THE RELATIONSHIP OF THE SUBSURFACE GEOLOGY TO THE PETROLEUM ACCUMULATION IN HARVEY COUNTY, KANSAS

by

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INTRODUCTION

Purpose of Investigation

The purpose of this work is to determine the relationship of the stratigraphy, structure and the geologic history of Harvey County, Kansas, to petroleum accumulation.

Location and Topography

Harvey County is in south-central Kansas, including Townships 22, 23 and 24 South, and Ranges 1 and 2 East, and 1, 2 and 3 West. The county which consists of 540 square miles and in 15 townships, is bordered on the north by McPherson and Marion Counties, on the east by Marion and Butler Counties, on the south by Sedgwick County, and on the west by Reno County.

The area lies mostly within the Great Bend Prairie physiographic province but the eastern boundary transgresses into the "Flint Hills".

The county is drained to the south by tributaries of the Arkansas River.

Climatic conditions in this part of central Kansas are characterized by moderate precipitation, a wide range of temperature variations, moderately high average wind velocity and comparatively rapid evaporation.

Procedure

The "Hunton" limestone of Devonian-Silurian age (Appendix, Fig. 7) and the Mississippi "Chat" of Mississippian age (Appendix,

Fig. 6) were chosen to be mapped because of their stratigraphic significance and structural reflection of underlying formations. Lack of sufficient control prevented mapping of other horizons which are perhaps more significant structurally.

All available elevations were used to compute datum elevations for contouring. These elevations were obtained from the Herndon Map Service and the State Geological Survey of Kansas.

Samples were examined from wells numbered 3, 8 and 10, on the panel diagram (Appendix, Fig. 5).

Previous Investigations

Previous investigations in Harvey County consisted of either individual studies of pools or studies of the county included with regional investigations.

Individual pool studies have been undertaken by Bunte and Fortier (1941) on the Nikkel Pool and Johnston (1934) on the Hollow Pool. The State Geological Survey of Kansas has published reports concerning oil and gas developments of Kansas which included Harvey County.

Koester (1935), Lee (1939, 1940, 1948), Morgan (1932), and Taylor (1946, 1947) included Harvey County in regional studies of central Kansas.

GEOLOGY OF THE AREA

Stratigraphy

Precambrian. The Precambrian rocks of Harvey County probably consist of metamorphic and igneous rocks. No wells in

Harvey County have penetrated to the Precambrian rocks. In adjacent counties deep wells have encountered igneous and metamorphic rocks below the Cambrian rocks.

Cambro-Ordovician. Arbuckle Group. The Arbuckle group (dolomite) is the term applied to the formations of Late Cambrian age and Early Ordovician age. Lying above the Cambrian Bonneterre dolomite and below the Simpson group of Early Ordovician age, the formations are, in ascending order: the Eminence dolomite of Late Cambrian age, the Gasconade dolomite, the Roubidoux formation, and the Cotter and Jefferson City dolomites, undivided, of Early Ordovician age. The various formations of the Arbuckle group are difficult to recognize in subsurface. One or more of the formations in the Arbuckle group are probably missing in Harvey County.

The Arbuckle group in this area is generally fine to coarse crystalline dolomite, containing zones of oolitic chert.

The structure of the Arbuckle is probably reflected in the overlying formations. Few wells in Harvey County have penetrated to the Arbuckle, therefore the Arbuckle surface was not used as a horizon for mapping purposes.

Ordovician System. Simpson Group. Lying unconformably on the Arbuckle group is the Simpson Group consisting of, in ascending order, the St. Peter sandstone and the Platteville formation. The average thickness of the Simpson Group is 76 feet.

The St. Peter sandstone consists of rounded, frosted quartz grains and various amounts of green shale. It grades both laterally and vertically into sandy shale and shale.

The St. Peter is also called the "Wilcox" by drillers and geologists.

The Platteville, the upper formation, consists of medium to dark green, splintery non-silty shale (Ricci, 1955).

Viola. The Viola limestone in Harvey County is thinner and more uniform in composition than farther north. Chert is sparse and normally the section is a gray or tan crystalline limestone which may be sandy near the base. The Viola of western Harvey County is a tan or brown calcitic limestone showing some black or gray splotches, while in the eastern part of the county the Viola is dolomitic and a rather uniform brown or gray. The average thickness is approximately 30 feet.

Maquoketa Shale. In South central Harvey County the Maquoketa shale is dark gray or grayish brown, comparatively thin, and only moderately dolomitic. Toward the west and northwest it thickens somewhat and assumes the characteristic two fold division, with gray siliceous, dolomitic, argillaceous strata at the top grading downward into gray or brown relatively non-dolomitic shales. The Maquoketa shales become darker gray, brownish gray and even black in eastern Harvey County.

The Maquoketa thins toward the south and ranges in thickness from 1 to 90 feet.

Devonian-Silurian. "Hunton" limestone. The limestones and dolomites lying between the Maquoketa shale and the Chattanooga shale are referred to as the "Hunton" formation or group by drillers and geologists in Harvey County.

Wallace Lee (1948) and other geologists have considered the southern Kansas "Hunton" to be an outlier of the Salina basin "Hunton". The southern Kansas "Hunton" shows a marked lithologic difference in contrast with Salina basin "Hunton" which generally does not show much change over widespread areas. This suggests that the two regions may never have been connected directly. Rather the deposits may have formed in two bays of the "Hunton" sea which filled the area at the northeast and may have extended independently into central Kansas from the east. (Taylor, 1946).

The "Hunton" limestone in Harvey County has a maximum thickness of approximately 95 feet and may be separated into two intervals. The upper interval or "white Hunton", ranging in thickness from 0 to 30 feet, is a light tan or very light gray limestone which is both calcitic and dolomitic in the northern part of the county, but becomes largely dolomitic as it thins and disappears farther south. The chert is light tan or white and has a rough to smooth texture.

The lower interval or "brown Hunton" covers Harvey County and ranges in thickness from 10 to 65 feet. This zone is largely brown crystalline dolomitic limestone with small amounts of light gray chert.

The "Hunton" strata of Harvey County have a rather uniform appearance, except for the contrast in brown and tan coloring. This comparative uniformity and the lack of clastic material seems to suggest stable undisturbed conditions of deposition such as would exist in an area some distance from land.

Mississippian or Devonian (?). The shale sequence between the Mississippian Kinderhookian and the Devonian "Hunton", limestones is divided into two formations separated by a marked disconformity; in ascending order, the Chattanooga shale (often called the "Kinderhook" shale) and the Boice shale. Moore, et al, (1951) stated that possibly the Boice shale is of Mississippian age and the Chattanooga shale is of Devonian age.

The Chattanooga shale lies unconformably above the "Hunton" limestone. Thickness of the Chattanooga ranges from approximately 20 to 110 feet and consists of gray or black to green fine micaceous shales. The Misener is a lenticular sand at the base of the Chattanooga shale. Ranging in thickness from 0 to 10 feet, the Misener consists almost entirely of reworked sand grains.

The Boice shale may be present in parts of Harvey County as a thin interval over the Chattanooga shale. Lee and others (1948) believe that the Boice shale is derived from weathering and erosion of the top of the Chattanooga shale. The Boice shale is included with the Chattanooga shale.

Mississippian System. Thickness of Mississippian rocks is extremely variable, as the result of erosion subsequent to anticlinal folding, and ranges from approximately 300 feet in the northern part of the county to slightly over 500 feet in southern Harvey County. The Mississippian rocks underlie the Pennsylvanian sediments with angular unconformity.

Rocks of Mississippian Age are primarily chert-bearing limestones and dolomitic limestones. Intensive weathering of these rocks removed many of the upper layers of the limestones and

dolomite leaving a relatively thick mantle of the more resistant chert. These weathered and eroded chert fragments are usually imbedded in red and vari-colored clay and shale or cemented by quartz or chalcedony; occasionally they are unconsolidated. The weathered chert is often called the Mississippian "Chat". This 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.

