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MINERAL RESOURCES OF KANSAS COUNTIES

By

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MINERAL RESOURCES CIRCULAR 6

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FOREWORD

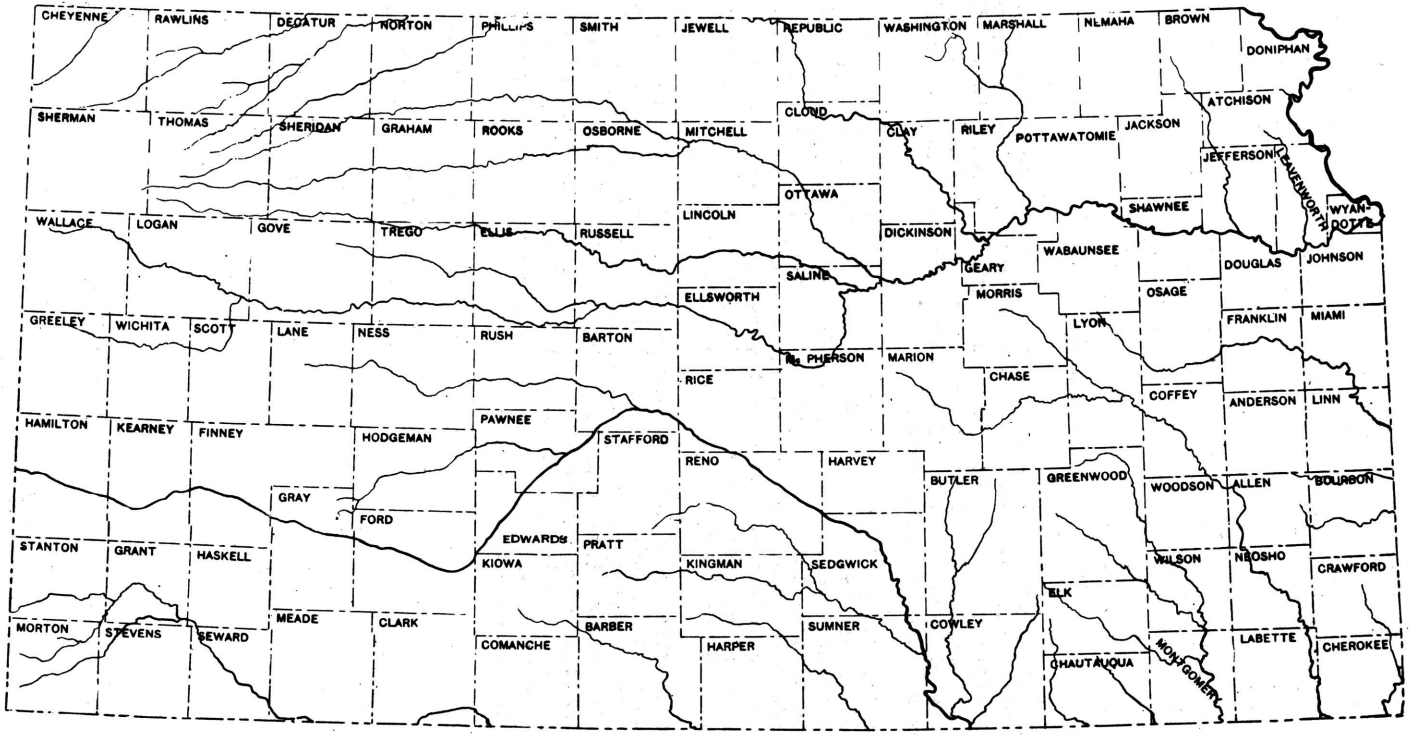
This publication not only serves a special purpose, but is also an excellent example of the usual method of work employed in the performance of the function of state planning. This booklet is the joint product of skill and knowledge found at the University of Kansas and the facilities and knowledge at hand in the Kansas State Planning Board.

This is designed as a ready reference manual from which the inquirer can determine the availability of mineral resources which he might need in the development of an industry. Since the present and future welfare of the people of Kansas depends in considerable measure on the creation of a balanced economy which would result from industrial growth, it is hoped that the planning board may contribute to this end. This is the first of a series of booklets which will be issued.

The University of Kansas, through its faculty members, is a great center of research and investigation in addition to performing its function as an educational institution. The same is true of the other state schools. One of the services which the state planning board undertakes to perform, is that of aiding these institutions in the dissemination of this research so that the opportunities which it reveals may become common knowledge and add to the common welfare.

David J. Teviotdale

Kansas State Planning Board



INDEX MAP SHOWING LOCATION OF KANSAS COUNTIES

INTRODUCTION

The relative importance of Kansas as a mineral-producing state is often not appreciated, even by citizens of the state. Figured over a 5-year period this state ranks tenth in annual value of mineral products sold. It outranks all of the famous mining states of the West, except California, and is far ahead of Alaska. Kansas ranks first in volcanic ash production, third in zinc, and fourth in salt and petroleum.

Within the state the leading mineral products in annual value are petroleum, natural gas, coal, zinc, salt, stone, natural gasoline, sand and gravel, clay products, lead, gypsum, and volcanic ash, in the order named.

The mineral industry is second only to that of agriculture in Kansas.

Purpose of Booklet. This booklet has been prepared at the request and with the cooperation of the State Planning Board, primarily for the use of the Industrial Committee of the State Chamber of Commerce. It is hoped that the cataloguing of mineral resources by counties will call attention to the opportunities present in different communities, and thereby lead to industrial expansion in Kansas.

The county summaries are by no means complete. In many instances additional details can be found in other publications of the Kansas Geological Survey. Furthermore, there no doubt are potential mineral resources in some counties which have not yet been discovered or investigated. Studies of the occurrence and utilization of chalk, clay, chat, volcanic ash, bentonite, potash, and other Kansas minerals are to be carried on by the staff of the State Geological Survey during the coming biennium.

A brief discussion of the availability of water is given for each county because this substance is not only a very important mineral resource, but is also essential to industrial development.

References. Many bulletins, circulars, reports, journals, and unpublished manuscripts have been consulted in the preparation of this booklet. The reports of the Kansas Geological Survey consulted include especially: Bulletins 6 (part 7), Oil and Gas Resources of Anderson County, Homer Charles; 10, The Geology of Russell County Kansas, with special reference to oil and gas resources, W. W. Rubey and N. W. Bass; 11, Oil and Gas Possibilities in Western Kansas, N. W. Bass; 12, The Geology of Cowley County, with special reference to the occurrence of oil and gas, N. W. Bass; 13, Underground Resources of Kansas, R. C. Moore and K. K. Landes, 14, Volcanic Ash Resources of Kansas, K. K. Landes; 15, The Geology of Cloud and Republic Counties, Kansas, Monta E. Wing; 16, The Geology of Mitchell and Osborne Counties, Kansas, Kenneth K. Landes; 18, The Geology of Wallace County, Kansas, M. K. Elias; 19, The Geology of Ness and Hodgeman Counties, Kansas, R. G. Moss; 20, Subsurface Studies in Northeastern Kansas, John W. Ockerman; and 21, The Geology of Johnson, Miami and Wyandotte Counties, Kansas, Norman D. Newell and John M. Jewett; Mineral Resource Circulars 1, Oil and Gas Resources of Kansas in 1927, L. W. Kesler; 2, Oil and Gas Re-

sources of Kansas in 1928, 1929, and 1930, Anthony Folger and Roy Hall; 3, Oil and Gas Resources of Kansas in 1931 and 1932, Edward A. Koester; and 5, Rock Wool Resources of Kansas, Norman Plummer; and Circulars 3, Diatomaceous Marl from Western Kansas, a Possible Source of Hydraulic Lime, M. K. Elias; 4, Mineral Resources of Wyandotte County, Kansas, Norman D. Newell; and 5, Preliminary Report on Ground Water Resources of the Shallow Water Basin in Scott and Finney Counties, Kansas, R. G. Moss. Also utilized was unpublished material, including manuscripts on Road Materials of Kansas by K. K. Landes, Asphalt Rocks in Eastern Kansas by J. W. Ockerman, and Origin of the Shoestring Sands of Greenwood and Butler Counties, Kansas, by N. W. Bass. The new geologic map of Kansas was of inestimable aid in preparing this report.

Miscellaneous publications consulted include Kansas Coal, Engineering Bulleting 13 of the University of Kansas, by C. M. Young; reports on the water resources of drought counties (typewritten) prepared by the Kansas Emergency Relief Committee under the supervision of Ogden S. Jones; mimeographed report on water supplies of Kansas by the State Board of Health; annual reports and manuscript report on the coal industry prepared by the State Commissioner of Labor; the Oil and Gas Journal, especially the annual review number; the Oil Weekly, especially the western Kansas number; and reports of the U. S. Bureau of Mines, including the Minerals Yearbook and statistical compilations especially prepared for the files of the State Geological Survey of Kansas.

Acknowledgments. I greatly appreciate the cooperation and assistance given in the preparation of this booklet by members of the staff of the State Planning Board, especially Jay Besore. The following individuals furnished important memoranda which have been incorporated into this report: George E. Blakeley, Commissioner of Labor; Nels Anderson, Chief Engineer, State Corporation Commission; Harold Allen, Materials Engineer, State Highway Department; H. D. Barnes, State Highway Engineer; W. L. Stryker, consulting geologist, Fredonia, Kansas; Kenneth Spencer and C. Y. Thomas of the Pittsburg-Midway Coal Mining Company; Evan Just, Secretary Tri-State Zinc and Lead Ore Producers Association; and E. T. McKnight, U. S. Geological Survey. The drafting of illustrations was done by Donald Dowers and Robert Garrett. Max Shoemaker assisted in the compilation of information in regard to the newer oil and gas discoveries. I am very grateful to all of these individuals for their assistance.

ALLEN COUNTY

Oil and Gas. Allen County was one of the first counties in the state to produce oil and gas. Gas was discovered in the Iola district in 1873, and in succeeding decades many additional gas and oil fields were discovered in other parts of the county. The three leading districts are: (1) the southwestern part of the county, in the vicinity of Humboldt and southward into Neosho County; (2) the Iola district, mainly gas; and (3) scattered pools in eastern Allen County, especially in the vicinity of Moran. Production is obtained mainly from sandstones in the Cherokee shale formation, at depths ranging from 600 to 900 feet. Several shale gas wells were drilled in the southwest corner of the county a few years ago.

The oil fields of Allen County produced 116,870 barrels of oil during 1935, the last year for which statistics are available. Most of this oil comes from small wells that have been producing for many years.

The latest development in the county is the installation of "water drive" equipment to increase the oil yield. A project of this character is now being carried on in an old field northeast of Moran. Although the county has been widely explored for oil and gas in the Pennsylvanian rocks and has produced in the aggregate a considerable volume of these materials, the increased use of special production methods will no doubt keep Allen County in the producing column for many years more. In addition there is a possibility of deeper production. But few wells in the county have tested the "Siliceous lime."

Cement. Portland cement is produced in Allen County in two plants, one at Iola and the other at Humboldt. A third plant at Mildred, in the northeastern part of the county, has been idle for several years and is being dismantled. The Iola limestone, which is used in making cement in Allen County, lies at or close to the surface over a large part of the county. The reserves in cement-making materials are therefore very large.

Limestone. Three operators (one the cement company at Humboldt) reported the production of crushed limestone in 1935. Most of this was used in road metal and concrete, the balance being marketed for agricultural purposes. A large quantity of limestone is available over most of the county.

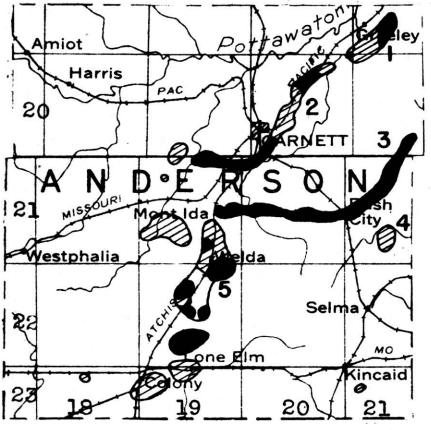
Clay. A plentiful supply of red burning clay and shale is available in Allen County. One plant at Humboldt manufactures bricks.

Water. Large supplies of potable water are to be obtained in Allen County from the surface only. The cities of Iola and Humboldt obtain water from the Neosho River, which drains the western part of the county.

Undeveloped Mineral Resources. Rock wool has been successfully blown in the experimental plant on the University of Kansas campus from limestone and shale samples collected in the quarries of the cement plants at Mildred, Iola, and Humboldt. The supply of raw material available for this product is practically inexhaustible.

