconformity.

X Hunton rocks were completely eroded from the Central Kansas Uplift. On the beveled edges where they wedge out against eastern limbs of the anticline, porosity has developed where the original texture of the rock was favorable. Oil may occur in this porous zone.

According to Landes in 1933, the surface structures in Mitchell and Osborne Counties are largely controlled by Permian topography. It is likely that the pronounced domes in southern Mitchell County owe their relative steep dips to deposition conformable to the surface of Permian hills. The presence of a "great angular unconformity" at the base of the Cretaceous is recognized by petroleum geologists working in this area. Subsurface maps of Osborne and Mitchell Counties show that the Permian surface has considerable local relief and a regional northward dip, whereas, strata within the Permian have a regional dip to the west and northwest. But the Abercrombie well drilled on the west dome of the salt creek twins revealed that there was no anticline present in the subsurface.

The vertical forces that might produce these domes could be injected igneous or salt plugs. However, the disappearance of these folds with depth rejects the theory of deep seated intrusions. Taking salt intrusion of shallow origin into consideration, a ring of structural depressions, surrounding the twins (Figure 5, Appendix) may be a clue in finding the nature and direction of forces that might have produced the domes. The writer suggests that the structual depressions are due to salt movement. It is possible that the Wellington Salt moved towards the center of the structure leaving a ring of depressions surrounding it.

The productive oil formations in central and western Kansas are older than the Cretaceous, so the domes in Mitchell County are not valuable in oil prospecting. Oil may be present in the deeper Pennsylvanian and older rocks, but at present the limited data is insufficient to map a detailed structure of these rocks which might show some favorable features for oil accumulation.

The lack of oil discoveries in a greater part of the basin is attributed to the absence of obvious structures favorable for oil entrapment, as well as inadequate testing for oil and gas in respect to deeper subsurface structural geology. Smith County is located between the Cambridge Arch on the west and the bottom of the Salina Basin on the east. Jewell and Mitchell Counties lie near the center of the Salina Basin. Wells must go to a considerable depth in order to reach the formations which are productive of oil to the south and southwest. For this reason oil companies have been slow in testing this part of the State. It is true that the search for new stratigraphic traps is more expensive than the search for structural traps. But it is worthwhile to search for stratigraphic traps in the discussed area, where the conditions are favorable.

It is impractical and expensive to test the entire area along the wedging out margins of different formations. So in order to estimate the extent of the area that can be promising from exploration point of view, the highest position of each wedging out formation along the eroded edge is determined. The emphasis should be on these selected areas in search for oil.

The highest position of Mississippian along its western limit lies in northwestern Smith County and the area most favorable for future development lies in T.2S, R.15W, T.1S, R.14W, and T.1S, R15W. Similarly, production from Hunton can be expected in T.1S, R.14W, T.9S, R.11W, and T.105, R.11W. Viola Limestone is sandy at the base and oil may occur in this zone. The highest position of Viola lies in Phillips County, but T.S5, R.14W, and T.8S, R.15W in Osborne County can be tested for oil from this group of rocks. Possibilities of new discoveries from Arbuckle are restricted to T.10S,R.15W, where the "bald head" is overlain unconformably by Pennsylvanian formations.

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APPENDIX

TABLE 1
Dry wildcat tests drilled in Smith, Jewell, Mitchell
and Osborne Counties, Kansas From 1948 to January 1, 1963

Year	County and Farm	Location	Surface Elevation feet	Depth to top of formation, feet							Arbuckle	Total Depth feet
				Topeka	Heebner	Lansing-K.C.	Miss.	Honton	Viola	Simpson		
	SMITH COUNTY											
1951	Lull Farm	Sec.5 T.35, R.11W.				2933	3593		3892	3010	4148	4176
1952												
1953	Jacob Lease	SE¼ NE¼ SW¼ Sec.28,T.4S, R13W	1735	2680	2916	2962	3678	3790	3970	4119	4175	4200
1954	Bates Farm	SW¼ SW¼ NE¼ Sec.21,T.15, R.15W	2112	3034	3238	3280	3860		3904	4104	4175	4200
	Harkinger Farm	S½ SE¼ SW¼ Sec.34,T2S, R.11W	1907	2672		2995	3705	3831	4010	4168	4202	4250
1955-59												
1960	No.1 Greik	SE NW SE 31-2-11W	1845	2637	2870	2915	3605	3704	3917	4103	4173	4185
	No.1 Anderson	SW SW SW 19-5-72W	1661	2680	3512	3950	3692	3812	3946	4150	4245	4275
1961												
1962	No.1 Caldwell	NW SE NW 10-5-13W	1760		2924	2973	3875	3876	3995	4206	4281	4305
	No.1 Conway	NW NW NW 20-3-14W	1843		3025	3075	3787	3893	4026	4257	4329	4367

Year	County and Farm	Location	Surface Elevation feet	Depth to top of formation, feet								Total Depth feet
				Topeka	Heebner	Lansing-K.C.	Miss.	Hunton	Viola	Simpson	Arbuckle	
	JEWELL COUNTY											
1948	RankFarm	Sec.12,T5S. R.6W	1413			2300	2949	3133	3417	3605	3701	3740
1949												
1950	Debays Farm	Sec.11,T5S. R.10W	1762	2804	2745	2805	3497	3715	3891	4097	4188	4202
1951	Froehreich Farm	Sec.30,T5S. R.10W			2540	2619	3247	3443		3696	3776	3800
1952	Beard Farm	NE¼ SW¼ SW¼ Sec.10,T.5S. R.10W	1636	2380	2624	2691	3368		3690	3900	3990	4052
1953	Glen Roe Farm	NE¼ NE¼ NE¼ Sec.19,T1S. R.7W	1706									4120
1954-55												
1956	Beard Lease	Sec.10,T5S, R.10W	1649									2715
1957-59												
1960	No.1 Volboril	C SE NE 8-3-10W	1829	2592	2777	2834	3524	3791	3906	4088	4161	4437
	No.1 Keebner	C NE NE 27-5-10W	1618	2400	2632	2707	3366	3509	3710	3991	4065	4246

TABLE 1 (Con.t)

Year	County and Farm	Location	Surface Elevation feet	Depth to top of formation, feet								Total Depth feet
				Topeka	Heebner	Lansing-K.C.	Miss.	Hunton	Viola	Simpson	Arbuckle	
	MITCHELL COUNTY											
1948	Black Farm	Sec.1,T.5S. R.7W	1561	2121		2490	3166	3395	3586	3860	3930	3952
1949												
1950	Van Pelt Farm	Sec.7,T.7S. R.7W.	1382	2092	2326	2439	3169	3395	3570	3848	3910	3948
	Reinhardt Farm	Sec.34,T.6S. R.9W	1427			2525	3192	3438	3542	3812	3905	3955
1951	Gasper Lease	Sec.31,T.7S. R.10W	1588	2380	2622	2698	3333	3508	3531	3792	3872	3897
1952												
1953	Stillwell Property	NW¼ SW¼ NW¼ Sec.12,T.5S, R.6W	1558		2392	2489	3130	3440	3680	3885	3982	4032
	Thiessen Property	SW¼ SW¼ SE¼ Sec.15,T.6S. R.9W	1436									3960
1954-56												
1957	No.1 Harmon	NW¼ NW¼ NW¼ Sec.17,T.9S. R.7W	1473		2425	2548	3210	3460	3600	3820	2900	3952
	No.1 Everall	NW¼ NW¼ NE¼ Sec.17,T.9S. R.7W	1471	2175	2406	2537	3223	3492	3624	3852	3918	3950
1958	No.1 Albercrombie	SW SE NE	1367		2348	2473	3125	3540	3643	3760	3853	3787
1959												

TABLE 1 (Con.t)

Year	County and Farm	Location	Surface Elevation feet	Depth of top of formation, feet Topeka	Heebner	Lansing-K.C.	Miss.	Hunton	Viola	Simpson	Arbuckle	Total Depth feet
	MITCHELL COUNTY											
1960	No.1 Hartman	C SW NW 17=6-6W	1528	2170	2388	2502	3140	3410	3640		3973	4048
1961	No.1 Schneider	C SW NW 20-9-9W	1662	2476	2800	2800	3412	3670	3794	4000	4067	4126
	No. 1 Zenke	C NE NE 11-9-10W	1827	2677	2920	2998	3647	3865	3973	4162	4261	4298
	OSBORNE COUNTY											
1948	No. 1 Dean	SW C SW¼ 5-8-14W	1808			3038			3551	3670	3725	3768
	No. 1 Spears	NW¼ SW¼ SE¼ 15-8-14W	1881		3300	3092						3126
	No. 2 Spears	SW¼ SE¼ NW¼ 15-8-14W	1879		3029	3092						3167
	No. 1 McEvea	NW Cor.SE¼ 27-8-15W	1939		3111	3168			3672		3828	3871
1949	No.1 Heiserwell	Sec.12,T.8S. R.14W	1845	2860		3083						3200
	No. 1 Seefeld	Sec.32,T.10S. R.15W	2027			3330				3883	3923	3950
	No. 1 Woreley	Sec.34,T10S. R.15W	1841	2715		3013				3418	3837	3482

TABLE 1 (Con.t)

Year	County and Farm	Location	Surface Elevation feet	Depth to top of formation, feet								Total Depth feet
				Topeka	Heebner	Lansing-K.C.	Miss.	Hunton	Viola	Simpson	Arbuckle	
	OSBORNE COUNTY											
1950	No. 1 Heitschmidt	SW Cor.SW¼ 11-9-14W	1943	2985	3156	3214			3788	3892		3922
	No. 1 Nagel	SW Cor.NE¼ 2-9-15W										3906
	No. 1 Cooper	NW¼ NE¼ NE¼ 29-10-11W	1669			2409						3061
	No. 1 Applegate	NE¼ SW¼ SW¼ 11-10-12W	1744		2925	2980						3221
	No. 1 Schloh	NW Cor.SE¼ 15-10-15W	1833		2995	3043					3450	3527
	No. 1 Hotbrock	SE Cor.NE¼ 20-10-15W	2026	2972	3218	3267						3500
1951	Finkenbinder	Sec.22,T.10S R.13W	1734	2840	2962	3020	3654		4571	3694	3742	3930
	No. 1 PfortMiller	Sec.7, T.10S R.15W	1945		–	3145						3610
1952												
1953	No. 1 Delaney	NW¼ SW¼ NE¼ 24-6-15W	1845			3143					3965	4010
	No. 1 Madson	NE¼ NE¼ SE¼ 17=9-14W	2036			3308					4170	4206
	No. 1 Beesner	SW¼ NW¼ NE¼ 5-9-15W	2051			3264					3816	3842
	No. 1 Kraft	SW¼ SW¼ NW¼ 22-9-15W	2045			3260					3875	3928