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

The Mississippian formations are the Sedalia dolomite and Gilmore City limestone of the Kinderhookian series, the Reeds Spring, Burlington and Keokuck limestones of the Osagian series and the "Warsaw" and Spergen limestones of the Meramecian series.

Pennsylvanian System. The Pennsylvanian System may be differentiated in well cuttings into six units; in ascending order, the Pennsylvanian Basal Conglomerate, the Marmaton Group, the Lansing-Kansas City Groups, the Douglas Group, the Shawnee Group and the Wabaunsee Group.

Desmoinesian Series. Pennsylvanian Basal Conglomerate. This zone of variable thickness at the base of the Pennsylvanian System consists of chert fragments imbedded in red and vari-

colored clay and shale or cemented by quartz or chalcedony. This conglomerate is discussed further in the section dealing with Mississippian Rocks.

Marmaton Group. The Marmaton Group consists of red and green shales. This group has a varying thickness due to the unconformity at the base.

Missourian Series. Lansing-Kansas City Groups. The Lansing-Kansas City is usually the first formation recorded by geologists in Harvey County. The top of these groups is found at depths varying from 2,200 feet in the eastern part of the county to 2,500 feet in the western part. This section consists of alternating layers of limestone and thick black shales. The interval from the top of the Lansing to the top of the Mississippian is close to 700 feet in most parts of the county.

Pedee Group. The Pedee Group in Harvey County is represented by the Iatan limestone. Drillers and geologists log this as the "Brown lime". It is a light bluish-gray to nearly white limestone. The texture is very fine and dense, but there are numerous thin, irregular crystals of clear calcite.

Virgillian Series. Douglas Group. The Douglas Group is represented by approximately 150 feet of shale and sandstone. The two lenticular sandstones in this group may become very thick, in which case the upper is called the Ireland sandstone and the lower the Tonganoxie sandstone. These sandstones are often separated by a fairly thick limestone, the Haskell, which may be as much as 40 feet thick. The shale layers are generally dark to black, or greenish gray.

Shawnee Group. The Shawnee Group is primarily made up of thick layers of limestone which contain many zones of dark shale and some sandstone. In the western tier of townships black and green shales are conspicuous. The Topeka limestone at the top of the Shawnee Group is fairly prominent in the subsurface geology of Harvey County. The Heebner, a black shale, is also a prominent "marker" bed. The average thickness of the Shawnee Group is approximately 350 feet.

Wabaunsee Group. The Wabaunsee Group is predominantly shale with thin limestone layers. This group is approximately 650 feet thick.

Surface to the Pennsylvanian System. This section is discussed as one unit since it has little bearing on the oil and gas production in Harvey County and sufficient data were not available for a complete study because formations above the Lansing-Kansas City usually are not recorded. This section lies above the section illustrated in the panel diagram.

The rocks that crop out in Harvey County are sedimentary in origin and range in age from Permian to Pleistocene.

Permian System. The Permian System of Harvey County is represented by, in ascending order, the Council Grove Group, the Chase Group and the lower formation of the Sumner Group.

The Council Grove and Chase Groups, sometimes called the "Big Blue" Series, consists of alternating beds of limestone and shale, which are largely vari-colored. This sequence of rocks from the Herington to the base of the Americus has two good "marker" beds which occur near the middle of the section.

These "marker" beds are the cherty zones of the Florence above and the Wreford below.

The Sumner Group is represented by the Wellington Shale. This shale attains a maximum thickness of about 500 feet. Approximately 230 feet of the upper Wellington crop out in Harvey County. The Hutchinson salt member is not present in either the surface or subsurface section of the Wellington in Harvey County due to leaching during Triassic and Jurassic time, but a few miles to the west in Reno County it is present in typical development. The upper part of the Wellington consists of gray shales with a few red layers prominent locally, the lower section is greenish-gray shale with a few thin layers of anhydrite.

Quaternary System. The Quaternary System in Harvey County is represented by the Blanco formation (Equus beds) of Pleistocene age, dune sand of Pleistocene and Recent age and alluvium of Recent age.

Major Structural Features

Salina Basin. The Salina basin occupies an area in north-central Kansas between the northern end of the Nemaha anticline and the Central Kansas uplift. This is an area of depressed Mississippian and older rocks between the two anticlinal areas and is bounded on the south by an unnamed archlike structure which separated it from the Sedgwick basin.

In the Salina basin five periods of folding are distinguished. (1) Upper Cambrian and Lower Ordovician dolomites lying below the St. Peter sandstone were deformed before the deposition of the St.

Peter sandstone. The structural movement resulted from many minor movements that occurred at different times prior to the deposition of the St. Peter sandstone. The movements involved a subsidence of a deep basin in central Missouri in which more than 2,000 feet of dolomites were deposited. During the same epoch, a south-trending positive area, termed the Southeast Nebraska arch, was developed in southeastern Nebraska and northeastern Kansas. In central Kansas, a parallel north-south syncline was developed.

(2) Another period of folding extended from St. Peter time to the beginning of deposition of the Mississippian limestone and may have continued through Kinderhookian time. During this period the structural deformation was a complete reversal of that preceding St. Peter time. For now the Ozark uplift rose from the deepest part of the syncline in southern Missouri and a segment of the southeast Nebraska arch became the site of a down-warped area called the North Kansas basin. Contemporaneous with these events was the development of the Chautauqua arch and the Central Kansas uplift on the south and west.

(3) A third period of folding began at least as early as the beginning of Mississippian time, culminated after Mississippian deposition, and continued with diminished movement through Pennsylvanian into Permian time. The principal structural feature developed in Kansas was the Nemaha anticline, which was flanked by the Salina basin on the west and the Forest City basin on the east. The Salina basin was a synclinal area which trended northwest and paralleled the northern flank of the Central Kansas uplift.

(4) A fourth period of deformation occurred after Permian time and before Cretaceous time. It involved the development of a broad synclinal basin in southeastern Kansas which gave the Permian and Pennsylvanian rocks of eastern Kansas a south-westerly dip.

(5) A fifth period of deformation occurred after the deposition of the Cretaceous rocks. As a result of this deformation these rocks were tilted toward the northeast in western Kansas and toward the north and northwest in central Kansas and were raised 1,500 to 2,000 feet above sea level in the Salina basin.

Central Kansas Uplift. The name Central Kansas uplift was first applied by Morgan to the major post-Mississippian uplift (Morgan, 1932).

The Ellis arch is referred to as the ancestral Central Kansas uplift of pre-Mississippian time by Moore and Jewett (1942).

The Central Kansas uplift occupies an area in central Kansas and probably part of south-central Nebraska, whose present northwestward trending structure has been developed by several periods of warping and erosion with subsequent truncation of sedimentary rock, the earliest of which dates back to Precambrian time. Warping has occurred chiefly in post-Proterozoic (?), post-Canadian, post-"Hunton", early Pennsylvanian, post-Missouri and post-Cretaceous time. Depositional thinning toward the north and west has affected mainly Cambro-Ordovician and Pennsylvanian strata (Koester, 1935).

The uplift was evidently a land mass throughout a large part of early Paleozoic time, while the thicker dolomites, limestones and sandstones of the Arbuckle group were forming in southern Oklahoma. Apparently the Central Kansas uplift is more closely related in geologic history to the Ozarks than to the areas north and south of the uplift.

The Precambrian rocks of Kansas consist of igneous and metamorphic rocks with lighter granite occupying the nucleus of the uplift. In general, the schist along with arkoses and red clastics have been found on the flanks of the warped areas.

Possibly the forerunner of the uplift was a series of more or less parallel batholiths which were intruded into the schist in Precambrian time.

The number of periods of uplift and erosion in Precambrian time is unknown.

The Central Kansas uplift was broadly elevated and folded along northeast-southwest trends during Mississippian time. Simultaneously, the Nemaha Granite ridge was folded and faulted, and similar movement took place along the Voshell anticline (Appendix, Fig. 2), which lies between the uplift and the Nemaha anticline (Koester, 1935).