Oil and Gas. Anderson County reached a peak in oil production in 1926, with a total of over one million barrels. Subsequently a steady decline has taken place, and in 1935 the production for the year was but a little over 280,000 barrels. The oil and gas are obtained from sands in the Marmaton group and in the Cherokee shale, especially the Bartlesville sand, from depths of less than 1000 feet as a general rule. Some of the most prolific pools produce from "shoestring sands", which are very narrow and elongate sand bodies completely surrounded by shale. One such sand body extends (with some gaps) from a point a few miles southwest of Garnett in a northeasterly direction east of the city to the northeastern corner of the county. Another shoestring sand makes the Bush City oil pool, which extends from central Anderson County to Bush City and then trends in a northeasterly direction to the county line. Other oil and gas fields have been found in the vicinities of Welda and Colony, and in the southeastern part of the county.

The oil fields of Anderson County have yielded the greater part of the oil that can be obtained by usual methods. It is anticipated that the use of water drive (now being practiced southeast of Garnett) will greatly increase the total recovery from these relatively shallow fields. New Pennsylvanian fields may yet be discovered, and in addition, the as yet largely untested "Siliceous lime" may contain oil in this part of the state.



OIL AND GAS FIELDS

1. Greeley
2. Garnett Shoestring
3. Bush City Shoestring
4. Hazlett
5. Welda

Natural-Gas Gasoline. One company, the Virginia Oil Company, reported the production by compression methods of natural gasoline during 1935 from gas obtained in the Bush City field.

Limestone. A very thick limestone series, the Stanton-Plattsburg, outcrops across Anderson County from north to south and has been exploited by a large quarry north of Garnett. Stone quarried in Anderson County during 1935 was used for road metal and concrete, railroad ballast, riprap, and for agricultural purposes. The supply of rock available is practically inexhaustible.

Water. As is the case in most parts of eastern Kansas, the water in the bed-rock formations is highly mineralized and large

municipal and industrial supplies of water in Anderson County must be obtained from surface runoff.

Undeveloped Mineral Resources. The uplands of central and south-central Anderson County contain high terrace flint gravel deposits which have been but little exploited as yet.

ATCHISON COUNTY

Limestone. The various ledges of limestone belonging to the Oread formation outcrop at the top of the bluffs bordering the Missouri River in eastern Atchison County. This limestone has been extensively quarried in the vicinity of Atchison. Most of the stone obtained in recent years from these quarries has been used for riprap along the Missouri River. The balance has been used in road metal and concrete. Beside the large reserve of Oread limestone as yet unquarried in eastern Atchison County, additional higher limestones crop out across central and western Atchison County.

Coal. Two small coal mines operated in Atchison County during 1935. The coal lies in the Lawrence shale formation and crops out along the bluffs and in the ravines adjacent to the Missouri River. Several decades ago a 36 inch bed of coal occurring in the Cherokee shale at a depth of 1123 feet was mined. The mine was eventually abandoned because of the large volume of water encountered which entailed excessive pumping costs.

Sand and Gravel. Sand and gravel used in the construction of buildings and highways are obtained from the bed of the Missouri River, which forms the eastern boundary of Atchison County. The supply of sand and gravel on the river bed is replenished during times of high water.

Water. The city of Atchison and industrial plants obtain water directly from the Missouri River. In the central and western parts of the county water is obtained from porous streaks in the valley alluvium and from the glacial deposits, which veneer the uplands in this county.

Undeveloped Mineral Resources. Rock samples collected in Atchison County have not yet been tested for rock wool, but there is little doubt that suitable rock for the manufacture of this important insulating material can be obtained.

So far only two deep tests for oil or gas have been drilled in Atchison County. One of these was a diamond-drill hole which was drilled in Atchison to a depth of 1,352 feet. It penetrated into the "Mississippi lime". The other well was drilled near the southeastern corner of the county, and reached a total depth of 3,085 feet. It encountered pre-Cambrian granite and schist below about 2,900 feet. Central and western Atchison County have not been tested for oil or gas.

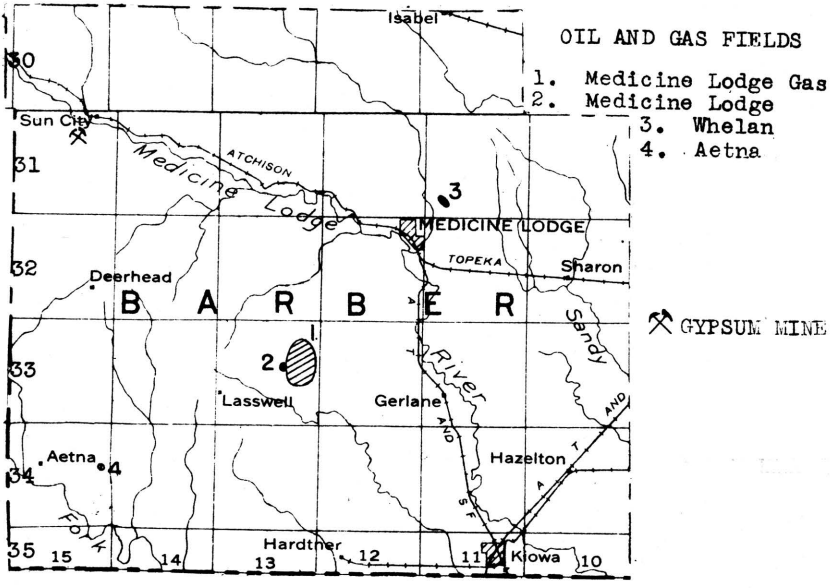
BARBER COUNTY

Oil and Gas. Gas was first encountered in Barber County in January, 1927, in the discovery well of the Medicine Lodge pool, in T. 33 S., R. 13 W., southwest of the city of Medicine Lodge. The first oil discovery was in the Whelan pool, a short distance

northeast of Medicine Lodge, in November, 1934. Oil was found on the southwest flank of the Medicine Lodge gas field in March, 1937. The oil production for Barber County (Whelan pool) has been: 1934 (November and December only), 2,848 barrels; 1935, 14,582; 1936, 24,686 barrels.

The Medicine Lodge field produces from the Viola lime at depths of about 4,800 feet. A total of 7,200 acres produce gas. The oil is found beneath 120 acres. The Whelan pool is producing from the Mississippi chat at a depth of about 4,400 feet. At the present time the pool has but two producers, and has no outlet for its oil other than by truck. A third pool in Barber County, the Aetna, was discovered in September, 1935. This is now a two-well gas pool, with production coming from the Viola lime at a depth of a little over 5,200 feet. It is dormant at the present time due to lack of pipe-line outlet.

Most of the western half of Barber County, and the southeastern part, were being actively leased during 1936.



Natural-Gas Gasoline. Gas from the Medicine Lodge field is piped to Medicine Lodge and treated in two plants for its gasoline content before being put back into the pipe line for distribution to market. These plants are of the absorption type.

Gypsum. Gypsum has been mined in Barber County for many years, but a large reserve is still available. The Best Bros. Keene's Cement Company mines gypsum by modern mining methods in the hills south of Sun City. Most of this gypsum is then transported by rail to the company's plant at Medicine Lodge, where it is calcined and made into various plasters, including Keene's cement.

Water. Much of the surface and ground water of Barber County is mineralized because of the presence of gypsum and salt

in the bed-rock formations. However, an ancient stream deposit covers much of eastern Barber County, from parts of which large quantities of usable water can be obtained. The northern end of the county is covered with Tertiary formations which likewise contain ground water.

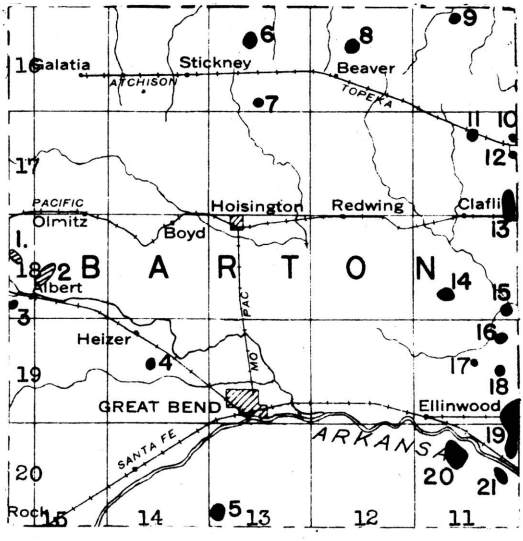
Undeveloped Mineral Resources. Central and northern Barber County are underlain by salt beds with an aggregate total thickness in excess of 500 feet. The thickness of the salt diminishes to the south, but according to drill records some salt underlies the entire county.

Sand and gravel deposits occur along Medicine Lodge River near the town of Medicine Lodge, and in a tributary valley about 6 miles north of town.

BARTON COUNTY

Oil and Gas. The first commercial oil well was completed in Barton County in March, 1930. Another field was discovered in 1931 and a third pool in 1932. In the four subsequent years 13 new oil and gas fields have been discovered in the county, making a total of 16. The names and positions of these pools are shown on the accompanying map. The average depth to production is about 3,300 feet. The Heizer and Hiss pools are producing from the Kansas City limestone, the Beaver, Ehly and Feist from sandstone or conglomerate at the base of the Pennsylvanian series, the Albert oil and gas field from a basal Paleozoic sandstone, and the remaining pools from the "Siliceous lime".

Barton County is the scene of a very active drilling play at the present time. Inside locations remain to be drilled in some of the newer fields. Not all of the fields have been completely outlined by dry holes as yet, and there are many parts of the county that remain to be tested.



OIL AND GAS FIELDS

1. "Schneider"
2. Hunter
3. Albert
4. Heizer
5. Hiss
6. Susank
7. Ainsworth
8. Beaver
9. Davidson
10. Breford
11. "Kraft"
12. "Myers"
13. Bloomer
14. Feist
15. Straub
16. Rick
17. Lanterman
18. Eberhardt
19. Silica
20. Ellinwood
21. Peter

Sand and Gravel. The Arkansas River, which curves through southern Barton County, has cut its course through Dakota sandstone, and in consequence its flood plain is sandy. Furthermore almost unlimited supplies of sand and gravel can be obtained from the river bed itself. Paving sand was produced in this county in 1935.

Water. Large quantities of water are available over Barton County by means of shallow wells dug or drilled into the alluvial deposits, which are very widespread in the southern half of the county, and into the sandstone beds of the Dakota formation.

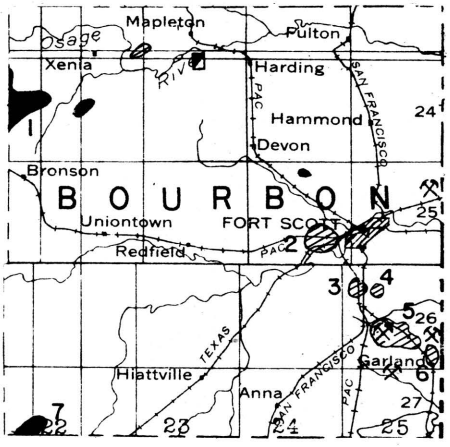
Undeveloped Mineral Resources. From three to four hundred feet of rock salt underlies Barton County.

BOURBON COUNTY

Oil and Gas. The Moran and some of the other eastern Allen County pools extend across the line into western Bourbon County. The Walnut-Hepler oil field lies across the western end of the line separating Crawford from Bourbon County. In addition some small and isolated oil fields occur in Bourbon County, especially in the western part. A shoestring oil field was discovered and extensively drilled in the northwestern corner of the county in 1933 and 1934. Repressuring is now being practiced in this field.

During the last decade the oil production of Bourbon County has ranged from 5,300 barrels up to nearly 22,000 barrels. The production during 1935 was 7,136 barrels.

The oil and gas of Bourbon County occur mainly in sand within and at the base of the Cherokee shale. This formation lies at a depth of but a few hundred feet in the western part of the county and is exposed in the southeastern part. Six gas fields with a northwest-southeast trend have been developed in eastern Bourbon County, mainly since 1928. The producing sands lie at depths as shallow as 250 feet. The wells range in initial flow from 65,000 to 260,000 cubic feet, with a pressure of 34 pounds.



COAL STRIP PIT

OIL AND GAS FIELDS

1. Moran
2. Moberg gas
3. Hughes gas
4. Bass gas
5. Dodge gas
6. Garland gas
7. Walnut-Hepler

Coal. The upper Cherokee coals occur at and near the surface in southeastern Bourbon County. The mining of coal increased in the county during 1936. Six strip mines and one shaft mine produced 21,726 tons of coal during that year.

Natural Cement. The Fort Scott limestone which lies immediately above the Cherokee shale is mined at a plant north of Fort Scott and burned to produce natural cement. This is the only natural cement plant in operation in Kansas. The Fort Scott limestone is extensively exposed over eastern Bourbon County.