TABLE 1 (Con.t)

Year	County and Farm	Location	Surface Elevation feet	Depth to top of formation, feet								Total Depth feet
				Topeka	Heebner	Lansing-K.C.	Miss.	Hunton	Viola	Simpson	Arbuckle	
	OSBORNE COUNTY											
1954	Enochs Farm	Cen.S.SE¼ NE¼ Sec.25, T8S. R.13W	1842	2772	3053	3092	3690		3882	4027	4077	4162
	La Rosh Farm	NW¼ NW¼ SE¼ Sec.23,T.8S. R.14W	1790	1008	2939	3005			3522	3637	3686	3740
1955	No. 1 Hackerott	SW SE SE 19-8-14W	1808			3068					3889	3911
	No. 1 Koelling	SE SW NE 35-8-15W	1923			3155					3850	3880
	No. 1 Beck	NW NW SE 12-9-15W	1902			3172					3958	4010
	No. 1 Finney	NE NE NE 15-9-15W	2014			3233					3885	3935
	No. 1 White	SE SE NW 27-9-15W	2021									
1956												
1957	No. 1 Bowen	NW¼ NW¼ NW¼ Sec.22,T8S. R.14W	1834	2812	3052	3114	3668		3860		4052	4085
	No. 1 Hogan	SE¼ NW¼ SE¼ Sec. 4,T.10S. R.15W	2002	2951	3185	3238			3758			3803
	No. 1 Meyer	NE¼ NE¼ NE¼ Sec.11,T.10S. R.15W	1858		3031	3081			3512		3722	3775
1958	No. 1 Bales	SW SW NW 14-8-14W	1803		2971	3032			3584	3711	3767	3847

TABLE 1 (Con.t)

Year	County and Farm	Location	Surface Elevation feet	Depth to top of formation feet								Total Depth feet
				Topeka	Heebner	Lansing-K.C.	Miss.	Hunton	Viola	Simpson	Arbuckle	
	OSBORNE COUNTY											
1954	No. 1 Thornburg	Cen. SW¼ 24-8-15W	1848		3050	3113	3586					3660
	No. 1 Napp	NW NE SE 22-9-15W	1996		3172	3223	3490		3695	3822	3895	3925
	No. 1 Hagan	SE SE SW 28-9-15W	2006		3196	3251	3541		3782	3825	3885	3895
	No. 1 Thruston	NW NW SE 11-10-11W	1760									4224
	No. 1 Nichlos	NW NW NW 15-10-11W	1730									4144
	No. 1 Mosure	C SE SW 21-10-11W	1682									3975
1960	No. 1 Thruston	NW SW SE 11-10-11W	1763		2923	2992	3602		3874	4124	4184	
1961	No. 1 Applegate	C SE NE 10-10-12W	1741		2920	2976						

TABLE 1 (Concl)

TABLE 2

Oil Production in Osborne County to January 1, 1963

Year of Production	Pool & Year of Discovery	Location of Discovery Well	Area	Production bbls. Total	Cummulative	No. Produc. Wells	Producing Zone	Depth Feet	Thickness Feet
1952	Ruggles(1952)	23-10-15W	640	73,200	73,200	12	Shawnee Lans.-K.C. Penn.Cglm.	2986' 3024' 3394'	16'
1953	Ruggles(1952)	23-10-15W	640	82,815	156,015	12	Shawnee Lans.-K.C. Penn.Cglm.	2986 3024' 3394'	16'
1954	Ruggles(1952)	23-10-15W	640	90,155	246,170	12	Shawnee Lans.-K.C. Penn.Cglm.	2986' 3024' 3395'	16'
1955	Ruggles(1952)	23-10-15W	640	82,276	328,446	12	Shawnee Lans.-K.C. Penn.Cglm.	2986' 3024' 3394'	16'
1956	Ruggles(1952)	23-10-15W	640	84,894	413,340	12	Shawnee Lans.-K.C. Penn.Cglm.	3986' 3024' 3394'	16'
1957	Ruggles(1952)	23-10-15W	640	70,899	484,239	12	Shawnee Lans.-K.C. Penn.Cglm.	2986' 3024' 3394'	16'
	Ruggles(1957) (South)	27-10-15W	40	5,199	5,199	1	Lans.-K.C.	3038'	4'
1958	Ruggles(1952)	23-10-15W	640	66,867	551,106	12	Shawnee Lans.-K.C. Penn.Cglm.	2986' 3024' 3394'	16'
	Ruggles(1957) South	28-10-15W	40	3,661	8,860	1	Lans.-K.C.	3038'	4'

Year of Production	Pool & Year of Discovery	Location of Discovery well	Area Acre	Production bbls. Total	Cummulative	No. Produc. Wells	Producing Zone Name Depth	Thickness
1959	Ruggles(1952)	23-10-15W	640	74,062	626,168	13	Shawnee 2986' Lans.-K.C.3024' Penn.Cglm.3394'	16'
	Ruggles(1957)	27-10-15W	40	2,763	11,623	1	Lans.-K.C 3038'	4'
	Worley(1959) Revised	33-10-15W	40	1,643	1, 643	1	Penn.Cglm.3408'	5'
1960	Ruggles(1952)	23-10-15W	640	64,690	690,858	13	Shawnee 2986 Lans.-K.C. 3024' Penn.Cglm. 3394'	16'
	RUggles(1957) South	27-10-15W	40	2,326	13,949	1	Lans.-K.C. 3038'	4'
	Worley(1959)	33-10-15W	No Report		16,43		Penn.Cglm. 3408'	5'
1961	Ruggles(1952)	23-10-15W	640	56,284	757,142	13	Shawnee 2986 Lans.-K.C. 3024' Penn.Cglm. 3394'	16'
	Ruggles(1957) South	27-10-15W	40	1,971	15,920	1	Lans.-K.C.3038'	4'
	Worley(1959)	33-10-15W	No Report		1,643		Penn.Cglm. 3408'	5'
1962	Ruggles(1952)	23-10-15W	640	56,593	803,835	13	Shawnee 2986' Lans-K.C. 3024' Penn.Cglm. 3394'	16'
	Ruggles(1957) South	27-10-15W	40	1,660	17,580	1	Lans.-K.C. 3038'	4'
	Worley(1959)	33-10-15W	No Report		1,643		Penn.Cglm. 3408'	5'

TABLE 2 (Concl.)