Nemaha Anticline. The Nemaha anticline or ridge is an asymmetrical structural high in eastern Kansas that plunges to the southwest (Appendix, Fig. 2). It exhibits a remarkably straight northeast-southwest alignment and has a maximum relief of 3,200 feet on the steeper east flank. Its configuration resembles a normal fault scarp (Rieb, 1954). The steep eastern flank is believed to be faulted in several places. The question then arises

that the entire ridge is a normal fault causing the ridge's straight alignment.

The Nemaha anticline resulted from uplift in post-Mississippian time. The initial movements of the anticline began in Mississippian time and were followed by the major uplift at the close of Mississippian time.

Chautauqua Arch. The Chautauqua Arch (Appendix, Fig. 2) is the name for the pre-Mississippian extension of the Ozark uplift along the Kansas-Oklahoma line (Barwick, 1928).

The Chautauqua Arch and the Ellis Arch in pre-Mississippian time structurally divided northeastern Kansas from southwestern Kansas. This elongated arch passed through the southwestern corner of Harvey County.

Sedgwick Basin. The Sedgwick basin, regarded as one of the major post-Mississippian structural provinces in Kansas, occupies an area in Central Kansas southward from McPherson and Marion counties (Appendix, Fig. 2). It is west of the Nemaha anticline and south of a low archlike structure that marks the southern boundary of the Salina basin (Appendix, Fig. 2), and east of a similar separation from the Dodge City Basin or embayment (Jewett, 1954).

Minor Structural Features

Voshell Anticline. The Voshell anticline (Appendix, Fig. 2) lies in Saline, McPherson, Harvey, and Reno Counties, approximately parallel to the Nemaha anticline which lies about 50 miles to the east.

The Voshell trend consists of an anticlinal fold extending in a northeasterly direction and plunging southwest. A reverse fault with a throw of about 400 feet is present on the west side of this anticlinal structure. The strike of the fault is almost parallel with the axis of the Voshell anticline and it is situated approximately 1/4 mile west of the axis.

The major structural uplift appears to have taken place in post-Mississippian time and minor movements followed in late or post-Permian time. In all probability the Voshell anticline was formed contemporaneously with the forming of the Nemaha anticline (Jewett, 1951).

Halstead-Graber Structural Trend. The Halstead-Graber structural trend is an anticline in McPherson and Harvey Counties approximately parallel to and about 10 miles east of the Voshell anticline. The axis of the anticlinal fold extends from T. 21 S., R. 1 W., to T. 23 S., R. 2 W.

Folding was probably contemporaneous with the formation of the Nemaha anticline.

Oil production from the "Hunton" does not occur on the crest of the fold as is normally expected. Production is found in the "Hunton" and Mississippian "Chat" on the east flank of the anticline.

Geologic History

Four major periods of folding have occurred in this particular area since Precambrian time. These periods 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 sea of late Cambrian covered all of Harvey County and ranged from a shallow transgressing sea in which the Lamotte sandstone may have been deposited to a relatively deep sea in which the Arbuckle sediments were deposited. This deeper sea continued into early Ordovician time, making it difficult to draw an exact time line between the two periods. Erosion following Arbuckle deposition created an erosional topography for the post-Arbuckle sediments to be deposited upon.

The Arbuckle erosional period was followed by a three stage depositional environment. The clastic Simpson group was deposited in a shallow fluctuating sea during the first stage. During the second stage there were two possible conditions for the deposition of the nonclastic Viola, the sea could have been deeper or the land mass may have been very nearly base leveled. Either of these conditions will permit the deposition of nonclastic sediments. A drop in the level of the sea or a slight rise in the land mass caused the fine clastics of the Maquoketa to be deposited in the third stage of this environment.

The "Hunton" limestone was deposited in conformable contact with the underlying Maquoketa shale as a result of the continuation of this deep sea during Silurian and Devonian time.

Prior to Chattanooga deposition, the area to the north of Harvey County was slightly uplifted and subjected to extensive erosion. The pre-Chattanooga valley cut through the "Hunton" of

southern McPherson County and into the Maquoketa rocks with an outlier (?) of "Hunton" and Maquoketa rocks being formed south of the valley in Harvey County (Olson, 1956).

Deposition of the Chattanooga shale unconformably on older truncated formations occurred during Lower Mississippian or Upper Devonian time. A thick section of Mississippian cherty limestone was then deposited in essentially conformable contact with the underlying Chattanooga shale.

Uplift and erosion of the Mississippian cherty limestones occurred in post-Mississippian and pre-Marmaton time, and the weathered chert formed the basal Pennsylvanian deposit.

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

The continuation of marine sedimentation into Permian time left deposits of interbedded limestone and shales until the end of Wolfcampian time when the seas withdrew to the south.

This area was probably above sea level during Triassic and Jurassic time causing a major portion of the thick Permian salt bed to be removed by leaching. Deposition of the Kiowa shale may have occurred during lower Cretaceous time, but has since been eroded away.

Quaternary sediments represented by alluvial and eolian deposits cover the western half of the county.

HISTORY OF DRILLING

The first oil discovered in Harvey County was found when the Newton Oil Corporation drilled its first well on the Wetschensky farm in sec. 4, T. 23 S., R. 2 E. The well was completed in October, 1923, at a depth of 2,430 to 2,450 feet in the Kansas City limestone. Eighteen wells were drilled in section 4 and adjoining sections, of which 8 proved to be dry. This pool, the Walton, was abandoned in 1936 after producing a total of 123,000 barrels.

The discovery well of the Halstead pool was drilled by the Shell Petroleum Company, in August 1928, on the Haury farm in sec. 11, T. 23 S., R. 2 W. The initial production was over 8 million cubic feet of gas in the "Mississippi lime" at a depth of 2,961 to 2,972 feet. The first oil was found when the McPherson Oil and Gas Company drilled Palmer No. 1 well in sec. 36, T. 22 S., R. 2 W. This well penetrated the "Mississippi lime" from 2,970 to 3,002 feet, and secured an initial production of 240 barrels of oil a day.

The Hollow-Nikkel pool, the largest in Harvey County, is in the northwestern township. In December, 1921, Frank Hollow drilled the No. 1 Fee well in sec. 20, T. 22 S., R. 3 W., and found oil at a depth of 3,509 feet in a limestone of unknown age. In July the well was deepened 3 feet and made a potential of 1,456 barrels per day. It was deepened again the following month to a total depth of 3,514 feet, where it was rated as having a potential of 520 barrels. Later drilling revealed the fact that a new producing

horizon had been tapped in this well, and it thus has the distinction of being the first commercial oil well to produce from the "Hunton" limestone in Kansas. As a result of the good showing of this well, the field expanded rapidly. Production was found in other zones, for example, the Lansing-Kansas City limestone at 2,499 to 2,520, the Mississippian "Chat" at 3,195 to 3,208, the "Wilcox" (St. Peter) sand at 3,500 to 3,515 feet. In October, 1935, one well was completed in the Arbuckle in sec. 7, T. 22 S., R. 3 W. The first "Chat" well, the Frost Drilling Company No. 1 Martens, was a surprise and flowed "wild" at a rate of 5,000 barrels per day. Oil was found at a depth of 13 feet within the "Chat".

The production from this field has been very great, 21,038,500 barrels to January 1, 1955. The field is on the Voshell anticline.

Bunte and Fortier (1941) made a study of the part of this pool formerly known as the Nikkel pool. Since their study was completed the Hollow pool and Nikkel pool have been combined. The discovery well in the Nikkel pool was discovered in October, 1932, by John Mabee, Inc., when he completed his Nikkel No. A-1, NE 1/4, NE 1/4, SW 1/4 of sec. 33, T. 21 S., R. 3 W., in "Hunton" limestone, at a depth of 3,454 feet, producing initially 850 barrels per day.