Stone. Crushed limestone was marketed by two producers in eastern Bourbon County during 1935. Most of this limestone was used in road metal and concrete. Other uses include riprap, railroad ballast, and agricultural limestone. A local sandstone occurring in the Bandera shale is quarried near the town of Bandera, mainly for flagging.

Clay. Brick and pottery are made in Fort Scott from local clay deposits. Other shales and clays occur in the county which are not exploited.

Water. The deeper ground waters of Bourbon County are too highly mineralized for use. The municipal supply at Fort Scott is obtained from impounded surface water.

Undeveloped Mineral Resources. Experiments by the State Geological Survey have shown that satisfactory rock wool can be blown from the rock that is being quarried for natural cement and brick manufacture in the vicinity of Fort Scott.

The same formations that contain commercial deposits of rock asphalt in Linn County to the north and in western Missouri extend southwestward into Bourbon County. It is possible that asphalt deposits may occur at and near the surface in northern Bourbon County.

BROWN COUNTY

Water. Most of the water obtained in Brown County comes from valley fill aquifers. This section of Kansas is veneered with glacial deposits, and consequently much of the valley alluvium consists of coarse sand and gravel, in which large quantities of water are stored. The glacial till itself is too erratic in texture to be a consistent source of ground water, but glacial outwash gravels yield abundant water. Water is also present in the bed-rock formations, but as a general rule is mineralized at depths below 200 feet.

Undeveloped Mineral Resources. The presence of glacial drift over most of the surface of Brown County has retarded geological exploration for favorable places in which to drill test wells for oil and gas. Several decades ago a diamond drill hole was put down at Horton to a depth of 1,108 feet. Only the Pennsylvanian beds were penetrated by this well.

Limestones are exposed in the stream valleys that penetrate through the glacial drift. Quarry sites have been found in southeastern and west central Brown County.

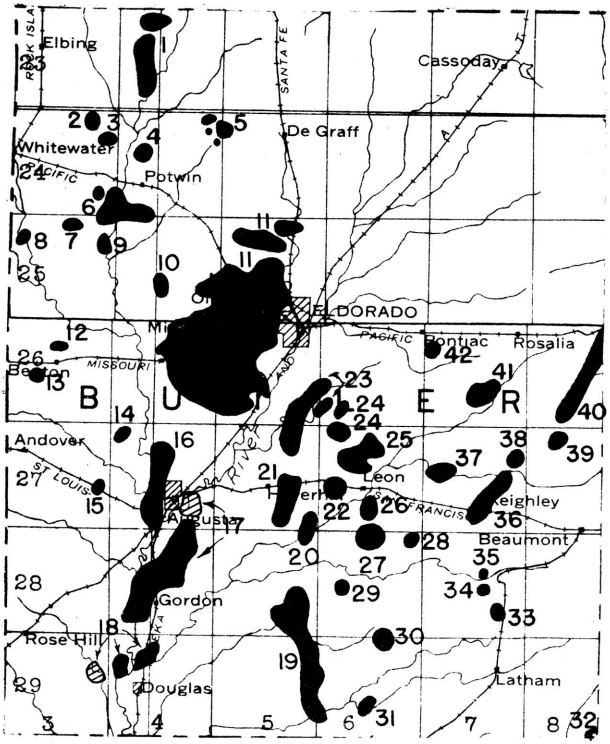
Sand and gravel deposits occur in the southeastern and

south central parts of the county.

BUTLER COUNTY

Oil and Gas. Kansas first became an important oil state in 1917 when a 20,000 barrel well was completed in what is now the El Dorado field. For several years this field produced most of the state's oil and was in addition an important factor in world production. Even today, nearly 20 years after discovery, the El Dorado field is the third largest field in Kansas (1936 production), with an annual yield in excess of 3½ million barrels. Repressuring by air drive has been practiced for over a decade in the 650 foot sand in this field.

Since 1917 many other oil and gas fields have been discovered in Butler County. To the south the Augusta field produces from an anticline that is only slightly smaller than the El Dorado anticline. Both of these oil-producing sectors overlie the buried Granite Ridge which crosses Kansas from north to south between Nemaha and Sumner Counties. The El Dorado and Augusta pools produce some oil and gas from Lower Pennsylvanian rocks, but the greater part of the yield comes from Ordovician rocks



OIL AND GAS FIELDS

1. Elbing
2. Thompson
3. Powell
4. King
5. Hazlett
6. Potwin
7. Brainerd
8. McCann
9. Moore
10. Pierce
11. El Dorado
12. Benton
13. Marnane
14. Gelwick
15. Bausinger
16. North Augusta
17. Augusta
18. Douglas
19. Fox-Bush
20. Weaver
21. Haverhill
22. Leon
23. Smock-Sluss
24. Garden
25. Reynolds-Shaffer
26. Stern
27. Kramer
28. McCollough
29. Pettit
30. Snowden-McSweeney
31. Steinhoff
32. Hannah
33. Brewer
34. Sensenbaugh
35. Brandt
36. Keighley
37. Knox
38. Seward
39. Lucas
40. Blandenship
41. Young
42. Pontiac

which immediately overlie the buried summits of the granitic mountains. To the west in western and northwestern Butler County are about a dozen fields, which produce from the "Mississippi lime" on the flank of the granite uplift. The largest of these fields is the Potwin. To the east are nearly a score of fields producing from the Bartlesville sand. Some of these, near the eastern boundary of the county, produce from "shoestring" sand bodies which lie on the southwestern extension of the Sallyards trend of Greenwood County.

The oil production of Butler County has been in the neighborhood of from 6 to 7 million barrels annually during the last few years. A little over half of this production comes from the El Dorado field. The balance is the aggregate from the many scattered oil pools in the county.

Natural-Gas Gasoline. One plant at El Dorado produces gasoline from natural gas by the compression process, and a larger plant at Gordon uses the absorption method of obtaining natural gasoline.

Stone. Three producers reported stone production (mainly limestone) in Butler County in 1935. Most of this stone was used for road metal and concrete, with a relatively minor amount being used as railroad ballast and agricultural limestone. A 70-foot limestone series, which includes the Florence limestone, limestones within the Oketo shale, and the lower Fort Riley limestone, lies at or close to the surface across central Butler County from north to south. The reserves are practically inexhaustible. The largest limestone quarry is 2 miles east of El Dorado. Other quarries lie to the southwest of El Dorado.

Sand and Gravel. One of the largest gravel deposits in southern Kansas occurs in Butler County between Douglas and the Cowley County line. The gravel caps the uplands and was probably deposited by late Tertiary streams that flowed over this area. The gravel is cherty and was apparently derived from the lower Permian rocks.

Water. Large users of water in Butler County, including the cities of El Dorado and Augusta, have found it necessary to impound surface supplies in order to obtain the desired quantity and quality of water.

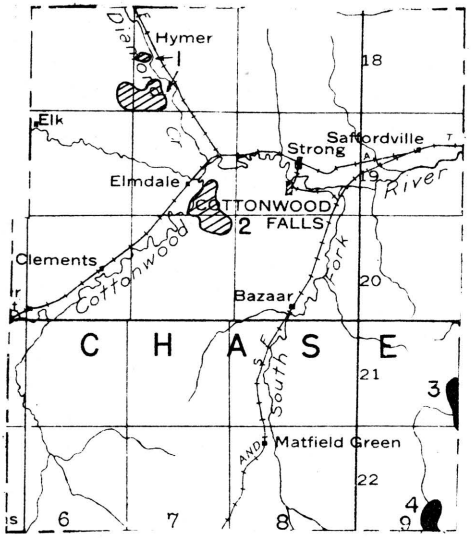
Undeveloped Mineral Resources. The limestone now being quarried in the Dolese quarry 2 miles east of El Dorado is too high in carbon-dioxide to be used in blowing rock wool without mixing it with clay or shale obtained from near-by deposits. However, there is a strong possibility that the rock below the present quarry floor could be used for this purpose.

CHASE COUNTY

Oil and Gas. Many thousands of dollars have been spent in southern Chase County on dry holes drilled in the hope of finding production similar to that obtained in Butler County from above the buried Granite Ridge. The only oil as yet found in Chase County is in the southeastern corner where the Teeter pool extends northward across the county line from Greenwood County and the Browning and Atyeo pools extend westward into Chase County from northwestern Greenwood and southwestern Lyon Coun-

ties. A few thousand barrels a year from these fields can be credited to Chase County.

Exploration in northwestern Chase County, although as yet unproductive of oil, has resulted in the discovery of two gas fields. One of these, the Elmdale, located in Ts. 19 and 20 S., R. 7 E., has been producing gas for over a decade. It supplies near-by cities. The gas occurs at a depth of about 500 feet in a formation in the Wabaunsee group of Upper Pennsylvanian age. A newer and larger field, the Lipps, lies in the western part of T. 18 S., R. 7 E. and in the southeastern part of T. 18 S., R. 6 E. This field was discovered in 1926. The gas is obtained from a sand in the Lawrence shale at a depth of about 1,200 feet. Individual wells vary in initial production from 1½ million to 5 million cubic feet. At last reports (1929) eighteen producing gas wells had been drilled.



OIL AND GAS FIELDS

1. Lipps gas
2. Elmdale gas
3. Atyeo
4. Teeter

Limestone. The Cottonwood, Wreford, Florence, and Fort Riley limestones cross the western half of Chase County from north to south. Limestone was produced and used in road metal and concrete in this county in 1935. Three quarry sites occur in the cherty limestones of the Permian in west central Chase County. An old and once very active dimension stone quarry in the Cottonwood limestone lies just south of Cottonwood Falls.

Sand and Gravel. Flint (chert) gravel veneers the uplands in many places in Chase County, especially in the south central part. It is also found in some of the stream beds.

Water. The most important source of water in Chase County at present is the flood plain of Cottonwood River. Coarse streaks within the valley fill yield ample supplies of water for local and municipal use. One bed-rock formation, the Wreford limestone, is an important source of water in the Flint Hills. Attempts to find bed-rock supplies in eastern Chase County have been failures as a general rule.

CHAUTAUQUA COUNTY

Oil and Gas. Oil and gas pools have been found in every township in Chautauqua County except along the western edge. The leading oil fields are grouped in the vicinities of Sedan, Chautauqua and Elgin. The Longton gas field of southeastern Elk County extends southward into northeastern Chautauqua County. Several scattered pools lie northwest of Sedan in T. 32 S., R. 11 E., and T. 32 S., R. 10 E.

An extremely important discovery, not only to Chautauqua County but also to other counties of eastern Kansas, was the discovery in the summer of 1935 of oil in the "Siliceous lime" in the Oliver pool in secs. 1 and 2, T. 32 S., R. 10 E. This well was rated with an initial production of 1,000 barrels a day from a depth of a little less than 2,300 feet. By February, 1936, six producing wells had been drilled into the "Siliceous lime" in this field. About twenty other wells produce from upper pay zones in the same field. Subsequently the "Siliceous lime" was tested beneath the Monett pool northeast of Sedan, a "Mississippi lime" gas field discovered in 1925. The deep test was a success, and by February, 1936, a half dozen producers had been drilled. One of these wells was estimated to have a potential of 1,500 to 2,000 barrels daily. The top of the "Siliceous lime" lies at a depth of 1,790 feet in this pool.

Oil production in Chautauqua County reached a peak in 1929, when nearly a million barrels of oil was produced. Production declined, however, and between 1932 and 1935 the annual yield was between 500,000 and 600,000 barrels. The increased production due to discovery of oil in the "Siliceous lime" should push Chautauqua County production to a new peak. It is anticipated that the "Siliceous lime" will be tested in many other fields during the next few months. The outlook for important quantities of Ordovician oil in eastern Kansas is very encouraging at the present time.

Stone. Both sandstone and limestone are produced in Chautauqua County. One quarry lies a few miles north of Sedan. Some of the formations that are massive limestones in northeastern Kansas become sandy to the south, and are sandstones in Chautauqua County. Both sandstone and limestone were quarried in this county in 1935 for use as road metal. Limestones are abundant at the surface in the western half of the county.

Water. Municipal and industrial supplies of water are obtained in Chautauqua County by impounding surface drainage and by shallow wells. As a general rule, the deeper bed-rock formations carry mineralized water.

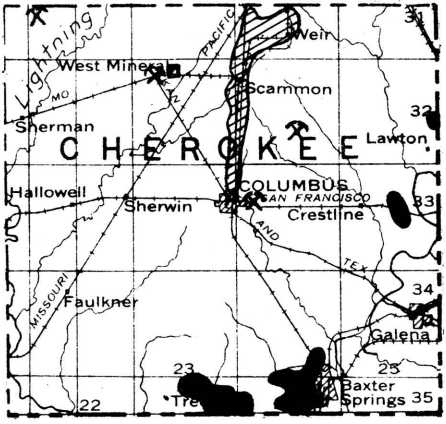
Undeveloped Mineral Resources. A deposit of volcanic ash has been reported as exposed in a road cut in the NE. ¼ of the SW. ¼ of sec. 9, T. 34 S., R. 13 E.