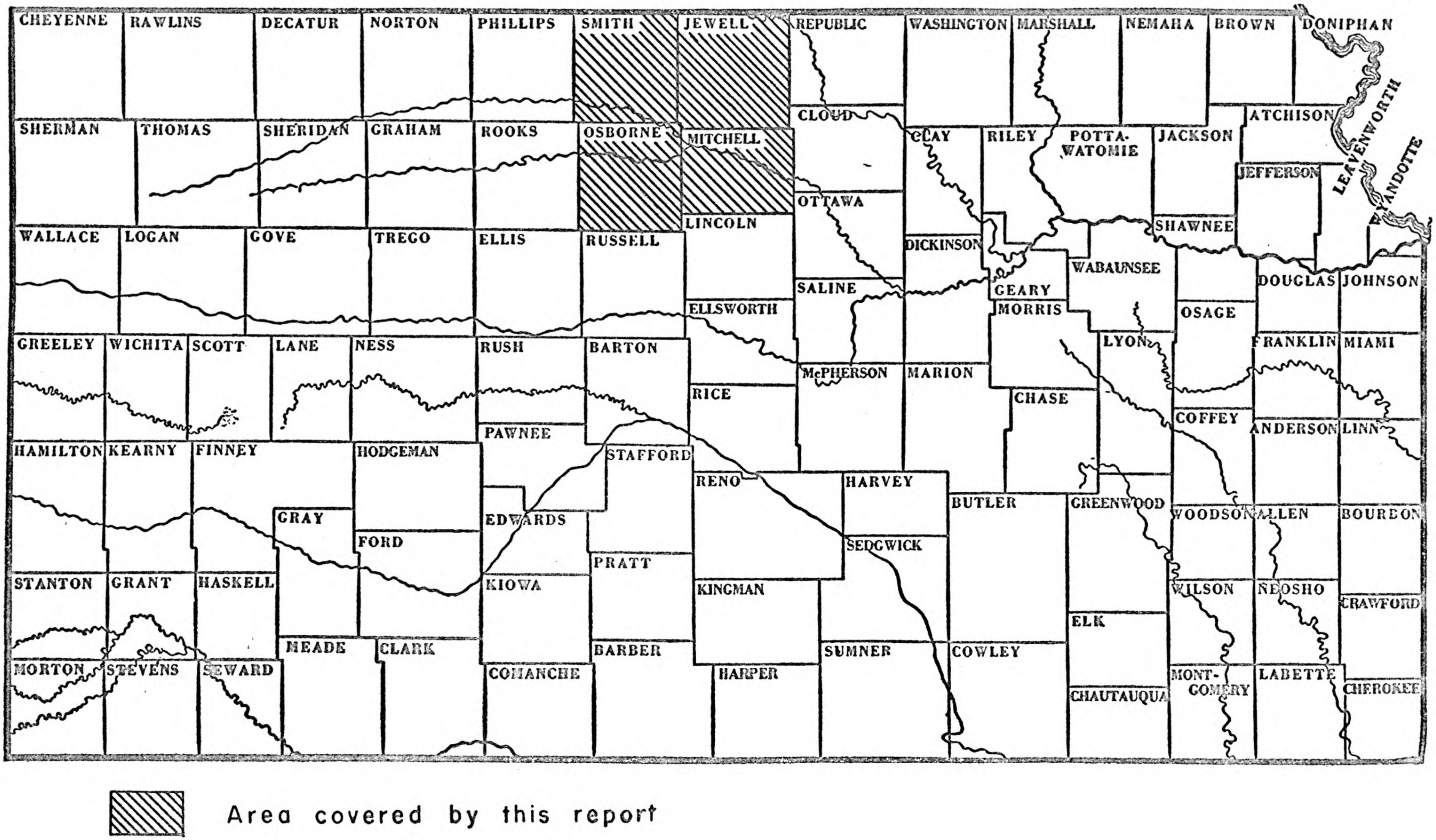
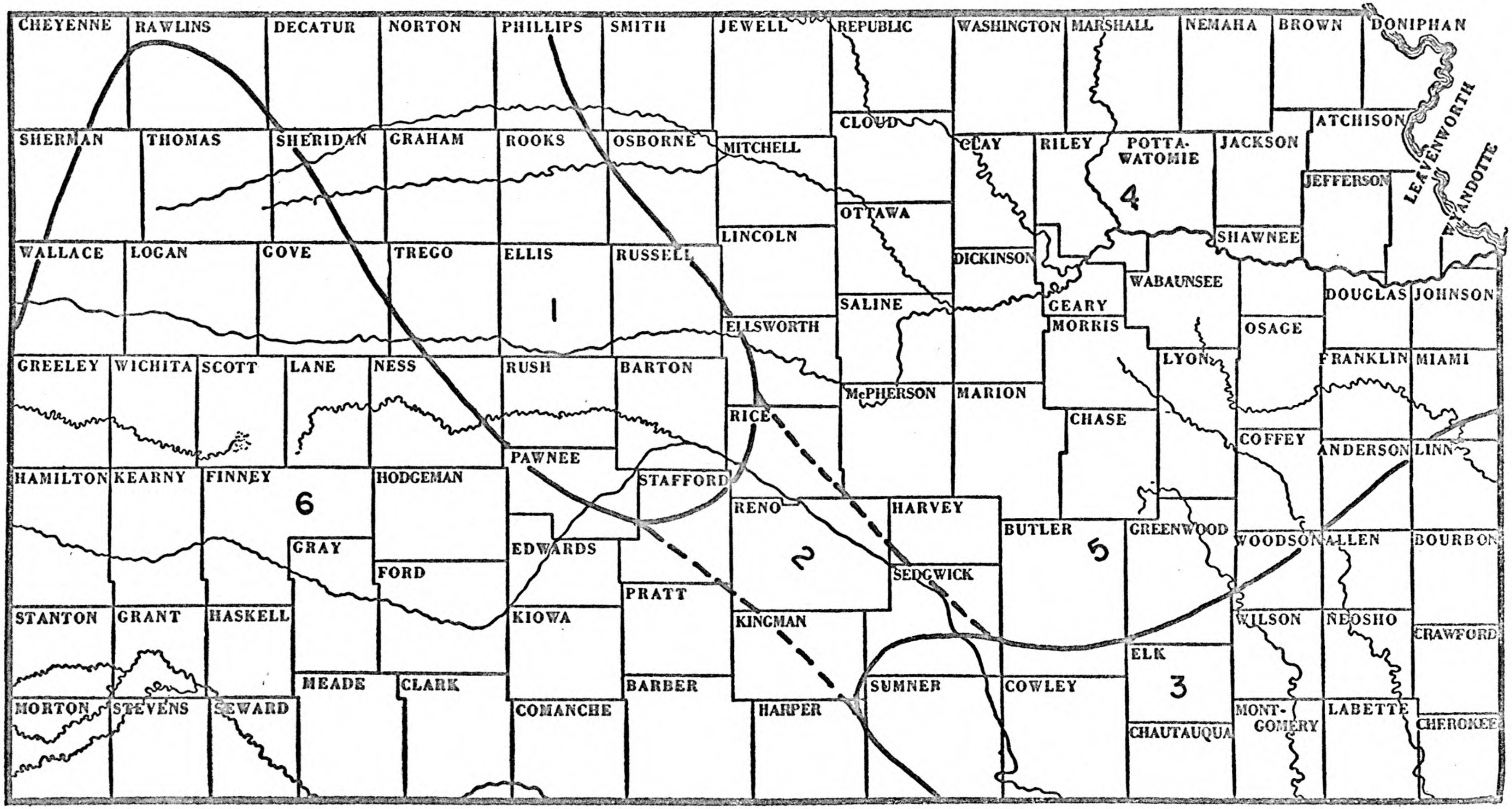


FIGURE 1

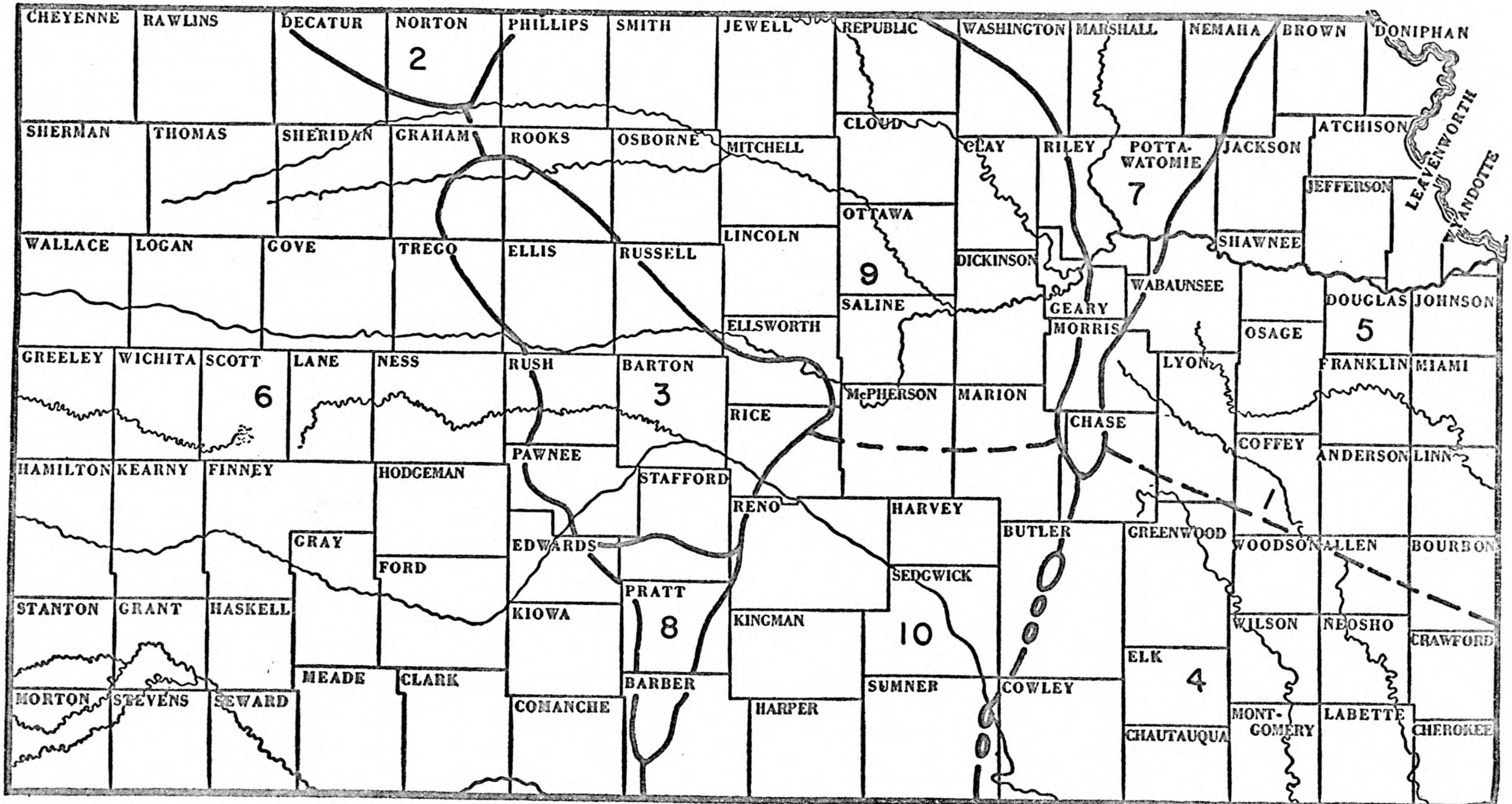
Index map showing location of Smith, Jewell, Mitchell, and Osborne Counties, Kansas.



EXPLANATION:

1. ANCESTRAL CENTRAL KANSAS UPLIFT
2. CENTRAL KANSAS ARCH
3. CHAUTAUQUA ARCH
4. NORTH KANSAS BASIN
5. OZARK HOMOCLINE
6. SOUTHWEST KANSAS BASIN

FIGURE 2
Major Pre-Mississippian Structures in Kansas



EXPLANATION:

1. BOURBON ARCH
2. CAMBRIDGE ARCH
3. CENTRAL KANSAS UPLIFT
4. CHEROKEE BASIN
5. FOREST CITY BASIN
6. HUGOTON EMBAYMENT
7. NEMAHA ANTICLINE
8. PRATT ANTICLINE
9. SALINA BASIN
10. SEDGWICK BASIN