The Burrton pool was discovered in Reno County in 1931 when the Empire Oil Company No. 1 Haury was drilled in sec. 1, T. 23 S., R. 4 W. Gas was found in the Mississippian "Chat" at a depth of 3,298 to 3,333 feet, where the production amounted to 23 million cubic feet per day. When deepened to 3,368 feet the production was increased to 26 1/2 million cubic feet. The first oil well

in the Burrton pool was drilled by Lloyd, Frost and Study on the Haury farm in the northwestern quarter of the same section about five months after gas was discovered. The oil was found in the Mississippian "Chat" at a depth of 3,254 to 3,364 feet. The initial production was 327 barrels, with about 7 million cubic feet of gas higher in the producing zone.

The Burrton pool was extended into Harvey County as its development continued. The pool is on the southern extension of the Voshell anticline.

The Burrton northeast was discovered in 1942 when Branine drilled on the Lagree farm in sec. 9, T. 23 S., R. 3 W. The zone of accumulation was found to be 10 feet thick in the Mississippian rocks at 3,305 feet. The initial production of the first well was 200 barrels per day.

The Graber pool extends into McPherson County as the result of the merging of the old Hesston and Showalter pools of Harvey County with the old Graber pool of McPherson County. The discovery well for the Harvey County section of the Graber pool was drilled by Frank Hollow, in August, 1934, on the Sommerfelt farm in sec. 8, T. 22 S., R. 1 W. Oil was found in the "Hunton" limestone at a depth of 3,310 to 3,317 and also 3,355 to 3,356 feet. The initial production amounted to 247 barrels of oil per day.

The Sperling pool is located on an offset of the Halstead-Graber anticline. The discovery well, completed in February, 1935, was drilled by Imo Oil and Gas Company, on the Sperling farm in sec. 24, T. 22 S., R. 2 W. This well had a potential of 1,624 barrels of oil and 22 million cubic feet of gas. The oil

producing zone was at a depth of 3,279 to 3,327 feet in the "Hunton" limestone while the gas came from the "Chat" at the top of the Mississippian.

The Jester Creek pool is in sec. 3, T. 24 S., R. 1 E. in the eastern part of the county four miles southeast of Newton. Here the Springer and Harper Drilling Company No. 1 Leffelman found oil in the Lansing-Kansas City limestone between 2,687 and 2,692 feet. The well was reported as making 20 barrels of oil and 35 barrels of water per day.

The wildcat test which opened the Wall pool was drilled in November, 1951, by the Drillers Production Company on the Wall farm in sec. 25, T. 22 S., R. 3 W., to a total depth of 3,713 feet. Production is obtained from a porous zone in the Mississippian rocks between the depths of 3,150 and 3,167 feet. The official test showed 2,900,000 cubic feet of gas.

CONCLUSIONS

All available points were used for the construction of the contour maps on the "Hunton" and Mississippian surfaces. The location of the points used in this report are shown on Figs. 6A and 7A (Appendix).

Petroleum accumulation in Harvey County seems to be primarily a result of structural traps. The Hollow-Nikkel pool, situated on the Voshell anticline, is a typical example of the structural "highs" occurring in the county.

The Halstead, Sperling and Graber pools, located on the Halstead-Graber anticline, are unique in that the oil production does

not occur over the crest of the anticline. Production from the "Hunton" limestone is found on the east flank of the fold. This "offset" production occurs within the 20 to 60 foot thickness zone of the "Hunton". This suggests that the trap is partially stratigraphic, probably a combination structural and stratigraphic trap. Oil sometimes occurs in stratigraphic traps near the thin edge of a rock unit. The thinning may be either an erosional or depositional feature. The trap is formed by impervious rock units coming into contact as the permeable layer thins. As the oil migrates updip, it is stopped and held in place by the impervious rock unit. As the "Hunton" thins toward the north and disappears in the southern tier of townships in McPherson County (Appendix, Fig. 8), it is very possible that this is the type of stratigraphic trap occurring here. Another possibility for this unusual occurrence is that there may have been a migration of the axis of the fold caused by a slight movement after the accumulation of the petroleum and the petroleum did not migrate subsequently.

FUTURE POTENTIAL

The future potential for discovery of additional reserves of petroleum in Harvey County is fair. All known structural highs have been explored and for the most part drilled out. The lower zones may warrant exploration in some of the pools that produce from Mississippian and "Hunton" limestones. In most cases, the Arbuckle has not been investigated when production was found in overlying formations. Arbuckle production has not been reported in the county.

Future production may be found in stratigraphic traps as in the Halstead, Sperling and Graber pools, which are in the 20 to 60 foot thickness zone of the "Hunton".

Secondary recovery operation using salt water injection methods was started on a small scale by the Magnolia Petroleum Company in 1940 in the Hollow-Nikkel pool. Shell Oil Company started using salt water injection in the same pool in 1941. These are the only two secondary recovery projects reported in the county. Secondary recovery practices in the older fields might possibly increase the production.

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APPENDIX

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

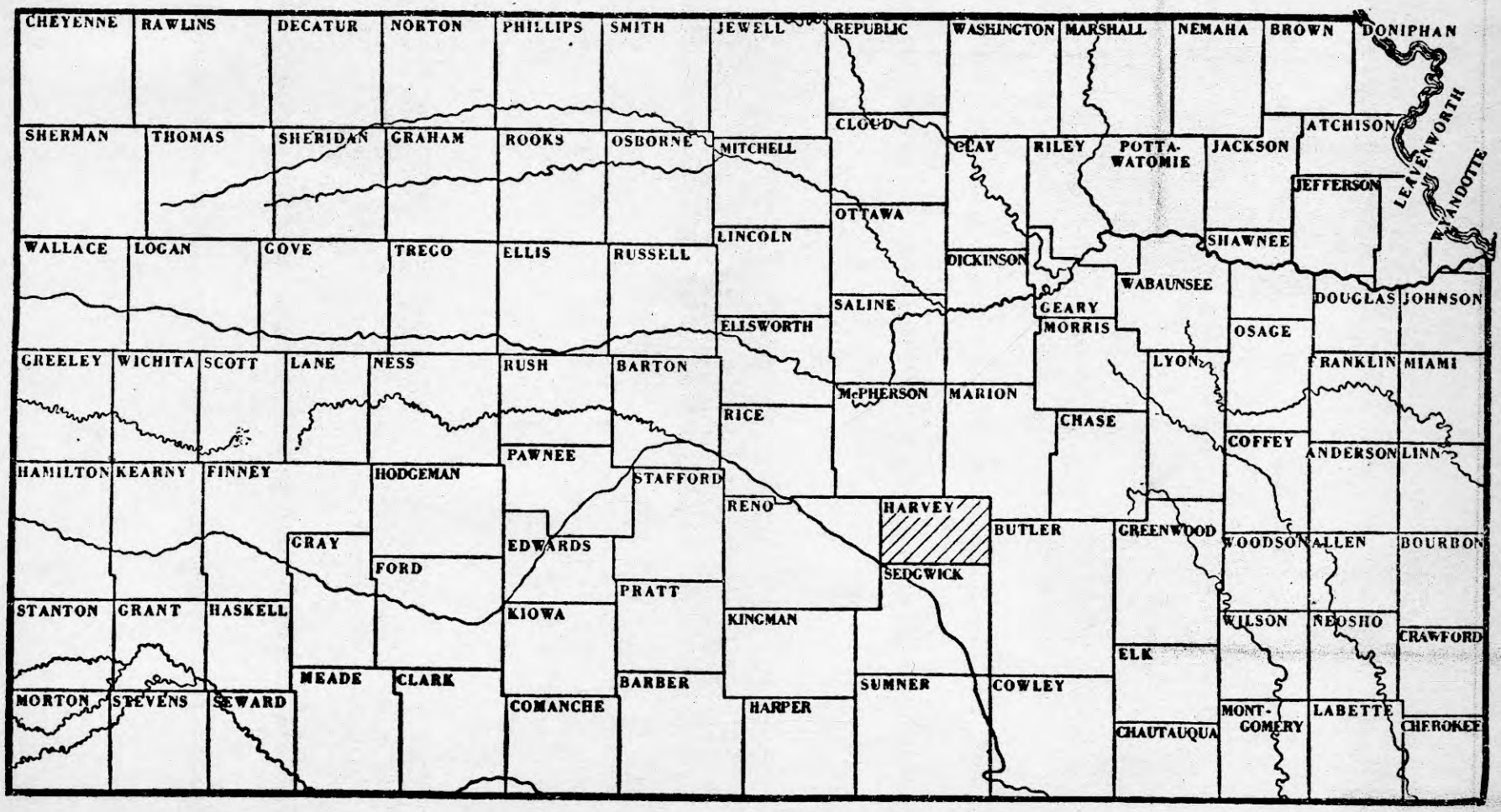
Pool and location of discovery well	Oil production: Discovery year	Number of wells	Area in acres	Depth in feet	Producing zone	Cumulative production in barrels
Burrton 1-23S-4W	1931	145		3,266 3,583	Mississippian "Hunton"	49,091,296*
Burrton Northeast 3-23S-3W	1942	2	200	3,224 3,269	"Chat" Mississippian	7,917
Graber 32-21S-1W	1934	1	100	3,274 3,323	"Hunton" Misener	154,299
Halstead 36-22S-2W	1929	10	1,200	3,005	"Chat"	1,963,639
Hollow-Nikkel 30-22S-3W	1931	38	2,000	3,195 3,507 3,500	"Chat" "Hunton" Simpson	21,038,500 Includes McPherson County production
Jester Creek 3-24S-1E	1949	1		2,687	Lans.-K.C.	1,202
Sperling 23-22S-2W	1935	8	400	3,279	"Hunton"	629,313
			County Total**			23,794,870