CHEROKEE COUNTY

Zinc, Lead and Chat. The outstanding zinc-producing district of the United States lies in southwestern Missouri, southeastern Kansas, and northeastern Oklahoma. The Kansas portion of this district lies in southeastern Cherokee County in the vicinity of Baxter Springs. The ore occurs in the Mississippian limestone which crops out in the very corner of the state. With

the zinc occurs lead ore, which is likewise mined. "Chat" is a colloquial term for chert which is mixed through the zinc and lead ore and is separated during the milling process. It is used as railroad ballast, road surfacing and in concrete aggregate. The total zinc and lead production from 32 mines in Kansas in 1936 was 119,022 short tons. During the same year 10 tailing-mills produced 24,714 tons of zinc. It has been estimated that the Tri-State district contains a six year supply of tailings yet to be treated. During the past decade Kansas has varied from second to fourth in rank among zinc-producing states.

No data are available in regard to the amount of zinc and lead ore yet to be mined from the Kansas part of the Tri-State district. Three potential sources of ore in addition to that being mined are known. One of these is a tract, explored by the core drill and known to be ore-bearing, about 3 miles north of the State line and 1 mile west of State Highway No. 7. It lies about 2 miles north of present production. A second tract, likewise cored drilled, lies west of Treece and south of Melrose. Barren ground lies between both of these tracts and the Treece ore deposit. The third possibility for additional ore is its occurence at stratigraphically lower levels than those now being exploited. One Kansas mine, the Ballard (3 miles southwest of Baxter Springs), is now working an ore body in the Grand Falls chert layer. This deeper ore may underlie other mines in the district.



ZINC MINING DISTRICT

COAL SHAFT MINE

COAL STRIP MINE

COAL MINES (Both shaft and strip).

Coal. The Cherokee formation, with several commercial beds of coal, crosses Cherokee County from northeast to southwest. The coal is mined by both open cut and underground mining methods. Five strip mines in Cherokee County produced 477,496 tons of coal during 1936. Thirty-eight shaft mines operated during the year with a production of 76,038 tons, or a total for the county of over a half million tons of coal. Additional detail on the coal industry of Kansas is given in the discussion of coal under Crawford County.

Stone. The only thick limestones to outcrop in Cherokee County are the Mississippian in the southeastern corner and the Fort Scott in the northwestern corner. A small production of limestone was reported for 1935. Several sandstone beds occur in the Cherokee formation and some have been exploited, but no

report of production was made for 1936.

Sand and Gravel. Sand and gravel are sporadically produced in Cherokee County. The deposits are formed through the weathering and transportation of chert occuring in the Mississippian limestone.

Pyrites. A new industry in Kansas was established in 1935 when a concentrating plant to extract iron pyrites from mine refuse was constructed by the Pittsburg and Midway Coal Mining Company at West Mineral, in Cherokee County. The iron sulphide (pyrite and marcasite) occuring in the coal had hitherto been allowed to go to waste. This plant has a capacity of 50 tons of mine refuse per hour, and produces a product containing about 48 per cent sulphur.

Water. Cherokee is one of the few counties in eastern Kansas where potable supplies of ground water are available from bed-rock formations. The Mississippian limestone, which crops out in the southeastern corner and underlies the rest of the county, contains an abundant supply of water. This water contains sulphur compounds, but is nevertheless usable.

CHEYENNE COUNTY

Water. All but the northern part of Cheyenne County is underlain by the Ogallala formation of Tertiary age, in which occurs an abundant supply of sheet water. In addition, the Republican River cuts across the northwestern part of the county, and ground water is available within its wide valley fill.

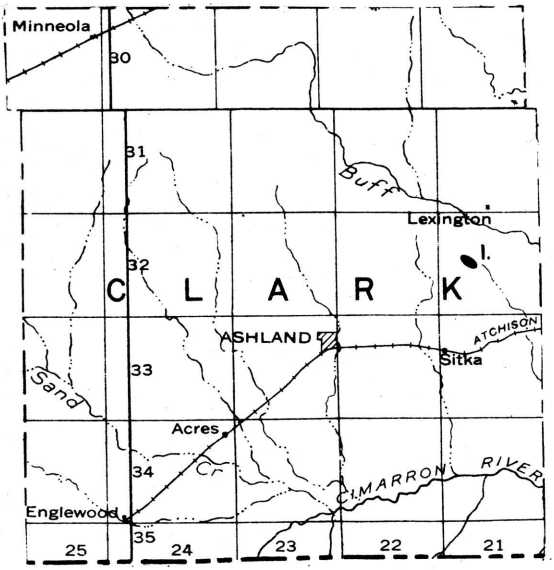
Undeveloped Mineral Resources. Cheyenne County has not yet been tested for oil and gas. Gas occurs in the Upper Cretaceous formations a short distance to the northwest at Beecher Island in Yuma County, Colorado. Not only does this horizon underlie Cheyenne County but also most, if not all, of the older and deeper formations which produce elsewhere in western Kansas lie beneath the surface in Cheyenne County.

Sand and gravel deposits occur along the Republican River. A deposit a short distance southwest of St. Francis has been investigated by the Materials Department of the State Highway Commission.

CLARK COUNTY

Oil and Gas. Gas was first discovered in a well drilled to a depth of 5,450 feet in sec. 21, T. 32 S., R. 21 W., in November, 1928. This gas well had an estimated capacity of 20,000,000 cubic feet open flow. The discovery oil well was drilled in sec. 17 of the same township in November, 1936. The oil is believed to occur in the Viola "lime" and the well produces from a depth of 6,477 to 6,481 feet. At the present time there are but two oil wells in this pool, which has been named the Morrison. The discovery well produced at the rate of 2,358 barrels a day on potential test, and is the deepest producing well in Kansas.

The discovery of oil in Clark County led to an intensive leasing campaign over practically the entire county, and in adjacent parts of Ford, Kiowa, and Comanche Counties.



OIL AND GAS FIELD

1. Morrison

Water. The bed-rock formations lying at and near the surface in Clark County consist of Permian red beds and similar formations in which the water is strongly mineralized. However, in many places in the southern half of the county the bed-rock formations are overlain by thick deposits of valley alluvium, dune sand, and Quaternary terrace sands and gravels (flood plains of older streams) in which usable water can be obtained in shallow wells. The northern edge of the county is veneered by the Ogallala formation of Tertiary age, in which sheet water occurs.

Undeveloped Mineral Resources. A bed of volcanic ash is exposed in the southeast corner of sec. 23, T. 30 S., R. 24 W. This bed contains about 10 feet of ash, but apparently is of very small areal extent. Another deposit has been reported in sec. 12, T. 30 S., R. 23 W. There has been little or no exploitation of these deposits.

According to available well records, salt underlies the entire county, ranging from a thickness of about 100 feet in the southeast corner to about 500 feet near the northwest corner.

Sand and gravel occur in potentially commercial deposits in northeastern, southeastern, and west central Clark County. These sediments lie in stream alluvium and terrace deposits.

CLAY COUNTY

Stone. Western Clay County is crossed from north to south by the Dakota sandstone, and central and eastern Clay County by shales and limestones (including the Herington) of Lower Permian age. The county quarried both sandstone and limestone during 1935 for use as road material and in concrete. Stone quarry sites are abundant across the southern half of the county and

in the northeast corner.

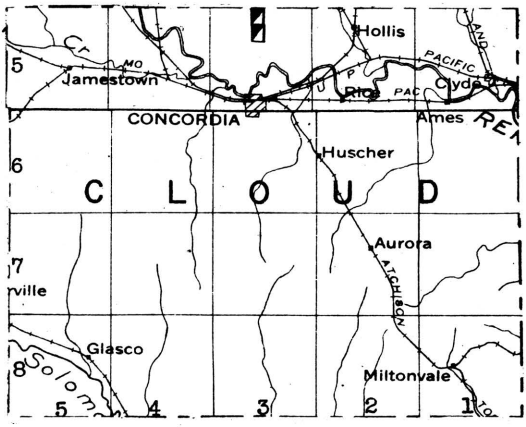
Sand and Gravel. Clay County is crossed from northwest to southeast by the Republican River. Sand and gravel are available both in the flood plain and in the stream bed. Two operators reported sand and gravel production near Clay Center during 1935 for use in paving.

Water. An abundant supply of ground water is obtainable along the flood plain of the Republican River by shallow wells penetrating streaks of coarser water-bearing sediment in the valley fill. Bed rock supplies can be obtained from the Dakota sandstone in western Clay County, but in the eastern part of the county the water in the bed rock is generally mineralized.

Undeveloped Mineral Resources. A 20-barrel oil well was completed in sec. 21, T. 9 S., R. 4 E., in December, 1928. Oil was struck at a depth of about 1,770 feet. This one-well field (now abandoned) was named the Wakefield pool. Two dry holes were drilled in the same section in 1934 and 1935. One well was abandoned at 1,781 feet, the other at a depth of 1,879 feet. Another well was drilled in section 4, T. 10 S., R. 4 E. in 1935. This well was abandoned as a dry hole at a depth of 1,834 feet.

CLOUD COUNTY

Coal. Coal occurs in Cloud County in the Dakota formation of Cretaceous age. This coal is much younger than that mined in eastern Kansas. It is black lignite, and occurs in a 2-foot bed which has within it a 4-inch parting of impure coal. The production of coal in Cloud County commenced in 1855 and has been carried on intermittently and on a small scale ever since. Two shaft mines are located about 6 miles north of Concordia. One of these operated during 1936, producing 670 tons of coal.



COAL SHAFT MINES

Stone. All of Cloud County except the uplands near the western end of the county is floored with Dakota sandstone and shale. The western end of the county contains the overlying Graneros and Greenhorn formations, including several relatively thin limestone beds such as the "Fencepost" limestone or "post rock". Several thousand tons of limestone were quarried in

southwestern Cloud County during 1935 for use in road material and concrete aggregate. Dakota sandstone has been quarried in the past and used locally as building stone.

Sand and Gravel. Sand and gravel for paving and structural purposes are obtained in Cloud County from the alluvium of the Republican River near Concordia. Terrace deposits have been extensively exploited in southwestern Cloud County both north and south of the Solomon river near Glasco. These sands and gravels were deposited by the Solomon river many years ago when it occupied a different and higher channel.

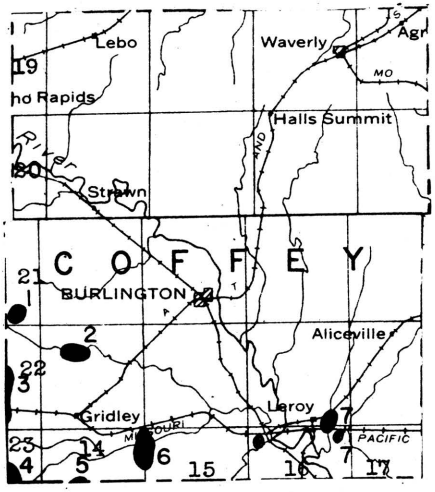
Water. Abundant supplies of water are available in central and eastern Cloud County by means of shallow wells dug or drilled into the outcropping Dakota formation, or into valley fill. However, wells drilled to the Dakota sandstone in western Cloud County, where this formation is covered by the overlying Graneros and Greenhorn formations, have encountered salt water in many instances. Local supplies are available throughout most of this upland area by shallow wells into the soil veneer, and in some cases into the bed rock in which water is stored in crevices.

Undeveloped Mineral Resources. Cloud County has not been adequately tested for oil and gas. No deep tests have been drilled in recent years. Only one well has penetrated the pre-Pennsylvanian rocks for any great distance. This was the Murdock well in section 6, T. 6 S., R. 4 W. It was abandoned at a total depth of 3595 feet.

A brick plant operated at Concordia at one time.

COFFEY COUNTY

Oil and Gas. Coffey County produced 28,821 barrels of oil in 1936. The fields are extensions of the Greenwood and Woodson County districts into the southern and southwestern parts of Coffey County. Production is obtained, as a general rule, at depths between 1,500 and 2,000 feet. The southwestern Coffey



OIL FIELDS

1. Hatch
2. Carter
3. Dunaway
4. North Virgil
5. Wintershied
6. Van Noy
7. Leroy

County fields, including the Van Noy and Carter, and fields along the Greenwood and Woodson County lines, produce from the "Mississippi lime". The LeRoy field in southeastern Coffey County produces from sandstones in the Lower Pennsylvanian. Attempts to find oil or gas production farther north in Coffey County have as yet been unsuccessful.