FIGURE 3
Major Post-Mississippian Structures in Kansas

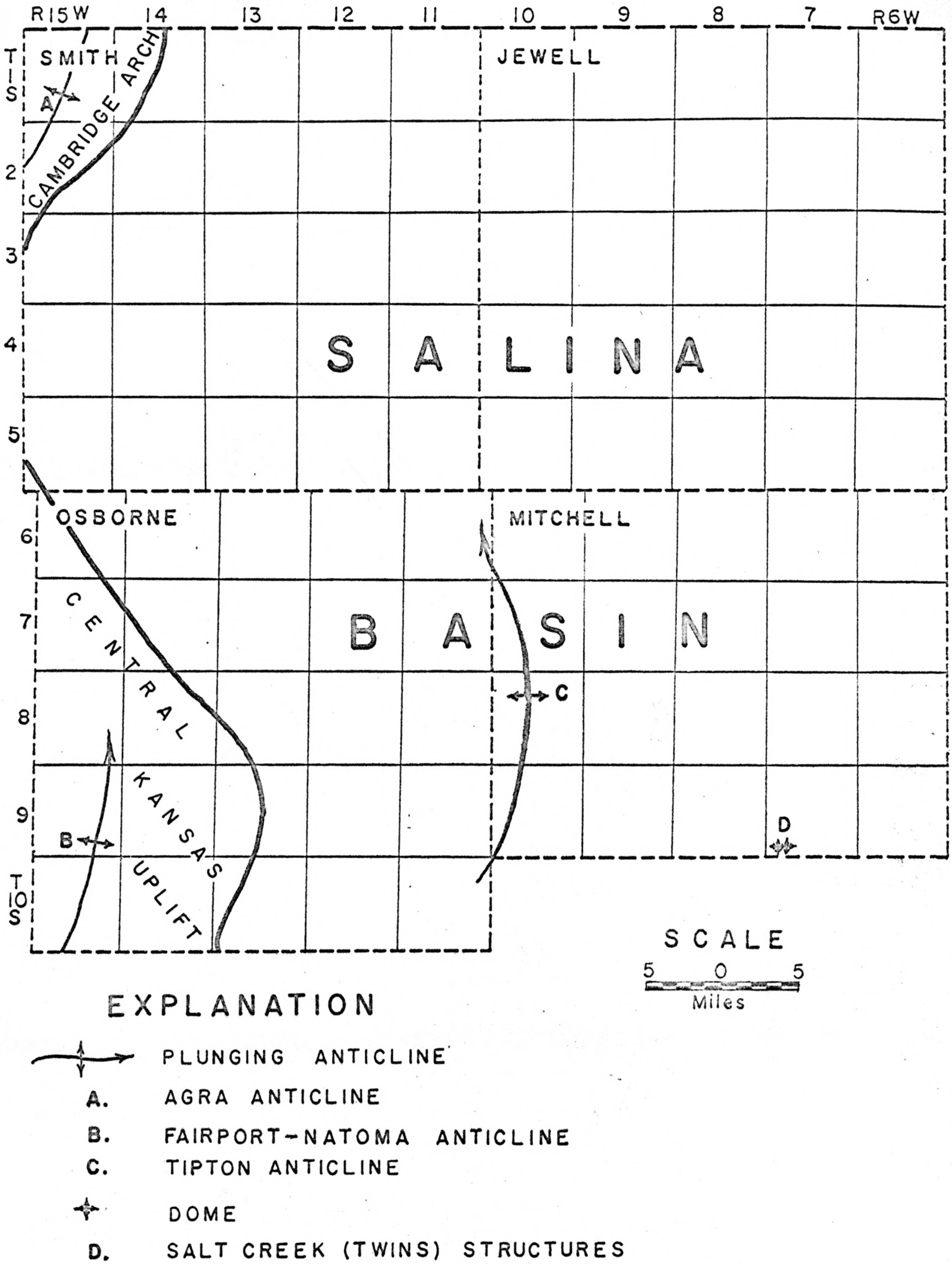
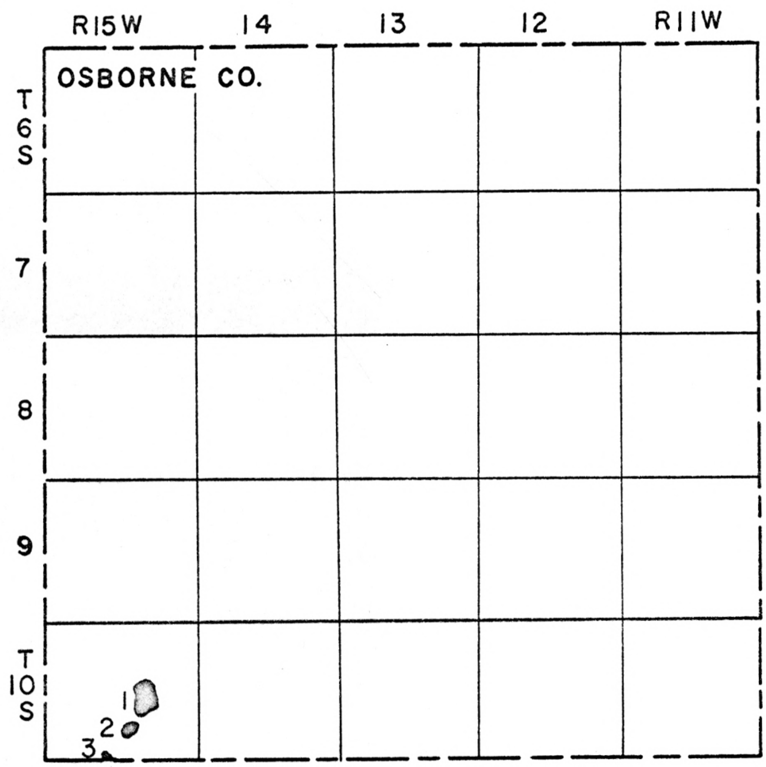


FIGURE 4
Minor Structures in Smith, Jewell, Mitchell, and Osborne Counties, Kansas



EXPLANATION

1. RUGGLES
2. RUGGLES SOUTH
3. WORLEY

FIGURE 5

Oil Pools in Osborne Coutny, Kansas

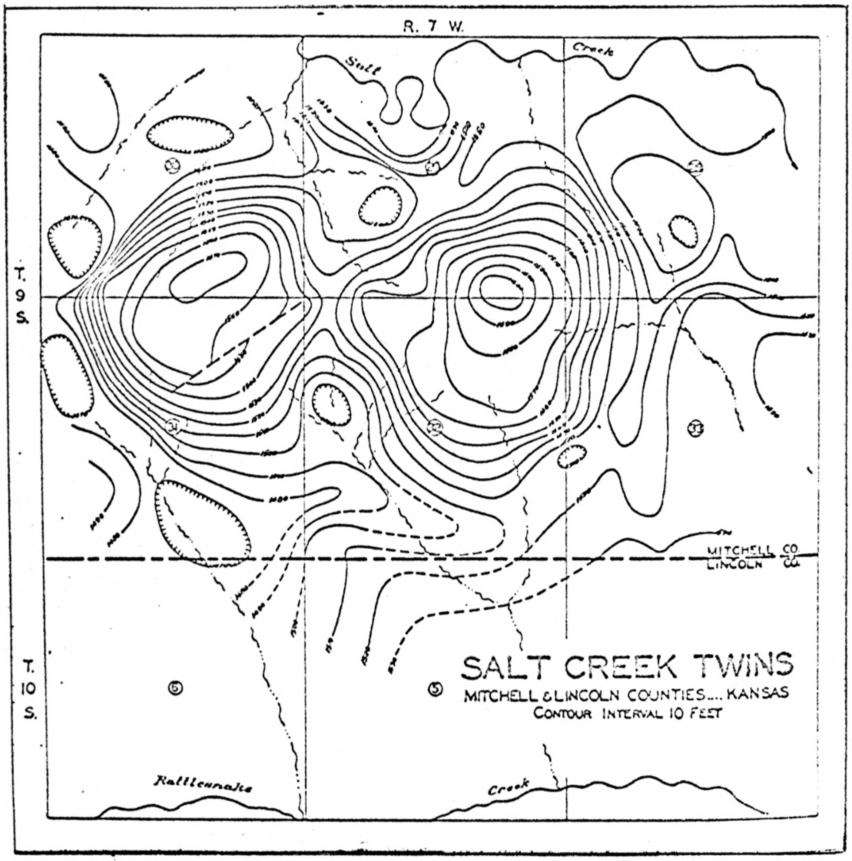


FIGURE 6

Structure Contour Map of the "The Twins" Mitchell County
(Adapted from Landes and Ockerman, 1933)

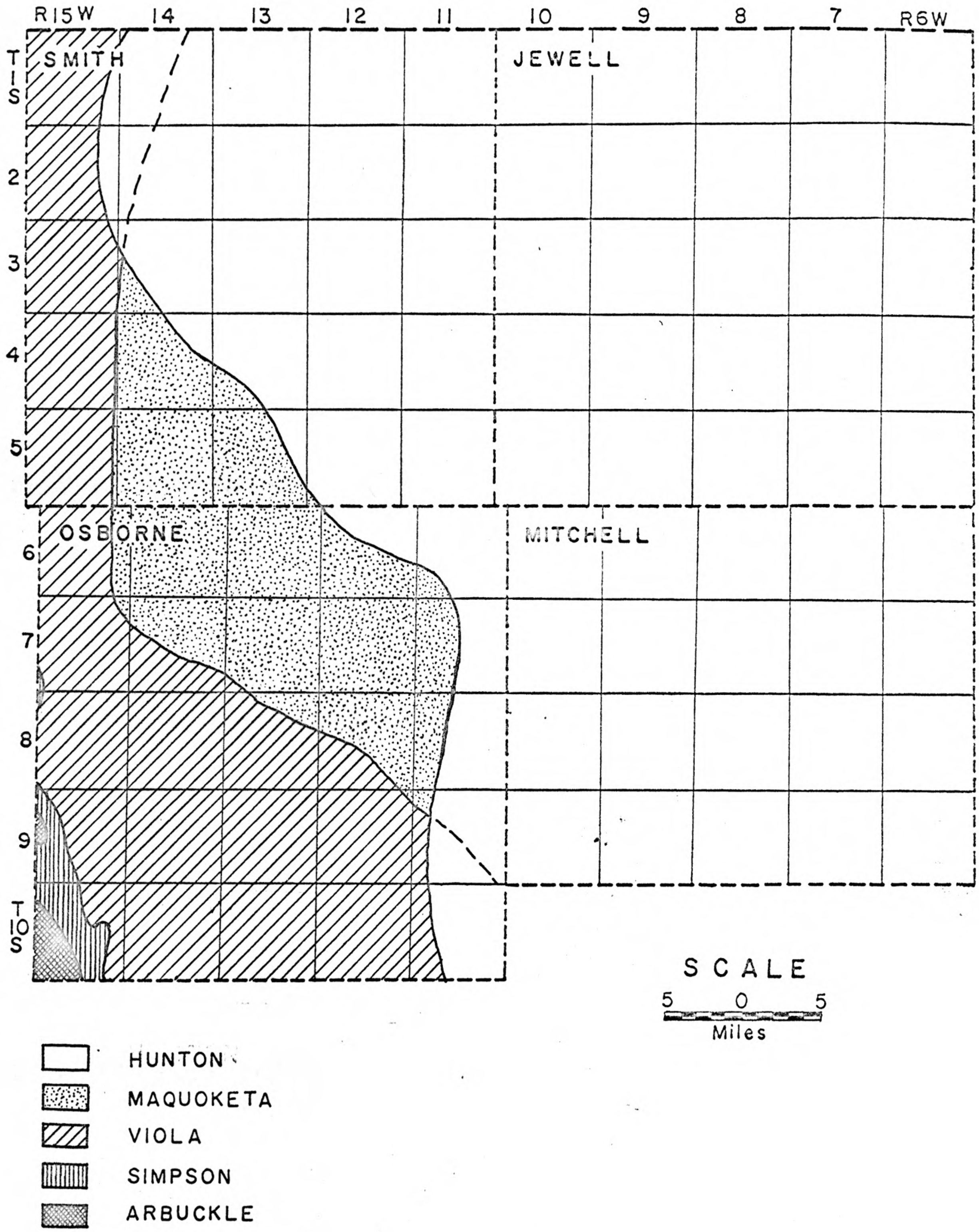


FIGURE 7

Distribution of Pre-Mississippian rocks in Smith, Jewell, Mitchell and Osborne Counties, Kansas