*Includes Reno County production
**Exclusive of Burrton Pool

Table 2. Gas production in Harvey County, Kansas to January 1, 1955.

Pool and location of discovery well	Gas production					
	Discovery year	Number of wells	Area in acres	Depth in feet	Producing zone	Cumulative production millions of cubic feet
Burrton 23-23S-4W	1930	13	800	3,298	Mississippian	757,817*
Burrton Northeast 3-23S-3W	1942	Included with Burrton		3,226	Mississippian	
Sperling 23-22S-2W	1935	1	250	2,955	"Chat"	7,505,775
Wall 25-22S-3W	1951	1		3,150	Mississippian	No report
			County Total			8,263,562

*Since 1953



Area covered by this report

Fig. 1. Area covered by this report

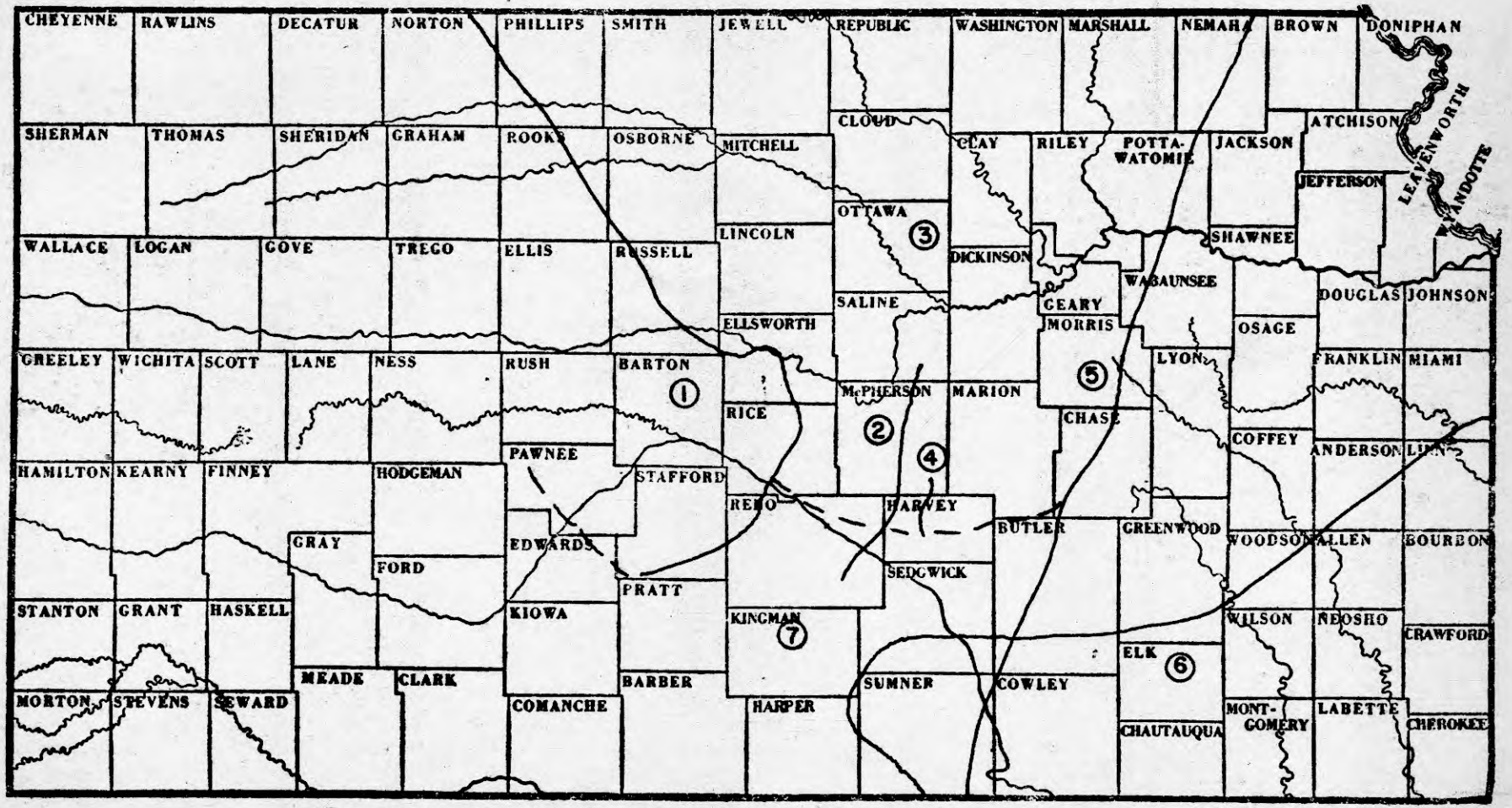


Fig. 2. Structural features in Central Kansas

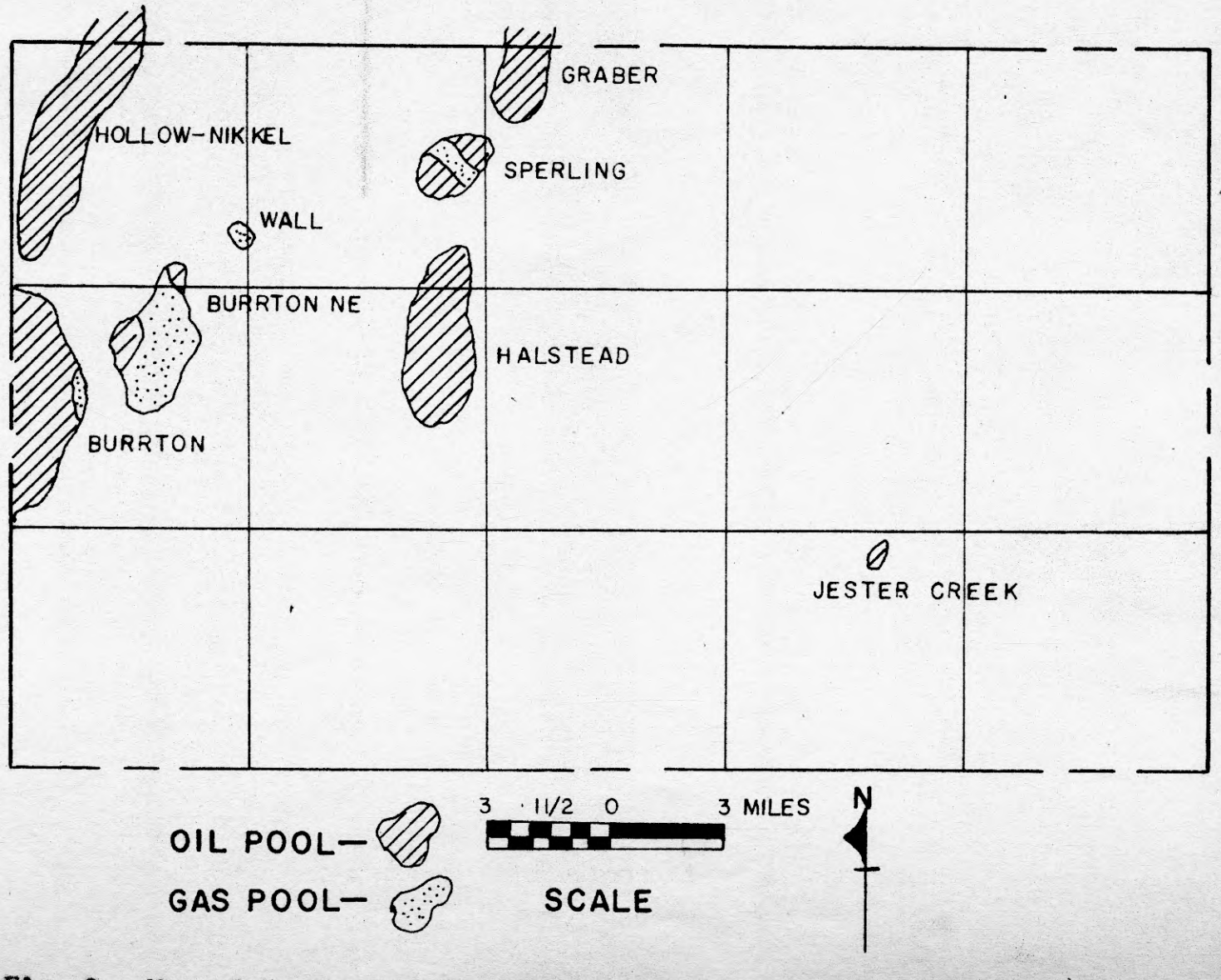


Fig. 3. Map of Harvey County, Kansas showing oil and gas pools

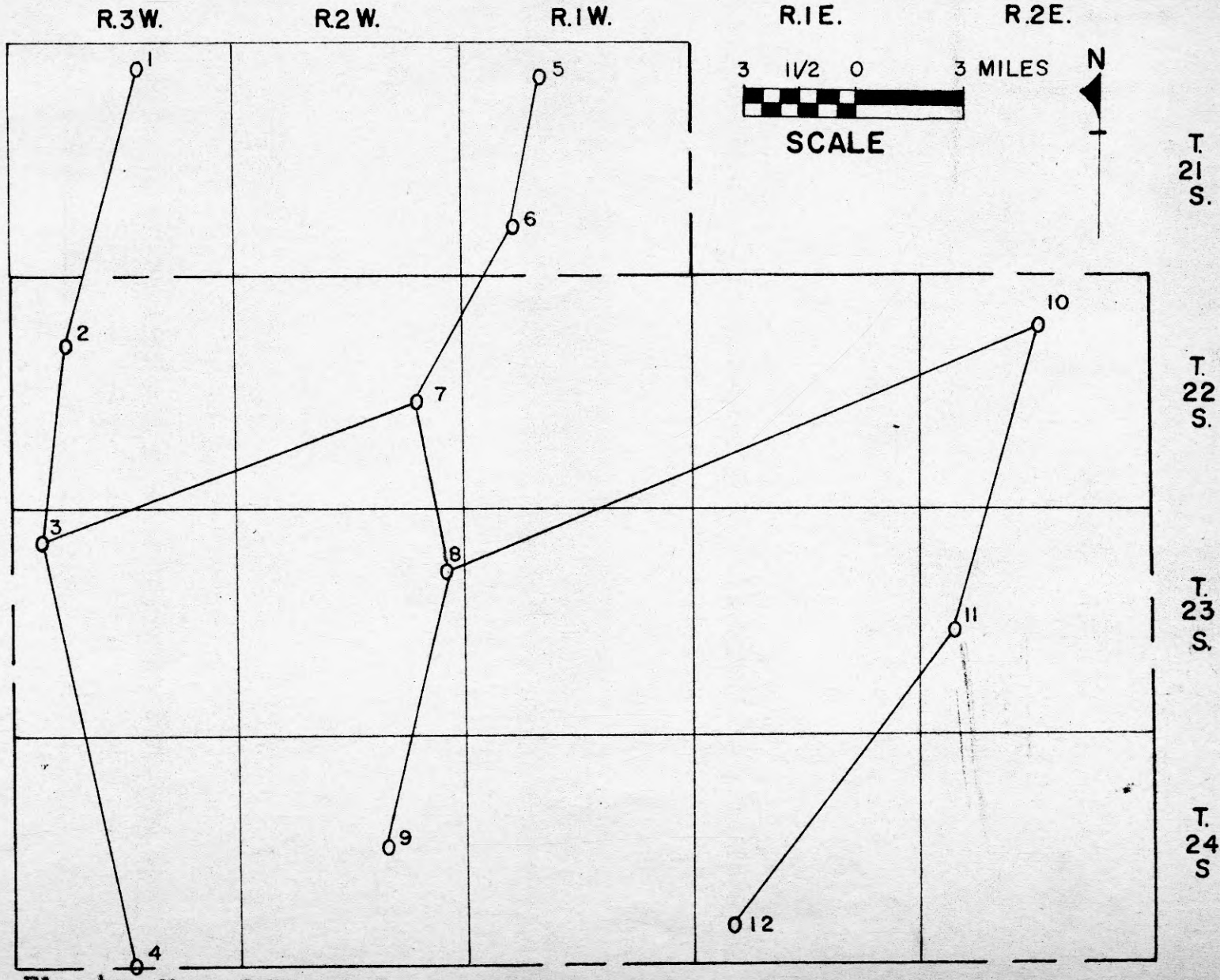
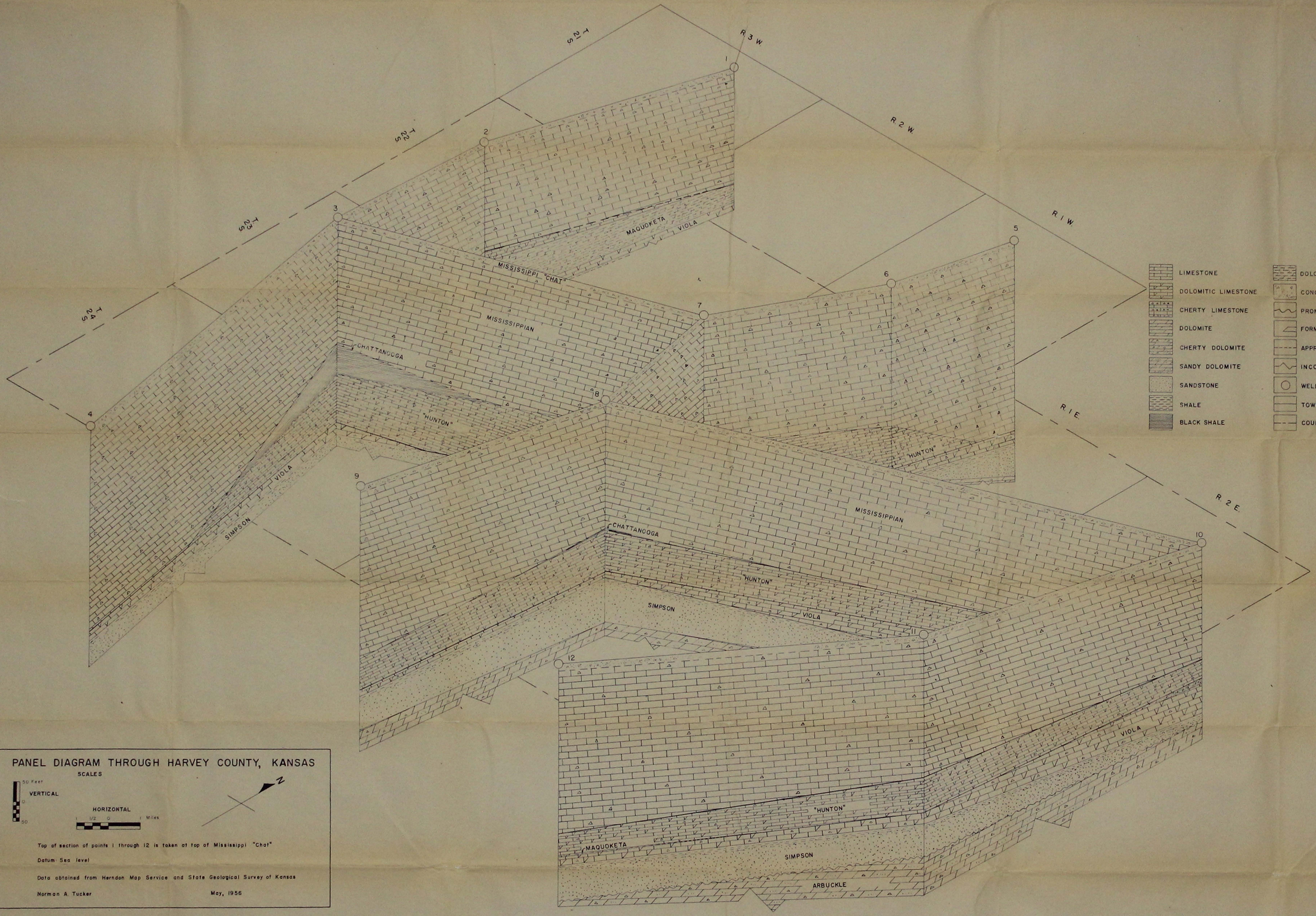