Coal. Coal is mined in northwestern Coffey County from the upper part of the Severy shale. This is the highest Pennsylvanian coal mined in Kansas. It lies about 2,000 feet stratigraphically above the Cherokee coal that is mined in southeastern Kansas. The Coffey County district is a southwestward continuation of the coal fields of Osage County. During 1936, four mines were in operation near Lebo in Coffey County, producing 1245 tons of coal. Two of these mines are shaft mines and the other two strip mines.

Water. The principal source of water in Coffey County is the Neosho River, which crosses the county from northwest to southeast. The flow of this stream is sufficient to furnish adequate municipal and industrial supplies. The deeper bed rock water supply is mineralized in most parts of the county.

Undeveloped Mineral Resources. Coffey County is crossed from northeast to southwest by a series of fairly thick limestones which are quarried when needed. Quarry sites are found in northern, central, and south-central Coffey County. Deposits of high terrace flint gravels of commercial value have been found in the uplands in northwestern and southern Coffey County.

COMANCHE COUNTY

Water. Northern and north-central Comanche County is veneered with the Ogallala formation of Tertiary age in which abundant supplies of water are available for domestic, farm, and municipal use. The valleys of Cimarron river and its tributaries in western and southwestern Comanche County are filled with river alluvium, dune sand, and terrace deposits in which water is available at shallow depths.

Undeveloped Mineral Resources. Comanche County lies between Clark County, with its recently discovered Morrison oil and gas field, and Barber County with three oil and gas fields. The Clark County discovery late in 1936 caused considerable leasing activity in western Comanche County. So far no deep tests have been drilled in this county.

The gypsum beds which are quarried at Sun City in northwestern Barber County extend about 12 miles up the valley of Salt Fork Creek into southeastern Comanche County. Gypsum has not as yet been exploited in Comanche County, but a fairly large tonnage is apparently available.

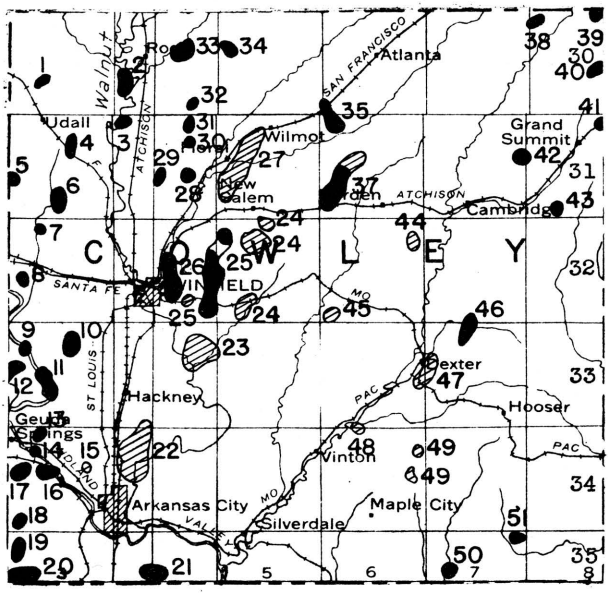
At least two deposits of volcanic ash occur in Comanche County. One of these is about 1 mile north of Wilmore and the other about 5 miles south of the same town. A small amount of material has been removed from these deposits and used in the construction of U. S. Highway 160.

Several sand and gravel deposits with commercial possibilities occur in the Tertiary area of northern Comanche County.

COWLEY COUNTY

Oil and Gas. One or more oil and gas fields have been found in almost every township in Cowley County. The greatest concentration, however, occurs in the northwestern half of the county, where such large fields as the Rainbow Bend, Winfield, State, and Weathered occur. Producing horizons include a shallow gas sand in the uppermost Pennsylvanian rocks, formations in the Shawnee group at depths in the neighborhood of 1,500 feet, formations in the Kansas City group at depths ranging from 1,900 feet in the eastern part of the county to 2,500 feet near Winfield, the Bartlesville sand, which produces oil in the Rainbow Bend and other prolific western Cowley County fields at depths in the neighborhood of 3,000 feet, and the Ordovician "Siliceous lime" which lies at a depth of about 3,500 feet where productive in western Cowley County. A relatively small amount of oil is obtained from the "Mississippi lime" in eastern and southern Cowley County.

Oil production in this county reached a peak of nearly 4,000,000 barrels in 1926 when the Rainbow Bend field, discovered toward the close of 1923, was at the height of its development. Subsequently, production fell off to a low point in 1934 of 1,680,934 barrels. New discoveries in the county boosted the



OIL AND GAS FIELDS

1. Udall
2. Trees
3. Clark
4. Smith
5. Churchill
6. Weathered
7. Collinson
8. Carson
9. Thurlow
10. Graham
11. Rainbow Bend
12. West Rainbow Bend
13. Martin
14. Gueda Springs
15. Mohler gas
16. Baird
17. Bestall
18. Millett
19. Murphy
20. De Mott
21. Pudden
22. Arkansas City gas
23. McCollum gas
24. Tisdale gas
25. Winfield
26. State
27. Wilmot-Floral gas
28. Lewis
29. Hittle
30. Sherwood
31. S. David
32. David
33. Rock
34. Daniels
35. Eastman
37. Burden
38. Mahannah
39. Hannah
40. West Ferguson
41. Grand Summit
42. Brown
43. Reidy
44. Estes
45. Werner
46. Countryman
47. Dexter
48. Esch
49. Otto
50. Falls City
51. Olsen

yield in 1936 to 1,804,114 barrels.

The Dexter gas field, in southeast-central Cowley County, was the scene of the discovery in 1908 of the first helium to be found in natural gas, from a well drilled in 1906. This gas runs about 2 per cent helium, with the balance mainly nitrogen. It is non-inflammable. A plant was constructed in 1927 to extract helium. It has been intermittently in operation since that time.

Limestone. Several thick beds of limestone cross Cowley County from north to south. The most important of these from an economic standpoint is the Fort Riley. This stone has been quarried for many years near Silverdale and is commonly marketed as "Silverdale stone". The Fort Riley limestone has also been quarried in the vicinity of Winfield and south and southeast of Arkansas City.

The Silverdale quarry is one of the very few places in the state reporting production of building stone during 1935. Rubble was also marketed. The Cowley County Highway Department during the same year quarried several thousand tons of limestone for use in road metal and concrete.

Sand and Gravel. Sand and gravel are dredged from the bed of the Arkansas River immediately west of Arkansas City. During 1935 paving and structural sand and gravel and engine sand were produced. A very large deposit of terrace gravel near Silverdale has been extensively exploited in past years.

Water. Cowley County is drained by the Arkansas river and two large tributaries, Walnut river and Grouse creek. The cities of Winfield and Arkansas City obtain municipal supplies from shallow wells drilled into pervious sand bodies in the fill of Arkansas river valley. The refineries in Arkansas City obtain industrial water from the same source. Smaller supplies are available in parts of the upland areas in crevices in the bedrock limestone formations.

Undeveloped Mineral Resources. High quality rock wool has been blown from samples collected at the rock quarry at Silverdale (utilizing much of the waste rock at that quarry) and from two localities in the vicinity of Winfield.

CRAWFORD COUNTY

Coal. The greatest mineral resource in Crawford County is coal, and Crawford produces more coal than all of the other counties combined. During 1936, 24 strip mines were in operation, producing 1,639,547 tons of coal. During the same period 53 shaft mines in the county produced 653,488 tons of coal. The total for the county was 2,293,035 tons, and the state total in 1936 was 3,147,225 tons.

The following remarks on the coal industry of southeastern Kansas were kindly prepared by C. Y. Thomas, Chief Engineer, The Pittsburg and Midway Coal Mining Co., at the request of the State Planning Board.

"Coal produced within the state has been and is an important economic factor in settling and industrial development of

the state of Kansas. All of the state's coal is bituminous in character and is produced in Leavenworth, Franklin, Osage, Labette, Linn and principally in Cherokee and Crawford Counties. With the exception of the well known Cherokee coal which is mined in the latter two counties, the distribution and use of the coal is almost entirely in local communities.

"The Cherokee coal deposits, so called because of being found in the Cherokee shales, are well known; this coal being shipped to portions of Oklahoma, Kansas, Missouri, Iowa, Nebraska and South Dakota.

"The Cherokee coal field is an elliptical shaped area, approximately 32 miles long and from 3 to 12 miles wide extending from the southwest to the northeast through Cherokee and Crawford Counties and into Barton County, Missouri. The formation in this area dips away from the Ozark up-lift at the rate of 22 feet per mile to the northwest. The regional dip is very uniform, characteristic of the simple geology of this portion of Kansas.

"Because of the level terrain and the uniform dip of the coal seams, this field has witnessed the development of the world's foremost and economical stripping mines. Because of stripping methods, three distinct coal seams are being mined regularly and two others occasionally, four of these seams being too thin to be mined by any other than stripping methods.

"The most important coal seam is the Weir-Pittsburg which has an average thickness of 36". The other important seams are the Lightning Creek or Mineral seam which is 22" thick and the Limestone or Pioneer seam which is 18" thick. The other seams which are of almost negligible importance are 12" or 14" in thickness.

"Records indicate that Kansas mines have produced, up to 1937, almost 227,000,000 tons of coal. In the most important Southeast Kansas or Cherokee field, the reserves or coal yet to be mined are closely estimated at 175,000,000 tons of which 100,000,000 tons is stripping reserve and 75,000,000 tons shaft coal reserve.

"Extremely low prices of fuel oil and natural gas have reduced the Kansas coal production to about half that of the 1920's or about 3,000,000 tons per year. There was, however, an increase in production in 1936 as compared to a few previous years.

"Kansas coal, while generally considered as an excellent industrial or steam coal, is widely used as domestic fuel. Its popularity and use has been extended through the installation of modern preparation facilities. Practically all mines are equipped with adequate shaking screens which are used to separate the mine run coal into as many as eight or ten different sizes. After sizing, the coal is carefully hand picked for the removal of impurities and is gently lowered into railroad cars by loading booms.

"From the consumer's standpoint the most significant development in the Kansas field has been the installation of mechanical cleaning plants. Because of the difference in specific gravity or weights of the same size pieces, coal being much

lighter than rock, shale and dirt, the coal is literally floated, the clean coal being skimmed off the top while the heavy refuse is drawn off at the bottom of the cleaning unit. Mechanically cleaned Kansas coal has been on the market since 1931 and has been established as a premium coal.

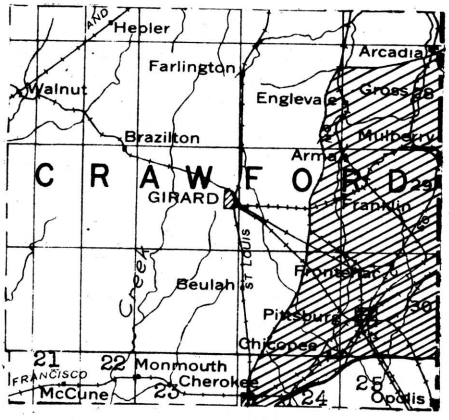
"Southeast Kansas coal has a higher heating value per pound than any of the high volatile bituminous coals of Missouri, Illinois, Iowa, Oklahoma or Colorado, either in the raw or mechanically cleaned states, and is the basis of comparison in the Missouri Valley for other similar coals.

"More money has been expended for the installation of new equipment and the modernization of old equipment in the seven years since 1929 than in the previous 15 years. It is known that almost $1,500,000.00 in new equipment has been ordered and will be placed in operation in the Southeast Kansas field before the fall months of 1937.

"Labor conditions in the coal field have been most favorable for a number of years.

"Adequate reserves of good coal, favorable labor conditions and many modern coal mines and preparation plants assure Kansas and the Missouri Valley of a plentiful supply of good coal for many years to come.

"The most interesting innovation in the Southeast Kansas field has been the construction and by now almost a year's operation of a plant to concentrate iron sulphide out of the coal mine refuse. Coal "brasses", which are removed by either hand picking or mechanically cleaning methods, are treated to make a very high grade concentrate of iron sulphide, generally known as pyrite. The concentrated pyrite is being shipped to St. Louis where in a roasting process, sulphuric acid is made. After the sulphur has been roasted out of the pyrite, the resultant iron oxide is sold for use as paint pigment, blast furnace charge or as a medium to make heavy density solutions. The complete plant is the only one of its kind in the world."



CRAWFORD COUNTY COAL FIELD
(Both Shaft and Strip Mines)

Clay Products. The Cherokee shale which lies at the surface in southeastern Crawford County contains, beside valuable beds of coal, beds of clay which have been exploited in the Pittsburg area for many years. As many as five plants have been in operation in Pittsburg at one time producing brick, stoneware, pottery, and other ceramic products.