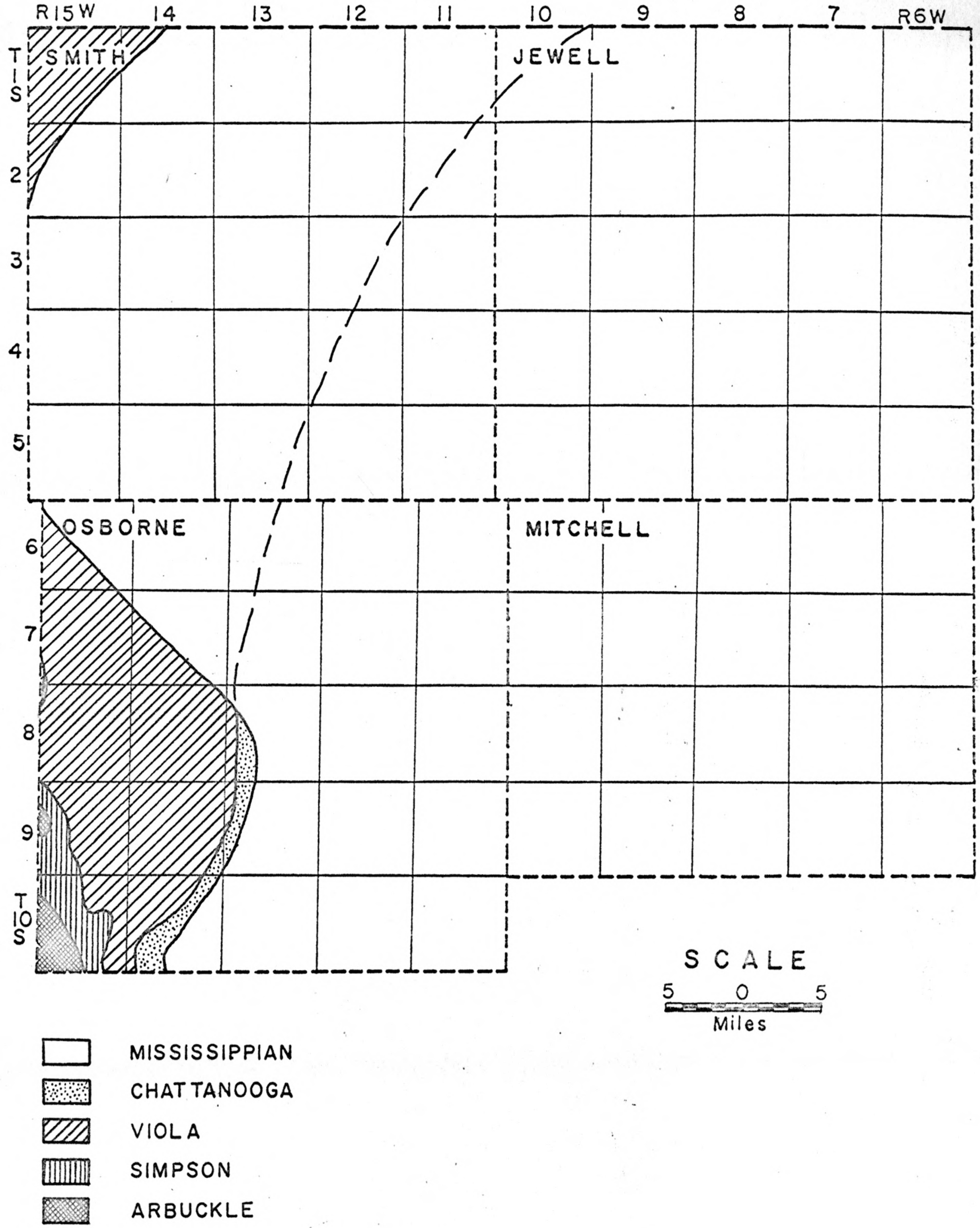


FIGURE 8

Post-Mississippian areal geology of Smith, Jewell, Mitchell, and Osborne Counties, Kansas

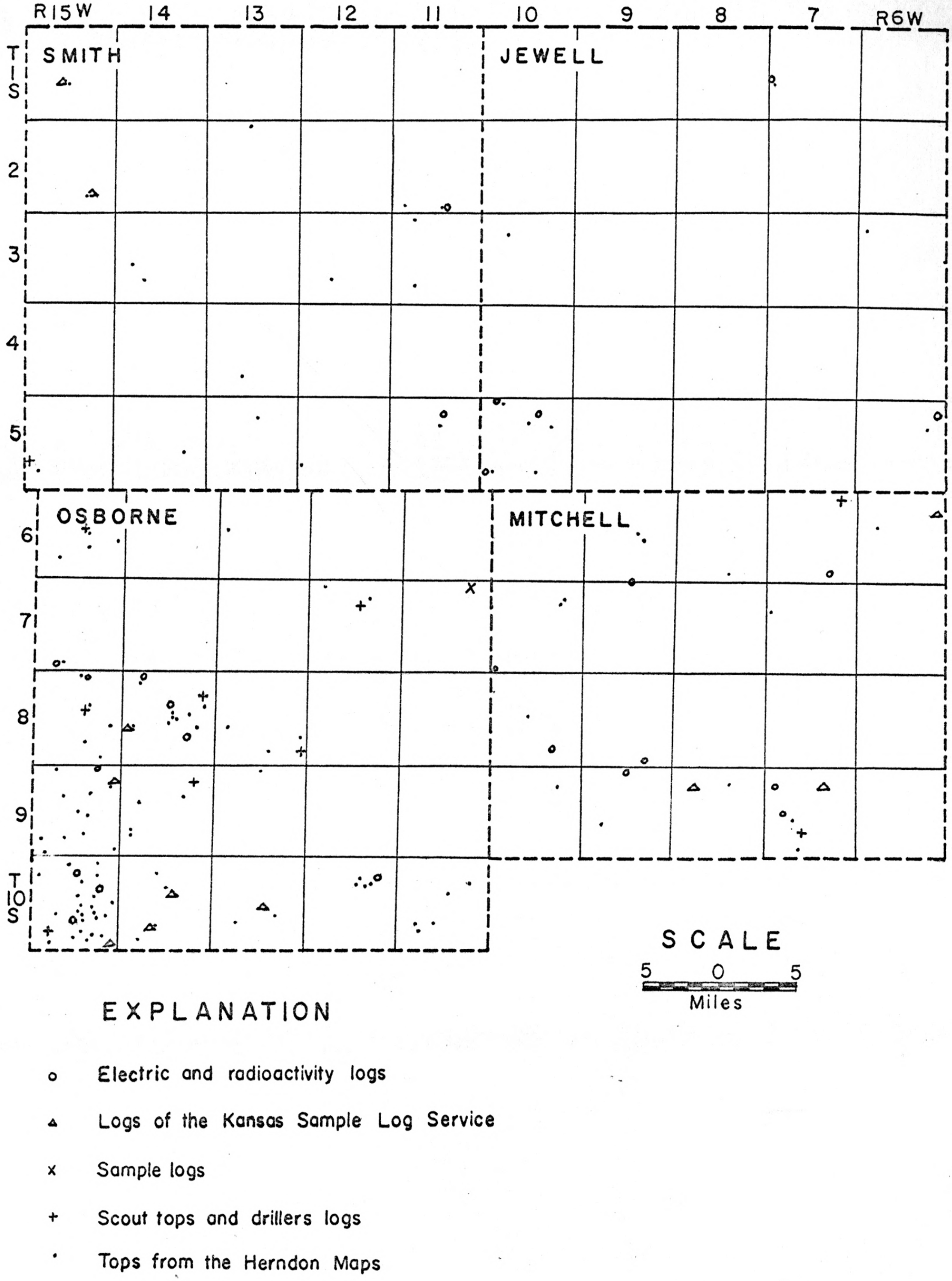
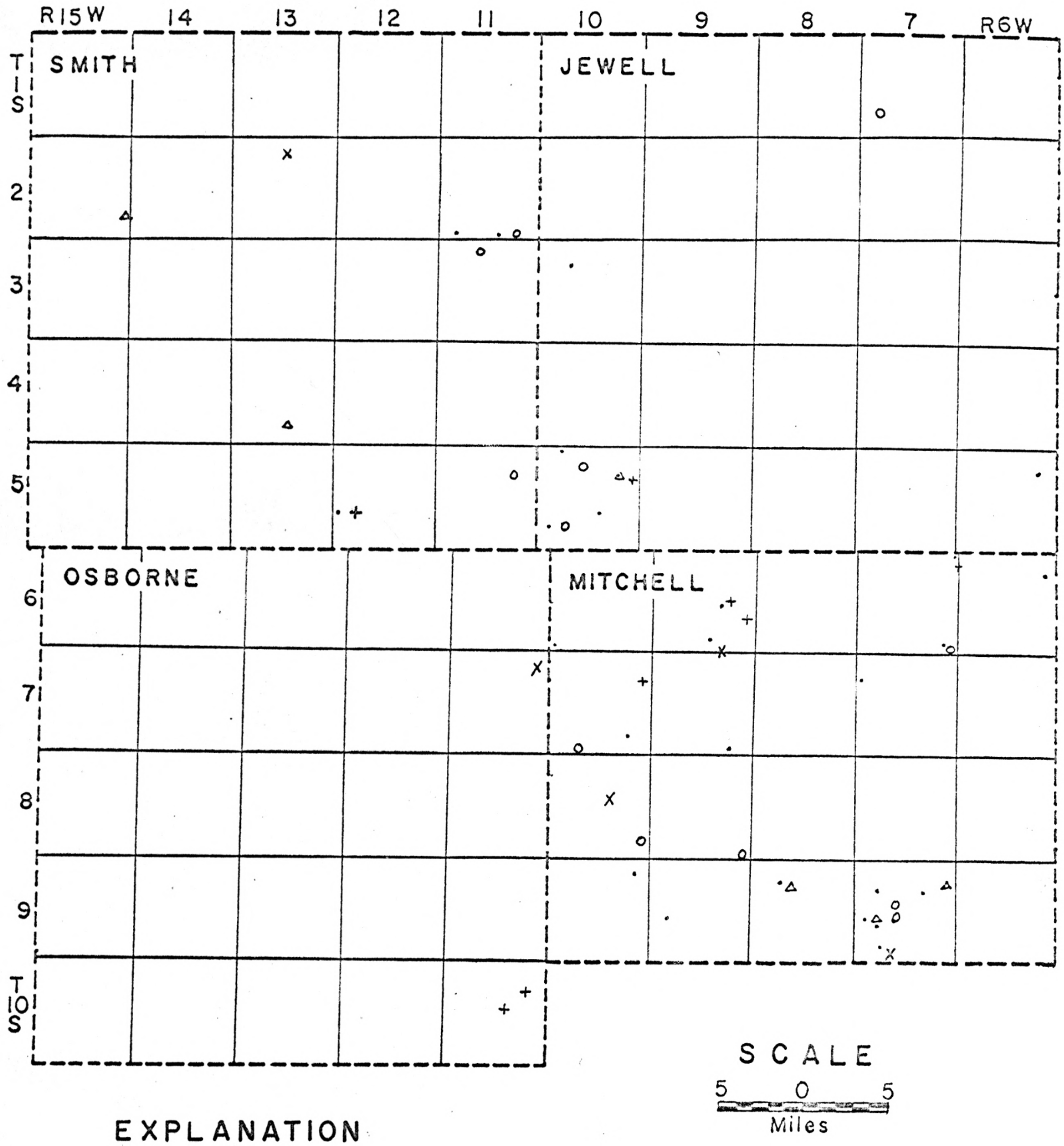