Fig. 4. Map of Harvey County, Kansas showing well locations of panel diagram

Fig. 5. Pannel diagram through Harvey County, Kansas

(in accompanying plate box)



PANEL DIAGRAM THROUGH HARVEY COUNTY, KANSAS

SCALES

VERTICAL

50 Feet
0
50

HORIZONTAL

1 1/2 0 1 Miles

N

Top of section of points 1 through 12 is taken at top of Mississippi "Chat"

Datum: Sea level

Data obtained from Herndon Map Service and State Geological Survey of Kansas

Norman A. Tucker May, 1956

Table 3. Location of wells used in Fig. 5.

Well number:	Location:	Section:	Township:	Range:	Elevation of Mississippian top below datum
1	Center NE 1/4, SW 1/4	3	21S	3W	1102 feet
2	SE 1/4, NW 1/4, SW 1/4	8	22S	3W	1703 feet
3	Center E 1/2, E 1/2	6	23S	3W	1801 feet
4	SW 1/4, SW 1/4, SW 1/4	34	24S	3W	1995 feet
5	SW 1/4, SW 1/4, SW 1/4	4	21S	1W	1435 feet
6	Center NW 1/4, SW 1/4	29	21S	1W	1432 feet
7	Center E line NW 1/4, NE 1/4	23	22S	2W	1459 feet
8	Center NW 1/4, SE 1/4	12	23S	2W	1569 feet
9	Center SE 1/4, SE 1/4	15	24S	2W	1928 feet
10	Center NW 1/4, NW 1/4	10	22S	2E	1352 feet
11	SE 1/4, NE 1/4, NE 1/4	19	23S	2E	1493 feet
12	Center SW 1/4, SW 1/4	29	24S	1E	1657 feet

Fig. 6. Structure contours on Mississippi "Chat" and limestone, Harvey County, Kansas.

(in accompanying plate box)

R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E.

STRUCTURE CONTOURS ON TOP OF THE MISSISSIPPIAN, HARVEY COUNTY, KANSAS

1 3/4 1/2 1/4 0 1 2 3 MILES

SCALE

CONTOUR INTERVAL 20 FEET

DATUM PLANE: SEA LEVEL
ALL ELEVATIONS BELOW DATUM

COUNTY LINES

TOWNSHIP LINES

FAULT

OIL AND GAS POOLS

N

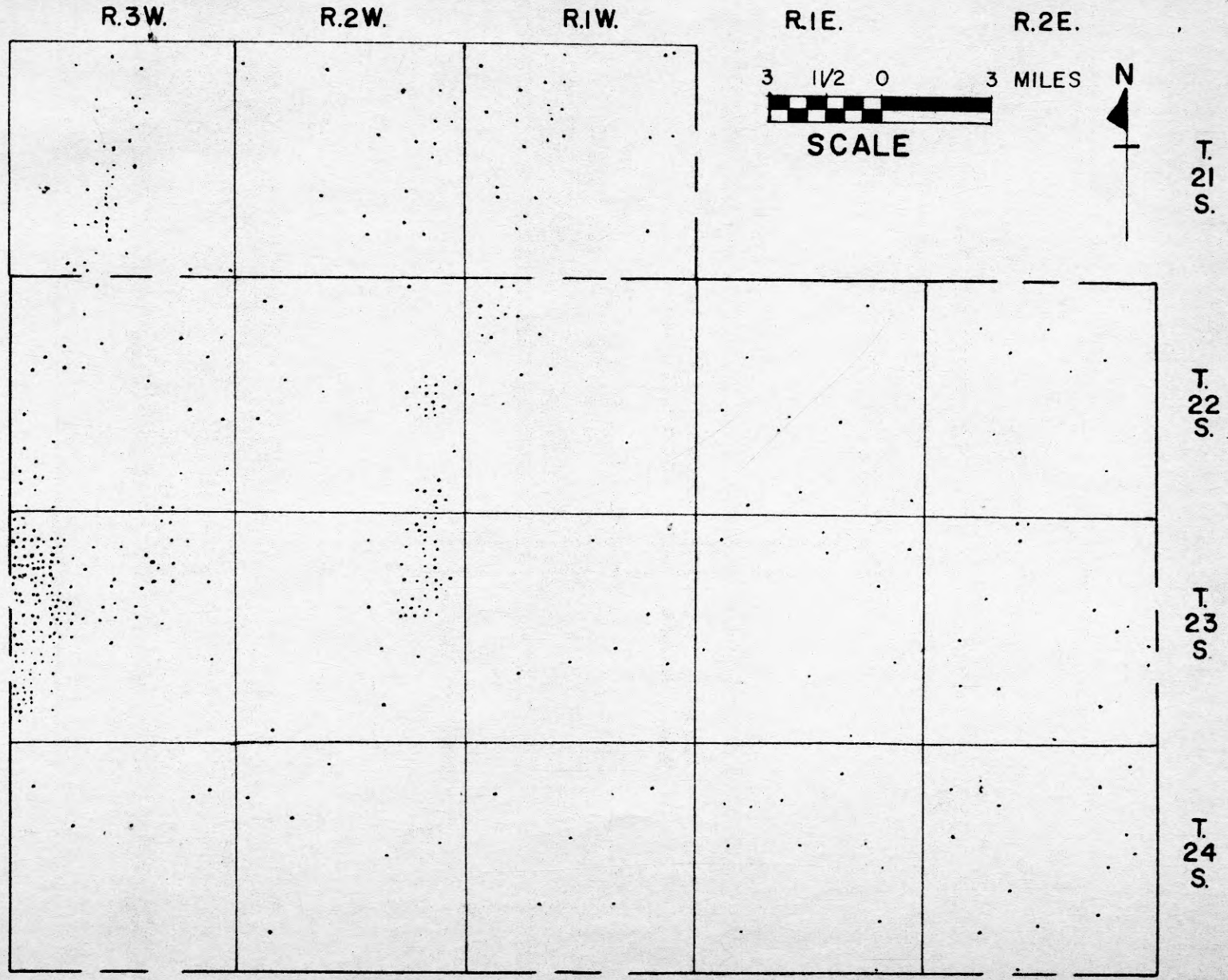
NORMAN A. TUCKER MAY, 1956

T. 21 S.

T. 22 S.

T. 23 S.

T. 24 S.



Figs. 6A. Map of Harvey County, Kansas showing 438 subsurface control points used for contouring structure on Mississippi "Chat" and limestone

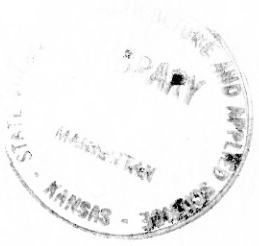


Fig. 7. Structure contours on top of "Hunton" limestone, Harvey County, Kansas.