Limestone. The Cherokee shale outcrop is succeeded to the northwestward in Crawford County by outcrops of younger limestones, including the commercially important Fort Scott, Pawnee, Altamont, and Bethany Falls formations. Limestone was quarried in the northern part of this county during 1935 for use in road metal and concrete.

Water. The deep bed-rock formations that produce municipal and industrial water supplies in Missouri extend across the line into Crawford County, and are the sources of potable water at Pittsburg, Frontenac, and Girard. Unfortunately, farther to the west and north these water-bearing formations lie at greater depths and are too highly mineralized for use.

Oil and Gas. Several small oil and gas fields occur near the western boundary of Crawford County. One field, the Walnut-Hepler, lies partly in southwestern Bourbon County and partly in northwestern Crawford County. Smaller fields have been developed in the vicinity of Walnut, a few miles to the south. The oil and gas occur in a sand which lies at a depth of about 600 feet. Southwestern Crawford County contains the McCune field, a relatively new discovery. Here oil lies at even more shallow depths, some producing wells having encountered the pay horizon at about 300 feet.

DECATUR COUNTY

Water. The greatest natural resource of Decatur County so far discovered is underground water. Almost the entire county is floored with the Ogallala formation of Tertiary age, and sheet water is available within this formation at relatively shallow depths over a large part of the county. A beginning has been made in using this water for irrigation.

Undeveloped Mineral Resources. Volcanic ash has been reported from two localities in this county. In at least one of these deposits the ash is of Tertiary age, and lies beneath mortar beds. Consequently it cannot be mined as cheaply as the ash which lies at the surface to the east in Norton County.

An oil test is now being drilled in Decatur County in sec. 34, T. 2 S., R. 28 W. A dry hole was completed in sec. 26, T. 3 S., R. 26 W. in March, 1937. This well encountered the top of the "Siliceous lime" at a depth of 4,080 feet, hit pre-Cambrian quartzite at 4,128 feet and was abandoned at a total depth of 4,149 feet. Three or four other wildcat tests have been drilled in the county. However, this part of the state has not been sufficiently tested to reach any conclusion as to the presence of oil in the deeper formations.

Commercially exploitable deposits of sand and gravel are common in central and southern Decatur County. These originate through the reworking of Tertiary sediments by recent streams. Tertiary "mortar beds" are also available in this county.

A stone quarry site has been found just north of Oberlin.

DICKINSON COUNTY

Water. Smoky Hill River crosses Dickinson County from west to east, and the municipalities along its valley obtain water from shallow wells into the valley fill. The city of Herington, near the southeastern corner of the county, uses impounded surface water for municipal supply. In the upland areas most of the water is obtained from either surface run off or from gravel beds in the tributary stream valleys. Bed-rock water in the western part of the county is so contaminated with gypsum that it is excessively hard.

Undeveloped Mineral Resources. Dickinson County is crossed from southwest to northeast by a narrow and elongate anticline, known to petroleum geologists as the "Abilene arch". The Ritz-Canton field to the southwest in McPherson County lies on the axis of this anticline. The Lost Springs field of northeastern Marion County almost reaches the county line in the southeastern corner of Dickinson County. Attempts to extend this field into Dickinson County and to find production along the "Abilene arch" have so far been unsuccessful, although several wells reported fairly good shows of oil. One well, completed in January, 1932, in sec. 13, T. 13 S., R. 2 E., about 2 miles east of the town of Abilene, is reported to have been drilled in "Siliceous lime" from 3,060 feet to 4900 feet, total depth, an unusual thickness for this formation in Kansas. A dry hole was completed during March, 1936, in sec. 15, T. 15 S., R. 1 E. This well reached a total depth of 3549 feet.

Gypsum occurs in southern and western Dickinson County in two beds, the upper one about 5 feet thick and the lower one reported to be 14 feet thick. This gypsum was exploited at one time at Hope and Solomon, but no production has been reported from this district for many years.

Two sand and gravel deposits have been found in southeastern Dickinson County near Herington.

DONIPHAN COUNTY

Stone. Doniphan County lies in the very northeastern corner of the state. It is bordered on the east by the Missouri River. Bed-rock formations are well exposed along the eastern edge of the county in the ravines carved by tributaries of the Missouri. The uplands to the west, however, are veneered with glacial deposits. A large tonnage of limestone was quarried during 1935 in eastern Doniphan County, mainly for use as riprap along the Missouri River. A relatively small amount was used for road metal and concrete. A few thousand tons of sandstone were likewise quarried in this county during 1935 for highway use.

Water. The valleys of Doniphan County are floored with alluvium consisting in the main of reworked glacial materials which are sufficiently coarse in many places to contain an adequate supply of water for local use. Some farm supplies are obtained from pervious layers in the glacial drift.

Undeveloped Mineral Resources. Six tests for oil and gas have been drilled in Doniphan County. Four of these did not penetrate below the Cherokee shale, one went through the "Mississippi lime", and one, in sec. 21, T. 1 S., R. 19 E., went into Siluro-Devonian formations at a depth of 2,281 to 2,315 feet, total depth. Doniphan County lies on the east flank of a large syncline known as the Forest City Basin. This part of Kansas has not yet been adequately tested for oil and gas.

Volcanic ash has been reported from Eagle Springs near Sparks, in the northern part of the county. No information is available as to the size of this deposit.

Sand and gravel deposits occur in the southwestern part of the county, and along the eastern edge in the bed of the Missouri river.

DOUGLAS COUNTY

Oil and Gas. Both oil and gas have been found in southeastern Douglas County in the vicinity of Baldwin. The most important of these occurrences is the Baldwin pool, which lies in T. 15 S., R. 20 E. The discovery well of this pool was completed in 1919. The oil is relatively heavy and occurs at a depth of about 800 feet. Due to the development of this field, Douglas County had a maximum oil production of 23,901 barrels in 1927. The yield fell off to less than 7,000 barrels the next year, and since 1932 Douglas County has not been included in tabulations of the oil-producing counties of Kansas.

A half dozen successful gas wells have been drilled near Eudora, in eastern Douglas County. Both the oil and gas produced in Douglas County come from sands occurring in either the Marmaton group or the Cherokee shale of Lower Pennsylvanian age. Only one deep test has been drilled in the county, in sec. 28, T. 12 S., R. 19 E. This well drilled 227 feet into the "Siliceous lime" between 2,155 and 2,382 feet, total depth.

Coal. Thin beds of coal occur in the Tonganoxie member of the Stranger formation. This coal has been intermittently mined in the Blue Mound area for many years. One small mine was in operation during part of 1935.

Limestone. Central and western Douglas County is crossed from north to south by the Oread and Lecompton limestones. Limestone was quarried during 1935 for use in road metal and concrete. Quarries and quarry sites occur at Lecompton, west of Lawrence, and in the hills south of Wakarusa Creek in the southwestern part of the county.

Sand and Gravel. Two dredges obtain sand and some gravel from the bed of Kansas river at Lawrence. This sand is marketed mainly for structural purposes, but some is sold as molding sand, glass sand, and engine sand.

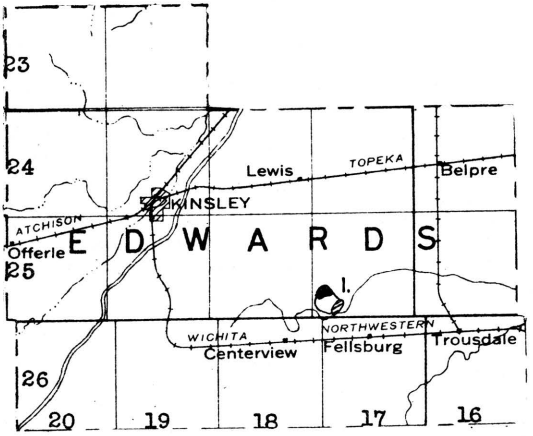
Water. There are three principal sources of water in Douglas County, surface, valley fill, and bed rock sandstones. The Kansas River supplies water to the city of Lawrence. The flood plain of Kansas River lies along the north side of the county. It contains widespread beds of permeable sediments, so it is very exceptional when a well drilled on the valley floor fails

to encounter sheet water. Somewhat the same conditions prevail in the flood plain of Wakarusa Creek, which crosses the central part of the county from west to east. Douglas County is underlain by the Ireland and Stranger sandstones, which have been penetrated by some very good wells in the eastern part of the county, including those supplying the city of Baldwin. However, in central and western Douglas County the water in these sandstones is too highly mineralized to use.

Undeveloped Mineral Resources. At one time a brick plant operated in Lawrence, making red brick from the Lawrence shale.

EDWARDS COUNTY

Oil and Gas. At the present time Edwards County contains one oil and gas pool, the McCarty, 12 miles south of Kinsley in T. 25 S., R. 17 W. This field was discovered in 1929, and produced 27,854 barrels in 1935 and 3,403 barrels in 1936 (intermittent production). The producing formation is the Mississippian "chat" at a depth of 4,575 feet. An 18,000,000 cubic foot gas well, 1¼ miles northeast of the discovery oil well, may occupy a separate structure. The oil field is dormant at the present time due to lack of pipe-line outlet. However, both eastern and western Edwards County were scenes of active leasing during 1936. A well is now drilling in section 18, T. 24 S., R. 19 W. Dry holes were completed in January, 1934, in section 1, T. 24 S., R. 16 W., at a depth of 4500 feet, and in February, 1937, in section 14, T. 26 S., R. 18 W., with a total depth of 4984 feet. A well completed in November, 1932, in section 30, T. 24 S., R. 18 W. at a total depth of 5319 feet encountered the "Oswald lime" at 3995 feet, the Mississippian at 4595 feet, and the "Siliceous lime" at 4968 feet. Oil shows were found at 4552, 4565, and 4573 feet.



OIL AND GAS FIELD

1. McCarty

Water. Western Edwards County is crossed by Arkansas River from the flood plain of which abundant supplies of water are available. The remainder of the county is covered by old river deposits and sand dunes in which sheet water is present at fairly shallow depths.

Sand and gravel occur near Kinsley and elsewhere along the Arkansas River.

ELK COUNTY

Oil and Gas. Elk County has been a producer of oil and gas since 1902, but the greatest development took place shortly after 1924. The county reached a production peak in 1927 with nearly 900,000 barrels of oil. During 1935 the production was 580,556 barrels. The greatest concentration of oil and gas fields is in the southern and western half of the county. Southeastern Elk County contains the Longton field, which extends southward into northeastern Chautauqua County. This field overlies an elongate north-south anticline. It was discovered in 1915, but was not actively developed until some years later when a 10,000,000-foot gas well was drilled. The gas comes from within the "Mississippi lime" at depths ranging from 1,540 to 1,690 feet. Other important oil and gas fields in Elk County include the Webb, Moline, Ferguson, and Bush-Denton. As a general rule the fields in the eastern part of the county produce from the "Mississippi lime", while those in the western part of the county obtain production from a half dozen sandstones in the Kansas City and Marmaton groups and in the Cherokee shale. Accumulation is due to the presence of anticlinal structures and not to "shoe-string" sand bodies.

Two fields in Elk County have recently drilled into the "Siliceous lime" with very successful results. One is the Key Pool, which lies in secs. 25 and 26, T. 31 S., R. 10 E., and the other is the Shambough pool in the northwestern corner of the county. In February, 1937, three wells in the Key pool were producing from depths of about 2,280 feet. The three wells had an estimated potential of about 5,500 barrels a day. The Shambough pool was likewise discovered in 1936 and had four producers in February, 1937. The "Siliceous lime" occurs at a depth of about 2,900 feet in this part of the county.

Limestone. Elk County is crossed from north to south by a series of thick limestone beds, including those belonging to the Deer Creek formation. One of the largest quarries in the state, east of Moline, mines rock from the upper part of the Deer Creek formation. The rock from this quarry is used for road metal and concrete, railroad ballast, and to a relatively minor extent for agricultural purposes.

Water. It has been necessary in Elk County to use surface waters for municipal and industrial supplies. Although water is abundant in some of the deeper bed-rock formations, it is too highly mineralized for use.

Undeveloped Mineral Resources. A very excellent quality rock wool was blown from samples collected in the quarry of the Solvay Process Company at Moline.