FIGURE 9

Subsurface points of control used to consturct structural map on top of the Lansing group.



EXPLANATION

- o Electric and radioactivity logs
- Δ Logs of the Kansas Sample Log Service
- x Sample logs
- \+ Scout tops and drillers logs
- • Tops from the Herndon Maps

FIGURE 10

Subsurface points of control used to construct structural map on the Hunton Rocks

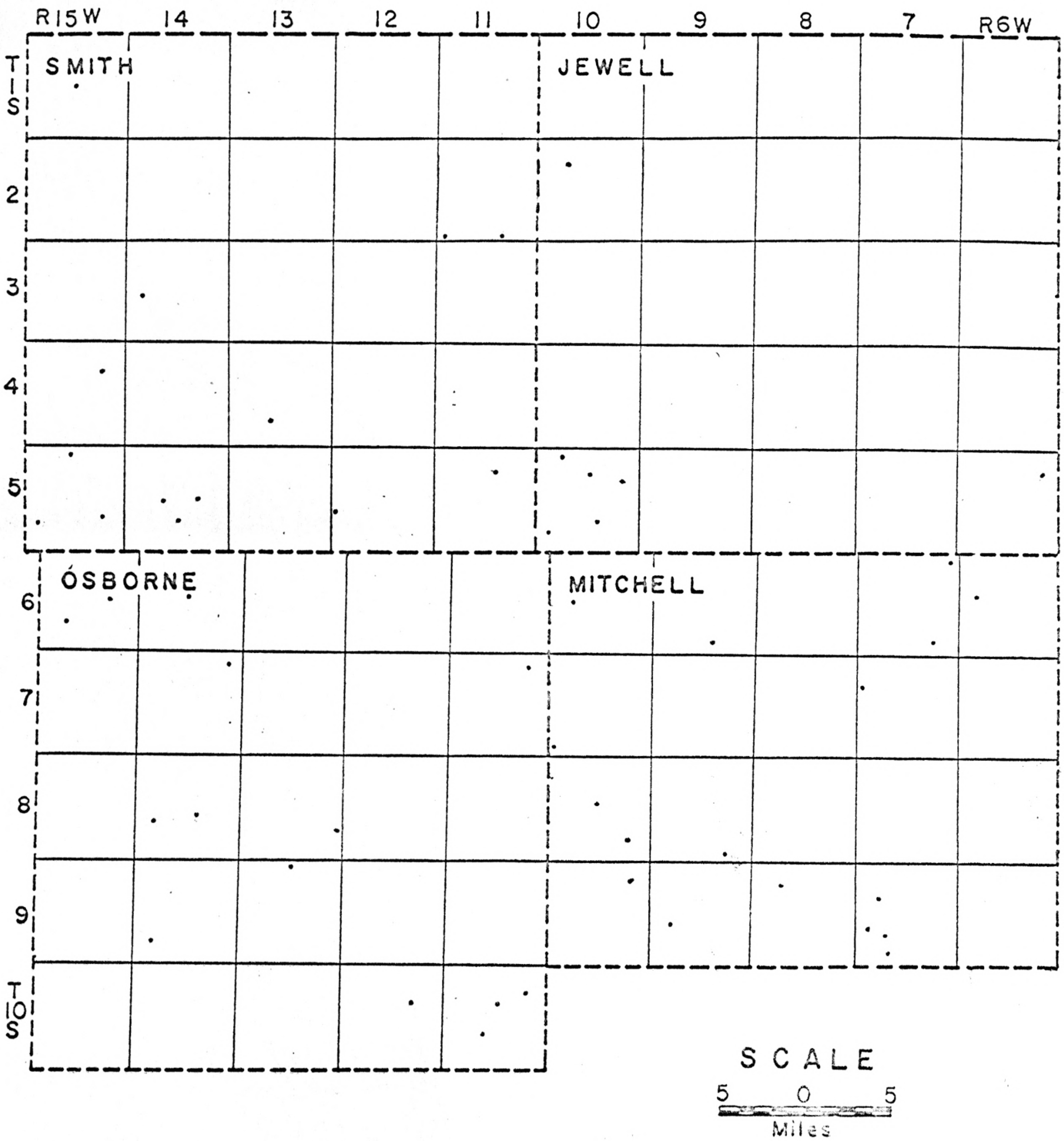


FIGURE 11

Subsurface points of control used to construct the Isopachous map of the interval between top of Miss. and top of Lansing Group.