(in accompanying plate box)

R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E.

STRUCTURE CONTOURS ON TOP OF THE "HUNTON" LIMESTONE, HARVEY COUNTY, KANSAS

1 3/4 1/2 1/4 0 1 2 3 MILES

SCALE

CONTOUR INTERVAL 20 FEET

DATUM PLANE: SEA LEVEL
ALL ELEVATIONS BELOW DATUM

COUNTY LINES

TOWNSHIP LINES

FAULT

OIL AND GAS POOLS

N

NORMAN A. TUCKER MAY, 1956

T. 21 S.

T. 22 S.

T. 23 S.

T. 24 S.

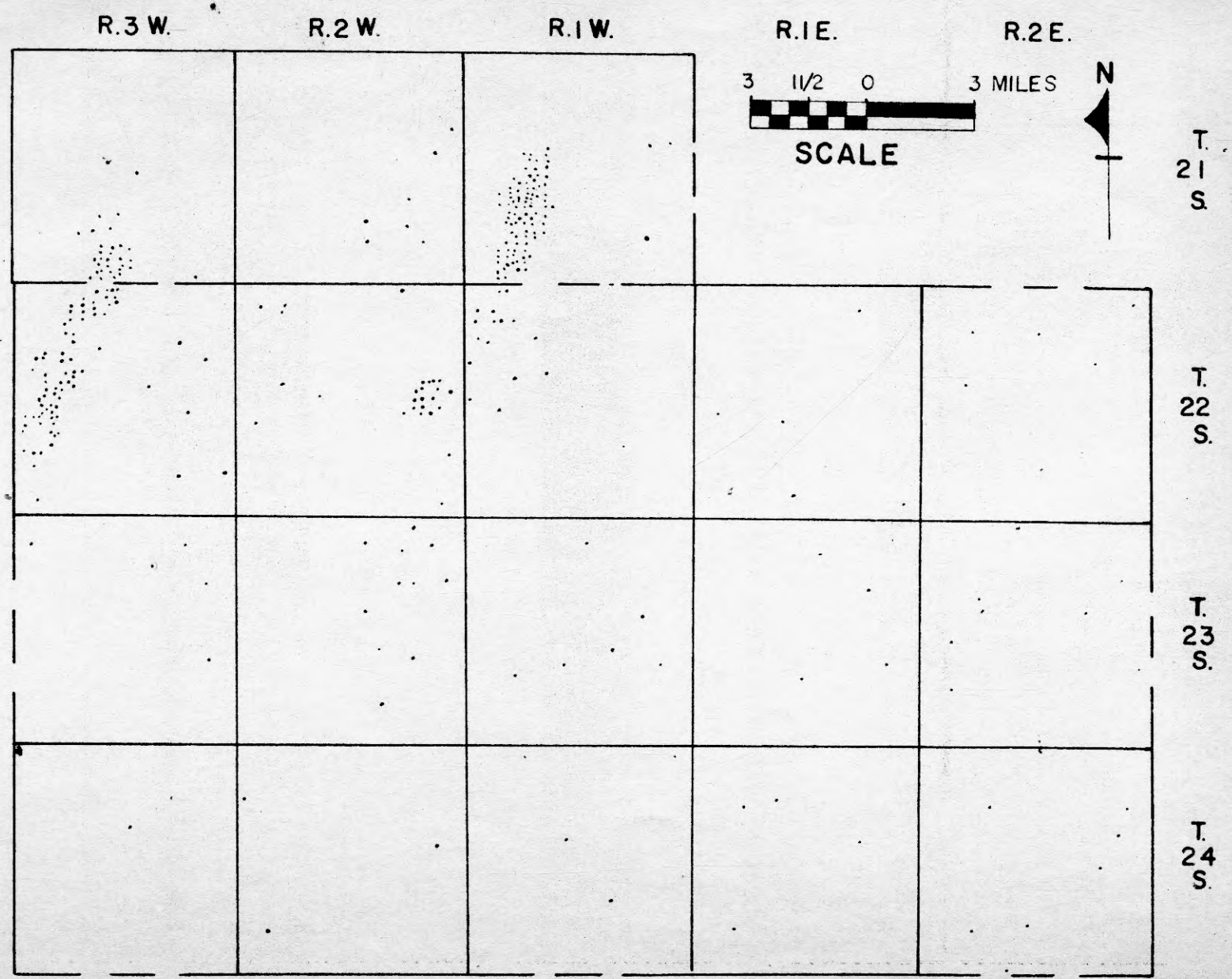


Fig. 7A. Map of Harvey County, Kansas showing 289 subsurface control points used for contouring structure on "Hunton" limestone

Fig. 8. Isopach map of the "Hunton" limestone, Harvey County, Kansas.

(in accompanying plate box)

R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E.

ISOPACH MAP OF THE "HUNTON" LIMESTONE, HARVEY COUNTY, KANSAS

1 3/4 1/2 1/4 0 1 2 3 MILES

SCALE

ISOPACH INTERVAL 20 FEET

N

COUNTY LINES

TOWNSHIP LINES

AXIS OF HALSTEAD-GRABER ANTICLINE

OIL AND GAS POOLS -----

NORMAN A. TUCKER MAY, 1956

T. 21 S.

T. 22 S.

T. 23 S.

T. 24 S.

0
20
40
60
80
60
40
80
60
60
40
20
40
60
80
60

THE RELATIONSHIP OF THE SUBSURFACE GEOLOGY TO THE PETROLEUM ACCUMULATION IN HARVEY COUNTY, KANSAS

by

NORMAN ALVI TUCKER

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

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology

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1956

Harvey County, an area of 540 square miles, consists of 15 townships in south-central Kansas. This investigation is an analysis of the relationships between stratigraphy, structure, and geologic history to petroleum accumulation.

A panel diagram and structure contour maps depict structural and stratigraphic features of the county. Data used to construct these maps were obtained from numerous well logs within the county.

Oil accumulation occurs in the subsurface of Harvey County in the following formations: The Lansing-Kansas City Group of Pennsylvanian Age, the Mississippi "Chat" and limestones of Mississippian Age, the "Hunton" limestone of Devonian-Silurian Age, and the Viola and Simpson of Ordovician Age.

The structure of Harvey County has been developed by several periods of warping and erosion with subsequent truncation of sedimentary rocks. Warping has occurred chiefly in post-Proterozoic(?), post-Canadian, post-"Hunton", early Pennsylvanian, post-Missouri, and post-Cretaceous time.

The only major structural feature in Harvey County is the northern edge of the Sedgwick basin. This basin occupies an area south of a low archlike structure that marks the southern boundary of the Salina basin and is west of the Nemaha anticline and east of the Dodge City basin or embayment.

The minor structural features in Harvey County are the Halstead-Graber structural trend and a part of the Voshell anticline. The Voshell anticline is about 50 miles west of the Nemaha

anticline; the Halstead-Graber anticline is about 40 miles west of the Nemaha anticline, both of these structures are approximately parallel to the Nemaha anticline. Oil accumulation occurs in the Mississippi "Chat" and the "Hunton" limestone.

The oil accumulation in the "Hunton" limestone on the Halstead-Graber anticline is within the 20 to 60 foot thickness zone. This suggests a stratigraphic trap as the production is on the east flank of the fold.

The future potential for discovery of additional reserves of petroleum in Harvey County is fair. As all known structural highs have been explored and for the most part drilled out, future production may be found in stratigraphic traps as in the Halstead, Sperling and Graber pools. Increased secondary recovery operations may increase the production in the older fields.