ELLIS COUNTY

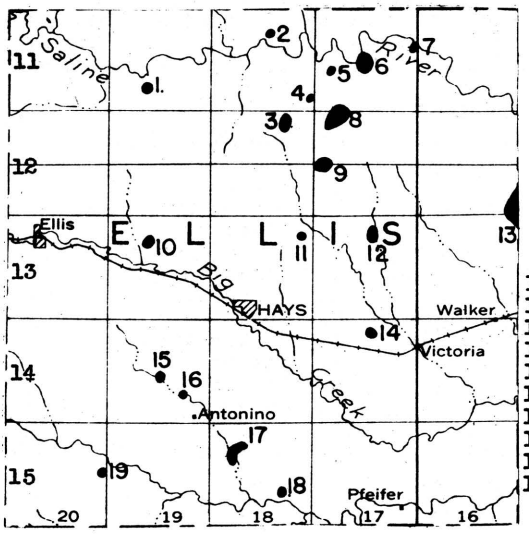
Oil and Gas. Ellis County did not have a producing oil or gas well 10 years ago. Now it has sixteen fields and is one of the "hottest" parts of the state in regard to oil and gas development. Most of these pools are very recent discoveries. The

production of oil for the county in 1935 was 166,814 barrels and in 1936 it rose to 758,152 barrels. These pools are prorated and the potential production is very much greater than the actual production.

A tabulation of Ellis County pools follows:

Name of pool	Discovery date	Producing formation	Depth
Antonio	1936	Basal Paleozoic sand	3,700 ft.
Bemis	1935	Topeka "lime"	3,030 ft.
		"Siliceous lime"	3,350-3,450 ft.
Catherine	1936	"Oswald" formation	3,272 ft.
Hadley	1929	Basal Pennsylvanian conglomerate	3,435 ft.
		"Siliceous lime"	3,630 ft.
Haller	1936	Topeka "lime"	3,040 ft.
Kraus	1936	Basal Paleozoic sand	3,735 ft.
Madden	1936	"Siliceous lime"	3,590 ft.
Marshall	1936	"Siliceous lime"	3,650 ft.
Penny Wann	1936	"Siliceous lime"	3,636 ft.
Ruder	1935	Kansas City "lime"	3,425 ft.
		"Siliceous lime"	3,575 ft.
Shutts	1928	Kansas City "lime"	3,225 ft.
		"Siliceous lime"	3,575 ft.
Solomon	1936	"Siliceous lime"	3,630 ft.
Ubert	1936	"Siliceous lime"	3,615 ft.
Victoria	1935	Kansas City "lime"	3,300 ft.
		"Siliceous lime"	3,550 ft.
Walters	1936	Topeka "lime"	3,100 ft.
		"Siliceous lime"	3,615 ft.
Yocemento	1929	Kansas City "lime"	3,590 ft.
		"Siliceous lime"	3,600 ft.

The location of these fields is shown on the accompanying map. Ellis County was very extensively leased by the close of 1936.



OIL AND GAS FIELDS

1. Solomon
2. Haller
3. Walters
4. "Marshall"
5. Hadley
6. Bemis
7. "Cress"
8. Shutts
9. Shutts
10. Yocemento
11. Ubert
12. Catherine
13. Fairport
14. Victoria
15. Kraus
16. Antonino
17. Ruder
18. Madden
19. "Penny Wann"

Water. Ellis County is floored mainly with chalk, shale, and thin limestone beds of Cretaceous age. These are not water bearing as a general rule. Some water is obtained in the upland areas in the western part of the county from the Codell sandstone immediately beneath the Niobrara chalk. Municipal supplies in this county are obtained from shallow wells in the flood plains of Smoky Hill River and its tributaries. The Dakota is relatively deep and yields highly mineralized water in many parts of the county.

Undeveloped Mineral Resources. The massive chalk beds that lie in the lower part of the Niobrara formation are exposed in the valley of Smoky Hill River west of Hays. At one time a cement plant was in operation at Yocemento, but it has been abandoned and dismantled for many years. The commercial possibilities of this chalk is to be a subject of investigation by the State Geological Survey of Kansas during the coming year.

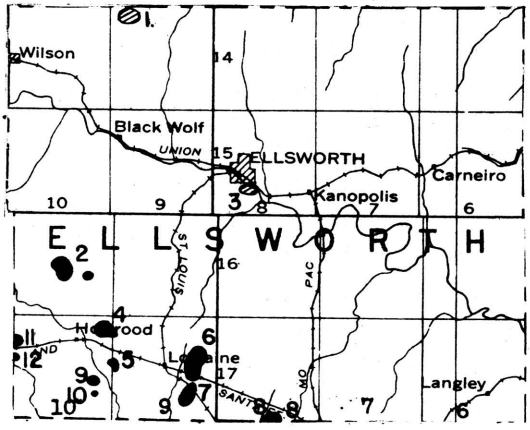
A very fine white rock wool was blown from samples collected in the Yocemento quarry.

Sand and gravel deposits occur in northern and western Ellis County along Saline River, Big Creek, and Smoky Hill River.

ELLSWORTH COUNTY

Oil and Gas. The discovery oil well of Ellsworth County was completed in October, 1930. Now there are eight oil fields in the county. These are all in the southern and southwestern part, and their names and locations are given on the accompanying map. Each of these fields produces from the "Siliceous lime" at depths ranging from 3,200 to 3,300 feet. In addition the Breford and Lorraine pools produce from the Kansas City formation. The production for the county during 1936 was 3,014,106 barrels.

Ellsworth County has in addition two gas fields, the Satran and the Ellsworth. The latter was discovered in about 1904 and produced for several years before being abandoned. The Satran gas field lies in secs. 5 and 6, T. 14 S., R. 9 W. It was dis-



OIL AND GAS FIELDS

1. Satran
2. Stoltenberg
3. Ellsworth (abandoned)
4. Stratman
5. Wilkens
6. Lorraine
7. S. Lorraine
8. Edwards
9. Heiken
10. Becker
11. Breford
12. S. Breford

covered in 1931. The producing sand occurs at a depth of a little less than 1,400 feet.

Salt. Two mines at Kanopolis in Ellsworth County produced many thousands of tons of rock salt during 1935. The salt lies at a depth of about 860 feet. It is a part of the great salt body that underlies central and southwestern Kansas.

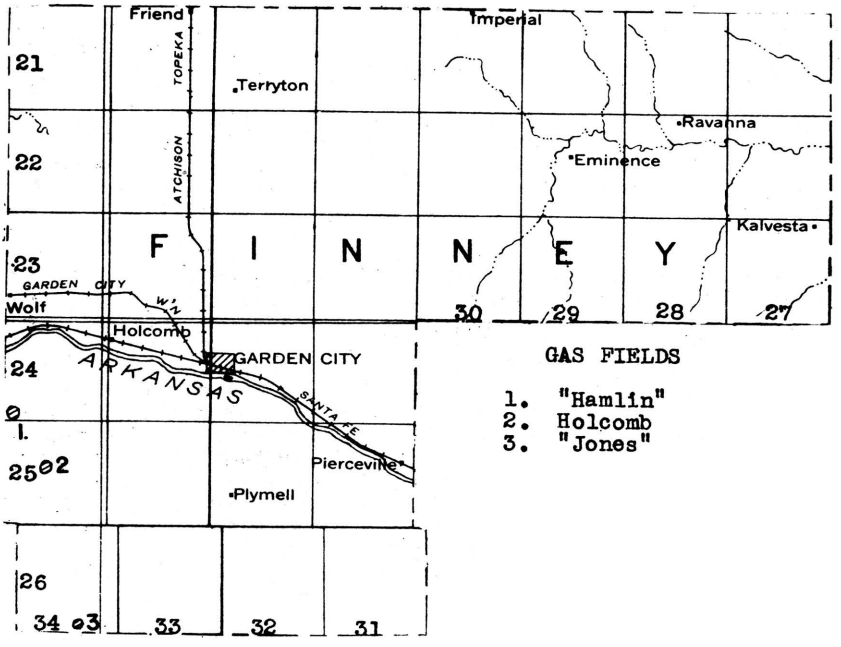
Volcanic Ash. At least two deposits of volcanic ash occur in Ellsworth County. These lie east and southeast of Kanopolis. The statistics of the U. S. Bureau of Mines for 1935 report a small shipment of ash from Wilson, near the northwestern corner of the county.

Water. All of Ellsworth County, except the uplands in the southwestern and northwestern parts, is floored with Dakota sandstone. Industrial and municipal supplies of water can be obtained in the Dakota sandstone by means of relatively shallow wells.

Undeveloped Mineral Resources. Sand and gravel deposits are abundant along Smoky Hill valley from near the northwestern corner of the county to the southeastern corner.

FINNEY COUNTY

Oil and Gas. Gas was discovered in a well drilled in sec. 16, T. 25 S., R. 34 W. at the close of 1932. This one-well field has been named the Holcomb. Subsequently gas wells have been drilled in the next townships to north and south (see map) and to the west and southwest in Kearny County. In all probability, these wells lie in the great Hugoton gas field which ex-



tends from south of the Kansas-Oklahoma line northward across parts of Stevens, Seward, Haskell, and Grant Counties, into Kearny and Finney Counties.

The Shallow Water oil field of southern Scott County is but 3 miles north of the Finney County line. Another field, the Aldrich, in western Ness County lies about 18 miles northeast of the northeastern corner of Finney County. Finney County has not yet been adequately tested for oil possibilities.

Water. Finney County is very well supplied with water. Most of the county north of the river is floored by the Ogallala formation of Tertiary age in which sheet water occurs. This is especially true in northwestern Finney County, which lies in the southern extension of the Shallow Water Basin of Scott County. Water is obtainable in this basin at depths of 20 to 75 feet. It is pumped and used for irrigation. Southern Finney County is crossed by the flood plain of Arkansas River, and covered with dune sand south of the flood plain. An abundant supply of water is available at shallow depth in the flood plain of Arkansas River and in the sand dune area.

Undeveloped Mineral Resources. Sand and gravel deposits are abundant along Arkansas River, and along tributaries of Pawnee River in the northeastern part of the county.

FORD COUNTY

Sand and Gravel. Sand and gravel deposits are abundant in the Arkansas River both in the present stream bed and in low terraces which are remnants of an older flood plain. Sand and gravel deposits also occur within the Ogallala formation, especially along the northern edge of T. 27 S., R. 25 W., and near the center of T. 25 S., R. 23 W. One operator in Ford County reported production during 1935 of several thousand tons of paving sand, structural sand, and lesser amounts of engine sand and sand used for miscellaneous purposes.

Water. Ground water is available over most of Ford County. Towns along the Arkansas River can obtain shallow water by wells into the valley fill. To the north and south of the flood plain the uplands are capped with the Ogallala formation of Tertiary age in which sheet water is obtainable at moderate depths as a general rule.

Undeveloped Mineral Resources. Ford County has not yet been adequately tested for oil and gas. It overlies what is known as the Dodge City Basin, and the same formations that are productive in counties to the east are buried to much greater depths in Ford County. Two deep tests have been drilled in the county. One, in sec. 22, T. 29 S., R. 21 W., was completed as a dry hole at a depth of 6206 feet in October, 1931. This well reached the "Siliceous lime" after encountering the "Oswald lime" at 4748 feet and the top of the Mississippian at 5268 feet. The other test was completed 13 months later in sec. 21, T. 25 S., R. 24 W. The "Oswald" was penetrated at 4220 feet, the Mississippian at 4890 feet, and the Ordovician at 5480 feet. The well was abandoned at 5782 feet in the "Siliceous lime". Shows of oil or gas were encountered at 1975, 3025, 4335, 4750, and 4885 feet. The recent discovery of oil in the Viola limestone at a depth of 6,400 feet in eastern Clark County has led

to considerable leasing activity in southeastern Ford County.

Extremely fine white wool has been blown from Tertiary "mortar beds" collected 7 miles northeast of Dodge City. This formation proved to be a natural wool rock.

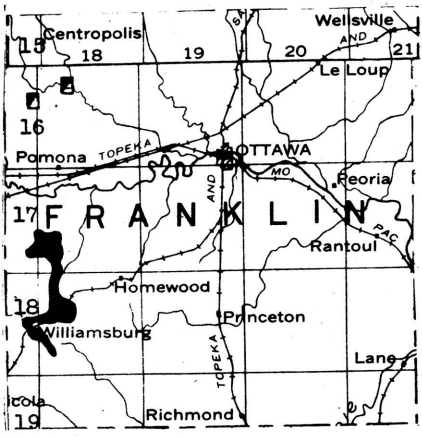
A study was made several years ago of the possibility of making sand-lime brick from the raw materials available in the Dodge City area. The ceramist consulted was of the opinion that such bricks could be successfully manufactured.

FRANKLIN COUNTY

Oil and Gas. Franklin County has been producing relatively small amounts of oil and gas for a great many years. Most of the oil fields lie in the eastern half of the county in the vicinities of Rantoul, Peoria, and Wellsville. Farther to the west, in the vicinity of Ottawa, and in the northwestern part of the county between Pomona and Centropolis are several gas fields, some of relatively recent discovery and development.