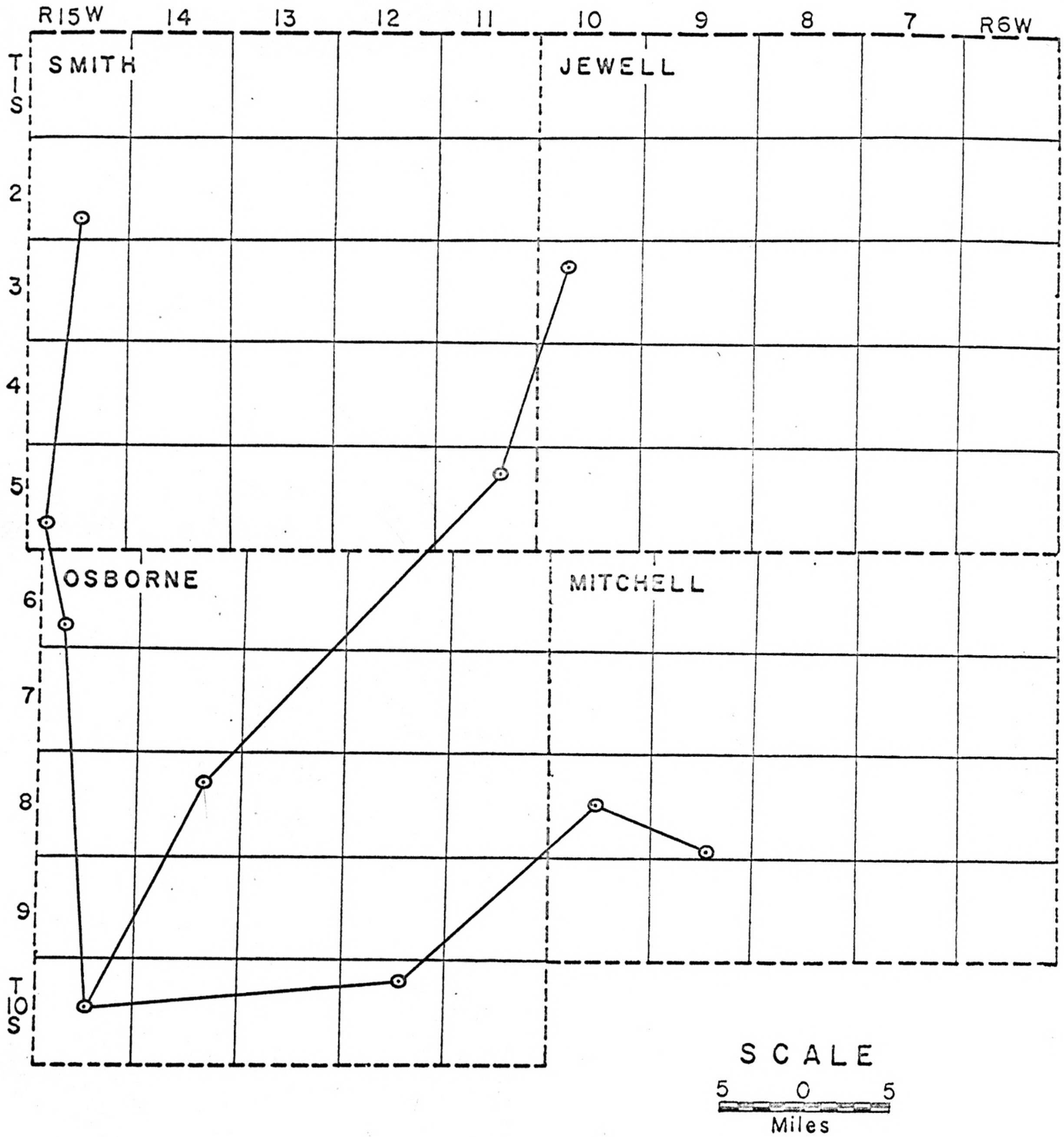


FIGURE 12

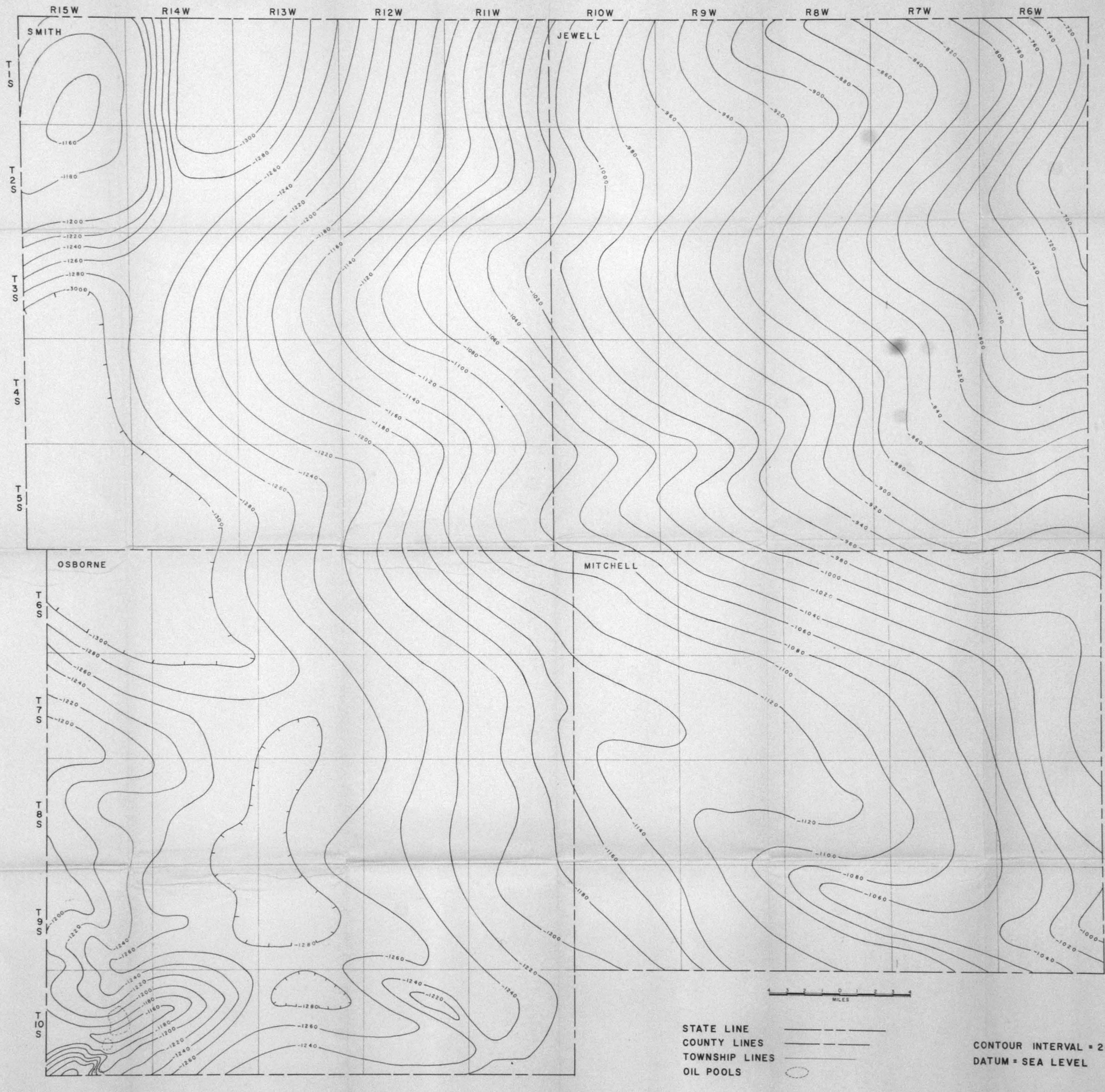
Map of Smith, Jewell, Mitchell, and Osborne Counties Showing Location of Wells Used in Making Cross Sections

PLATES I TO IV INCLUSIVE

(In accompanying Plate box)

STRUCTURAL CONTOUR MAP ON TOP OF THE LANSING GROUP IN SMITH, JEWELL, MITCHELL, AND OSBORNE COUNTIES, KANSAS

PLATE I

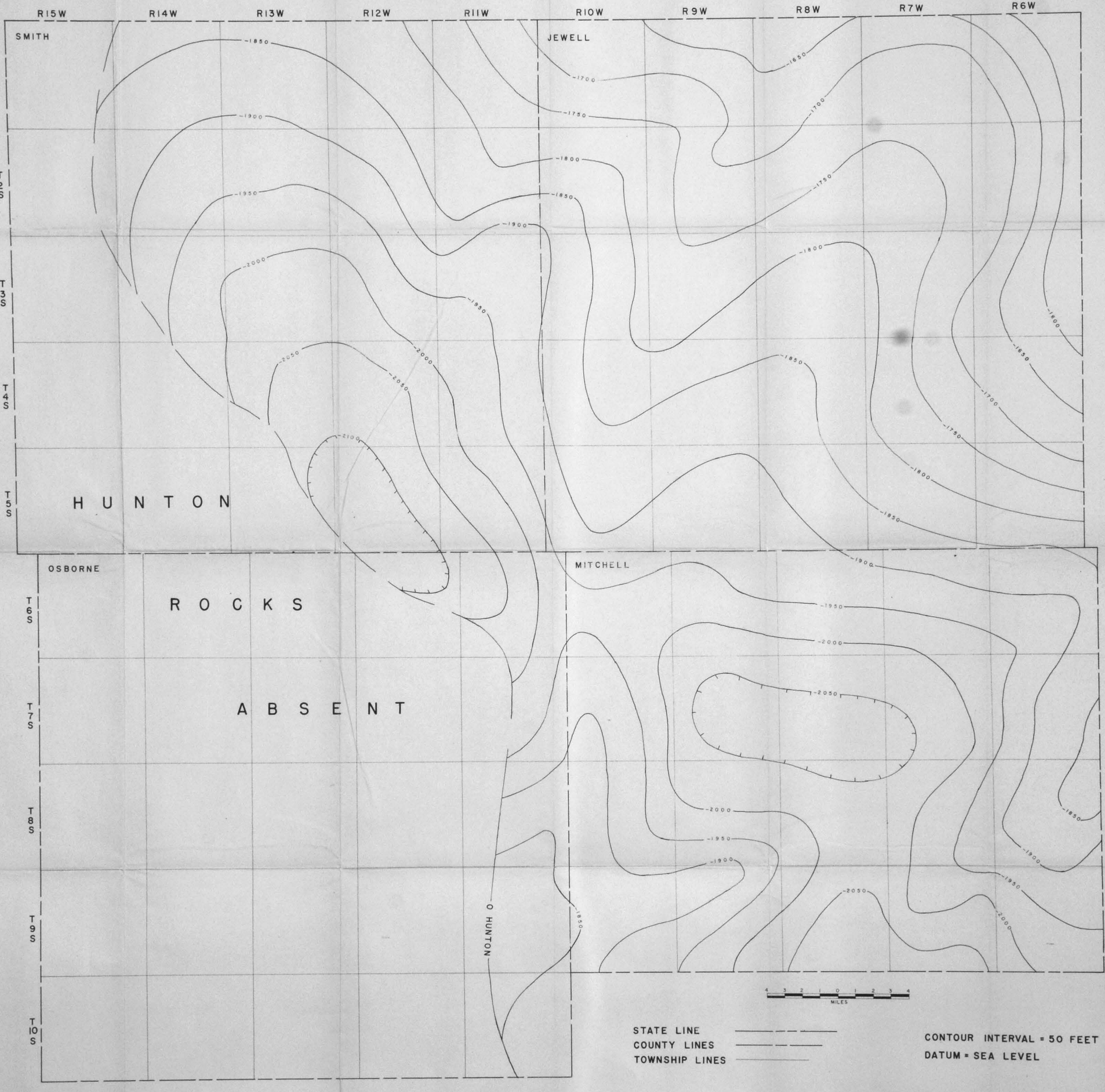


CONTOUR INTERVAL = 20 FEET
DATUM = SEA LEVEL

June 1965
Noorul W Ansari

STRUCTURAL CONTOUR MAP ON TOP OF HUNTON ROCKS IN SMITH, JEWELL, MITCHELL AND OSBORNE COUNTIES, KANSAS

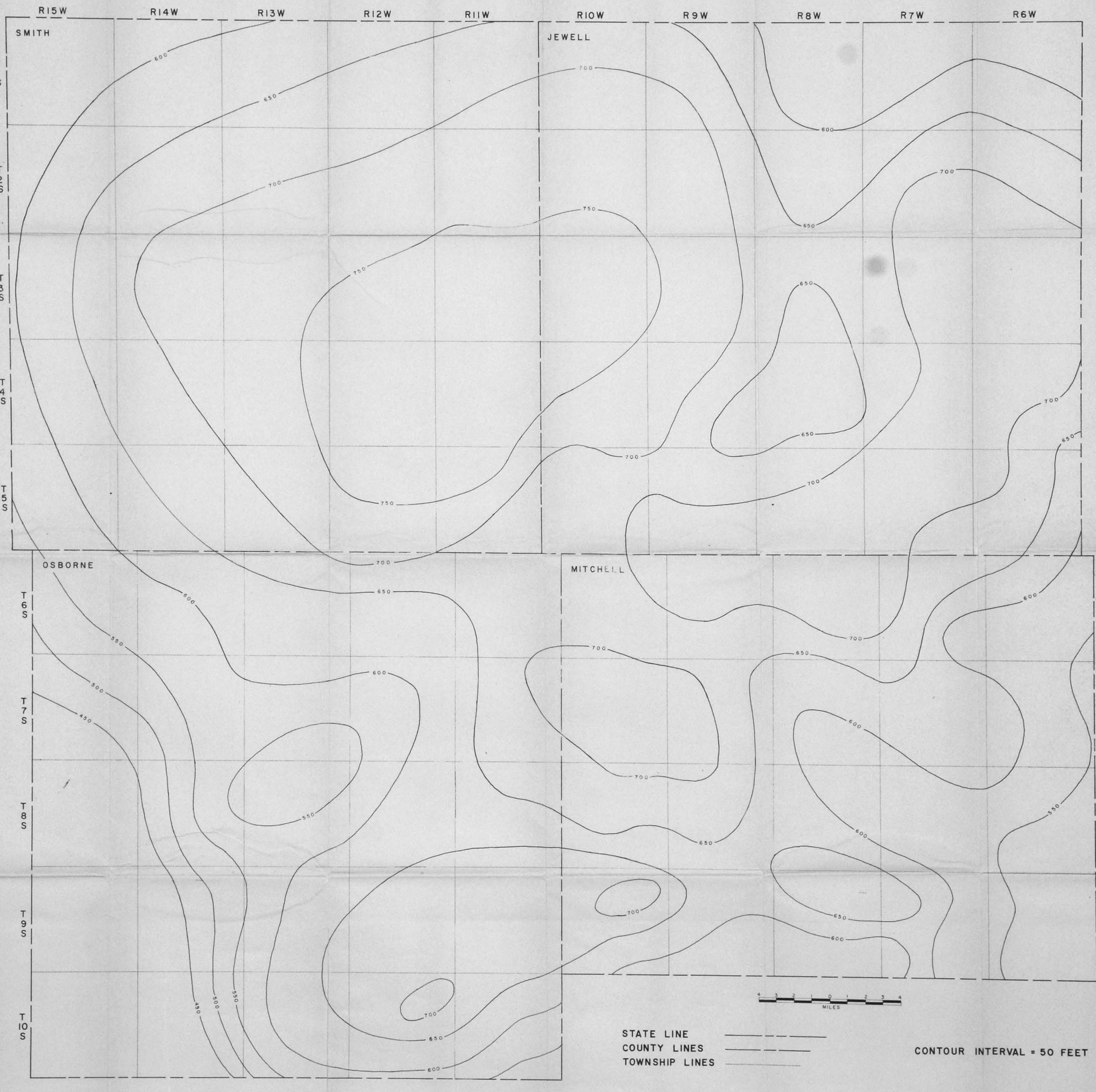
PLATE II



June 1965
Noorul W. Ansari

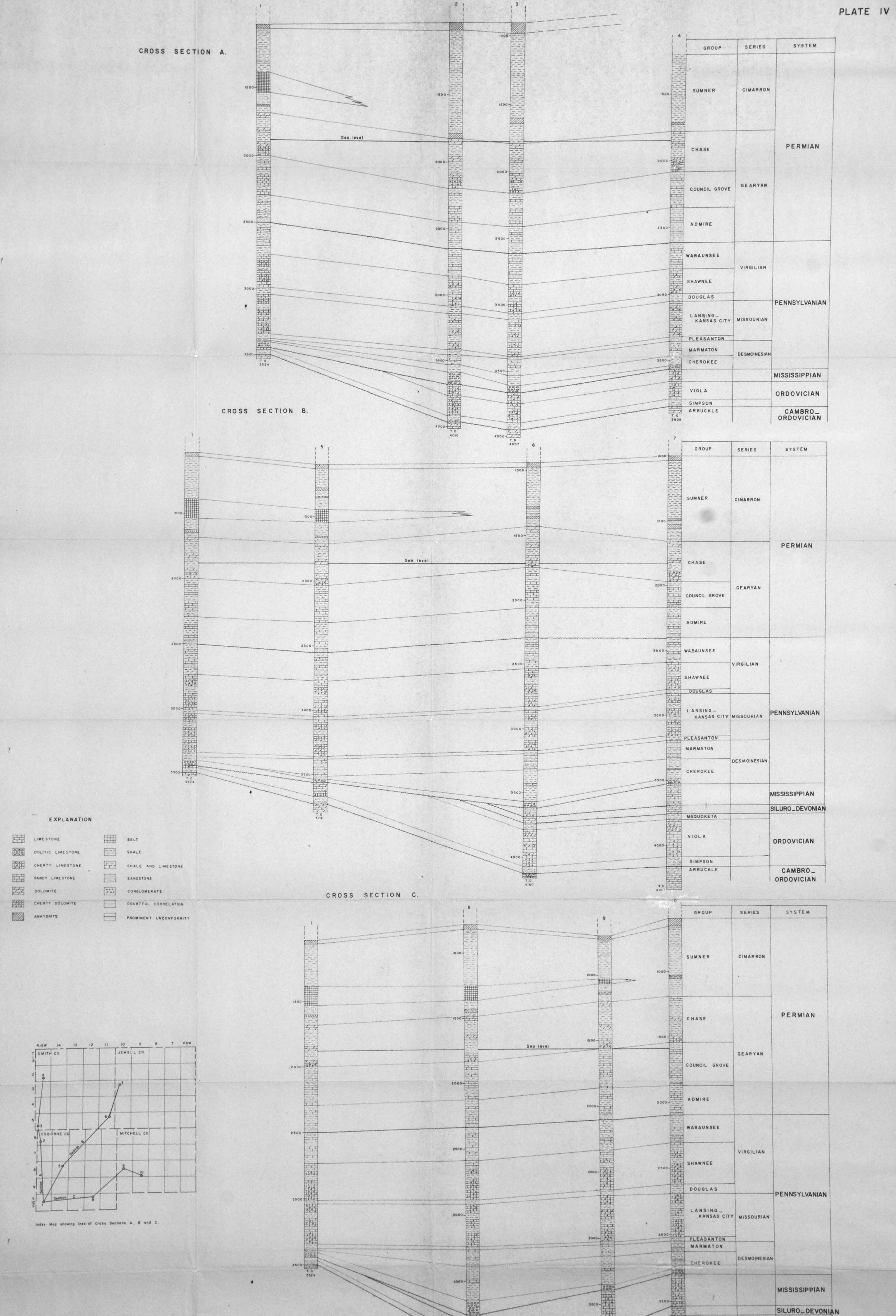
ISOPACHOUS MAP SHOWING INTERVAL BETWEEN TOP OF MISSISSIPPIAN ROCKS AND TOP OF LANSING GROUP IN SMITH, MITCHELL, JEWELL, AND OSBORNE COUNTIES, KANSAS

PLATE III



June 1965
Noorul W. Ansari

PLATE IV



List of Wells

Well No	Company	Farm name	Fee No	Location	Elevation in feet above sea level
1.	Anderson_Prichard Oil Corp.	Ruggles "A"	2	Sec. 23, T.10 S., R.15W. SE NW NW	1891
2.	Anderson_Prichard Oil Corp.	Delaney	1	Sec. 29, T.6 S., R.15W. NW SW NE	1845
3.	Stanolind Oil & Gas Co.	Anton G. Rehor	1	Sec. 30, T.5 S., R.15W. SEc NE	1798
4.	Earl F. Wakefield	Stockton	1	Sec. 26, T.2 S., R.15W. SW SW SW	1852
5.	Carter Oil Co.	Neuschwanger	1	Sec. 15, T.8 S., R.14W. NEc SW	1870
6.	Helmerich & Payne, Inc.	Meyer	1	Sec. 10, T.5 S., R.11W. NEc SW	1714
7.	National Drilling Co.	Voboril	1	Sec. 8, T.3 S., R.10W. C SE NE	1829
8.	Paul McIntyre Et Al	Applegate	1	Sec. 11, T.10 S., R.12W. C SW SW	1744
9.	Seidhoff Et Al	Grief	1	Sec. 16, T.8 S., R.10W.	1563
10.	Northern Ordnance Inc.	Mary Burr	1	Sec. 35, T.8 S., R.9W.	1593

JUNE 1965
NOORUL W. ANSARI

THE SUBSURFACE GEOLOGY OF SMITH, JEWELL, MITCHELL, AND OSBORNE COUNTIES OF KANSAS, RELATED TO PETROLEUM ACCUMULATION

by

NOORUL WASE ANSARI

B. Sc., Osmania University, 1961

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology and Geography

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1965

This report is concerned with the subsurface geology of Smith, Jewell, Mitchell, and Osborne Counties of Kansas, in relation to petroleum accumulation and the geologic factors unfavorable to the presence of oil in the area.

To facilitate this study, three subsurface cross sections, two structural contour maps, and an isophachous map were constructed. Data used for the preparation of sections and maps were obtained from Herndon maps, Kansas Sample Log Service logs, and preliminary structure maps by Merriam and others.

Rocks of the area range in age from Pre-Cambrian to Quarternary; however, as a result of numerous hiatuses, the complete stratigraphic section is not represented in the area. Pre-Pennsylvania erosion removed nearly all the Paleozoic rocks from the Central Kansas Uplift and beveled parts of the rocks on its flanks.

Various phases of regional tilting and structural deformation occurred during different geologic periods. The structural features important for petroleum accumulation are the Central Kansas Uplift, Fairport Anticline, and Agra Anticline, which developed during Late Missippian and Pennsylvanian times. Oil production in the area is limited to the southwestern corner of Osborne County where petroleum accumulations occur in anticlinal structures. The three oil pools in the area are Ruggles, Ruggles South, and Worley, and are found in zones of the Shawnee and Lansing-Kansas City groups and in the Pennsylvanian conglomerate.

The possibility of new discoveries in the area is very likely. The accumulations could be structural or stratigraphic. The Agra Anticline in T.1S, R.15W is the most favorable for future development. The wedging out of the rocks on the eastern flanks of the Kansas City Uplift may localize oil accumulation. The conditions are favorable for stratigraphic traps along the belts of overlap and beveling, where the beveled edges of the rocks are porous and structurally closed. The wedgout type of trap is largely confined to sedimentary basin rims and, therefore, the more promising areas for oil lie on the highest position on the beveled edge of each wedging out formation.

The scarcity of oil discoveries in a greater part of the basin can be attributed to the absence of easily located structural formations favorable to oil entrapment, and to inadequate and insufficient testing for petroleum in the deeper subsurface. The area of investigation lies between the Central Kansas Uplift and the center of the Salina Basin. In order to reach the oil producing formations, wells in this area must be drilled to a considerably greater depth than is necessary in the Central Kansas Uplift to the south and southwest. Because of the greater cost and a lack of information, oil companies have been reluctant to test in this part of Kansas.