The oil production of Franklin County has declined from a peak of 194,148 barrels of 1926 to 78,053 barrels in 1935.

Coal. Coal with an average thickness of about 24 inches occurs in the Lawrence shale from 15 to 40 feet below the Oread limestone in southwestern Franklin County. It is mined in the vicinities of Williamsburg, Pomona, and Quenemo, and has been mined around Homewood and Ransomville. The depression caused an increase in mining in this district. During 1936 there were 14 shaft mines and one strip mine (which was abandoned in May) in operation in Franklin County, yielding a total production for the year of 22,010 tons.



COAL DISTRICT (SHAFT MINES)

COAL SHAFT MINE

Limestone. Franklin County is crossed from northeast to southwest by a series of thick limestones, including especially the Stanton-Plattsburg. Two operators reported production of limestone in this county during 1935 for use in road metal and concrete. Quarries are located near Ottawa, and in the southwestern part of the county.

Water. Central Franklin County is crossed from west to east by the Marais de Cygnes River. The city of Ottawa obtains its water from this stream. Except in the northeast corner of the county, bed-rock waters as a general rule are too highly mineralized for use. However, in the northeast corner the Ireland and Stranger sandstones yield the purest ground water to be found in the state. A shallow well into this formation supplies water to the city of Wellsville.

Undeveloped Mineral Resources. High terrace chert gravels in deposits thick enough to be exploitable cap the uplands in the west central part of Franklin County.

GEARY COUNTY

Limestone. Two thick limestone formations, the Florence, and Fort Riley, crop out over a large part of Geary County. The Winfield limestone occurs along the west border of the county and in the panhandle. Production of limestone for road metal and concrete was reported in 1935 by the city engineer of Junction City and by the government at the Fort Riley Military Reservation.

Water. The Republican River, with a wide flood plain, extends from the northwestern corner of Geary County to Junction City, where it joins the Smoky Hill River which flows from southwest to northeast across the western end of the county. Adequate supplies of ground water are obtained by shallow wells into the flood plains of these two streams. Ground water is less abundant in the uplands.

Undeveloped Mineral Resources. The nearest gas production is the Wilsey field in central Morris County about 12 miles south of the Geary County line. The nearest oil field is the Lost Springs field in the northeast corner of Marion County, about 20 miles from the southwest corner of Geary County. Attempts to find oil and gas in Geary County have not been successful as yet, but the county has not been very thoroughly tested.

Sand and gravel are available in the beds of Smoky Hill and Republican rivers and have been exploited in the vicinity of Junction City.

GOVE COUNTY

Water. The northern half of Gove County is covered with the Ogallala formation in which wells drilled to a moderate depth encounter an abundant supply of usable water. The southern half of the county is crossed from west to east by Smoky Hill River. Some water is available in the flood plain of this stream, but water is scarce in the Niobrara chalk that outcrops between the flood plain and the Tertiary-capped uplands to the north and south.

Undeveloped Mineral Resources. Two deep tests were drilled for oil and gas in Gove County during 1931. One, in sec. 11, T. 12 S., R. 27 W., was abandoned at a depth of 4856 feet without encountering any oil or gas shows. This well went into the Ordovidian at 4550 feet and the "Siliceous lime" at 4705 feet.

The other well was drilled in sec. 24, T. 13 S., R. 27 W., to a total depth of 4813 feet. The top of the Ordovician was encountered at 4530 feet and the "Siliceous lime" at 4671 feet. A show of oil was obtained in the "Oswald lime" at 4065 feet. Oil occurs in commercial quantities in Trego County to the east and in Scott County to the southwest. Southwestern Gove County and the northeastern corner of the county were scenes of active leasing in 1936.

A deposit of unusually fine volcanic ash, containing an estimated 60 thousand tons, occurs about 10 miles southwest of Quinter on the east side of a southward-flowing tributary of Hackberry Creek. The State Geological Survey office contains no record of this deposit ever having been exploited.

Sand and gravel are abundant in southern Gove County along Smoky Hill River. Other deposits occur in the central and northern parts of the county along southeastward flowing tributaries of the Smoky.

GRAHAM COUNTY

Water. Water supplies are obtained in Graham County from four sources: Valley fill, Ogallala formation, Codell sandstone, and Dakota sandstone. The south fork of Solomon River crosses the central part of the county from west to east. Farms and towns on the flood plain of this stream obtain water from shallow wells into the alluvium. Sheet water is available on the uplands north and south of the river in the Tertiary rocks of the Ogallala formation. Where the cover of Tertiary sediments is thin, and where the underlying Niobrara formation is exposed, deep wells are necessary. Water is obtainable in parts of central and eastern Graham County at depths in the neighborhood of 450 feet from the Codell sandstone, which lies immediately beneath the Niobrara, but this sandstone is erratic in thickness. The Dakota carries good and abundant water in this part of the state. It is reached at depths of about 650 feet. In many cases the water rises in the well to within 100 feet of the surface.

Undeveloped Mineral Resources. Oil occurs in Trego County to the south and Rooks County to the east. Active leasing was underway in 1936 in the northeastern and southwestern parts of the county. Graham County is fairly high on the Central Kansas Uplift. Six dry holes have been drilled in recent years in this county. A few data in regard to these wells follow:

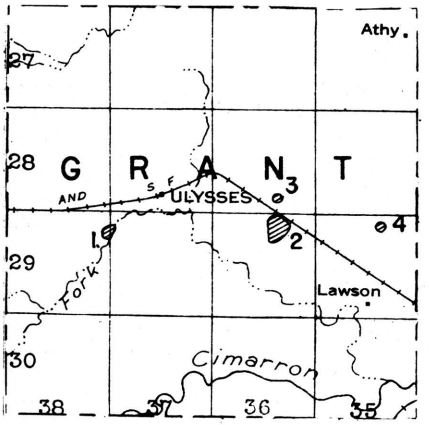
Location	Date	Total Depth
Sec. 11, T. 9 S., R. 25 W.	October, 1931	4656
Sec. 24, T. 8 S., R. 25 W.	September, 1933	4180
Sec. 8, T. 10 S., R. 22 W.	October, 1935	4220
Sec. 29, T. 8 S., R. 22 W.	July, 1936	3870
Sec. 27, T. 10 S., R. 22 W.	November, 1936	4123
Sec. 19, T. 10 S., R. 21 W.	November, 1936	3974

A deposit of unknown extent containing exceptionally fine volcanic ash occurs in the western part of Graham County about 1½ miles north of the west edge of the town of Morland. The ash outcrops in a draw where it has a width of 40 feet and a maximum thickness of 9 feet.

Sand and gravel deposits are abundant along the Solomon. A thick mortar bed that has been silicified into a quartzitic conglomerate crops out along the edges of the Tertiary exposures north and south of the river. Numerous stone quarry sites are available in this rock.

GRANT COUNTY

Oil and Gas. Several producing gas wells occur in Grant County in T. 29 S., Rs. 35, 36, 37, and 38 W., and in T. 28, S. R. 36 W. In all probability these wells are but a part of a great gas field that extends northward from the Hugoton area into southern Kearny and southwestern Finney Counties. If subsequest drilling proves this surmise to be correct, all except perhaps the northwestern corner of Grant County is underlain by gas in commercial amounts. Southeastern Grant County was being actively leased in 1936.



GAS FIELDS

1. New Ulysses
2. Hickok
3. "Webster"
4. "Gray"

Volcanic Ash. At least four deposits of volcanic ash occur in the southeast corner of Grant County in T. 30 S., R. 35 W. The nearest town and shipping point for this ash is Satanta, which lies a few miles east in Haskell County. One deposit in the NW ¼ of sec. 24 was first exploited a number of years ago, when it was connected with the Santa Fe Railroad by a narrow-gage spur running north from what is known as Spar Siding. This ash is of very fine quality. Grant County was an important producer of volcanic ash during 1935.

Water. The entire surface of Grant County is covered with formations of Tertiary age, in the more pervious parts of which ground water occurs. In many parts of the county this water lies at shallow depths.

Undeveloped Mineral Resources. Sand and gravel occur in potentially commercial deposits in Grant County, especially in the southern part along Cimarron River.

GRAY COUNTY

Stone. With the exception of the alluvium of Arkansas River, which crosses northern Gray County from west to east, and a belt of sand dunes south of the river, practically all of Gray County is covered with rocks of Tertiary age. A small amount of stone was quarried from the Tertiary in Gray County during 1935 and used as rubble.

Water. Water is available in the flood plain of Arkansas River at shallow depths. Communities in southern Gray County obtain water from deeper wells drilled into the Tertiary rocks.

Undeveloped Mineral Resources. No deep tests for oil or gas have been drilled as yet in Gray County. It lies midway between the Morrison oil and gas field of Clark County and the Shallow Water oil field of Scott County. Gray County is in what is known as the Dodge City basin, and consequently the Ordovician formations are deeply buried. The eastern edge of the southwestern Kansas gas field has not yet been outlined by dry holes. At the present time the nearest gas well is in southwestern Haskell County, about 18 miles from the southwestern corner of Gray County.

A series of sand and gravel deposits occurs along Arkansas River in north central Gray County. Additional deposits are found to the north where local streams have reworked the Tertiary sediments.

GREELEY COUNTY

Water. The entire surface of Greeley County is veneered with the Ogallala formation of Tertiary age, although Upper Cretaceous formations occur in Colorado adjacent to the western boundary. Water is obtained in the alluvium of White Woman Creek, which crosses central Greeley from west to east, at shallow depth, and in the Ogallala at depths as much as 200 feet. In a few places in the county the Tertiary is too thin to be water bearing. Two wells have been drilled to the Dakota, which lies at a depth of about 1100 feet, and have encountered good water.

Undeveloped Mineral Resources. Greeley County has not yet been tested for oil and gas. The nearest production is the Shallow Water field in Scott County, two counties to the eastward.

Sand and gravel deposits occur in the vicinity of Tribune in central Greeley County, where local streams have reworked the Tertiary sediments.

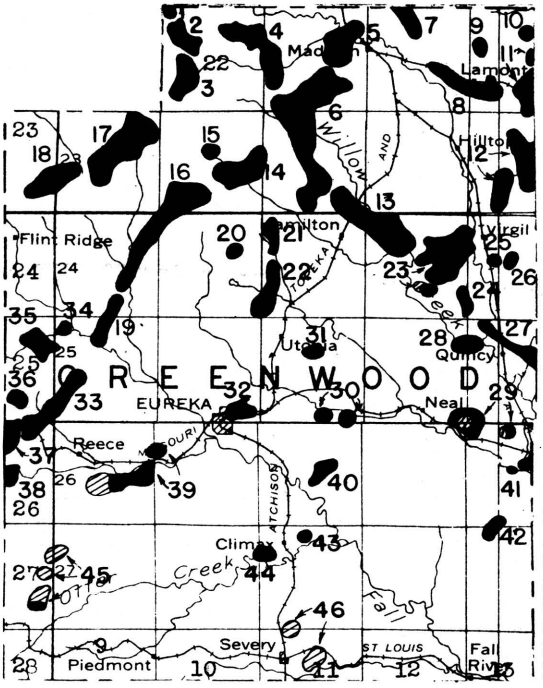
GREENWOOD COUNTY

Oil and Gas. Greenwood is the outstanding county in Kansas for "shoestring" sand production. The northern half of the county is crisscrossed by these exceptionally elongate oil pools. Production is obtained from the Bartlesville horizon in the lower part of the Cherokee shale formation at depths of 2,000 to 2,500 feet. The "Mississippi lime" is also productive in Greenwood County, especially in the northeastern and south-

central parts. A few pools produce from Lower Pennsylvanian horizons other than the Bartlesville.

The first important oil well in Greenwood County, drilled in 1921, led to the discovery of the Sallyards pool, which was eventually found to be an important link in the "Golden Lane" that extends from eastern Butler County northeastward across northern Greenwood County. New discoveries followed rapidly and by 1926 Greenwood was the leading oil-producing county of the state, with a production slightly in excess of 17,000,000 barrels. During 1936 the production for this county (along with that of Woodson County) totaled 4,001,076 barrels. The largest field was the Virgil-North Virgil.

An extensive repressuring project is being carried on in the Madison field.



OIL AND GAS FIELDS

1. Atyeo
2. Pixlee
3. Browning
4. De Malorie-Sowder
5. Madison
6. Seeley-Wick
7. Fankhauser
8. Lamont
9. Ott
10. Hubbard
11. Dunaway
12. North Virgil
13. Hamilton
14. Burkett
15. Hollis
16. Thrall-Agard
17. Teeter
18. Scott
19. Polhamus
20. Parks
21. Gaffney
22. Wiggins
23. Virgil
24. Christy
25. Hinchman
26. Blackwell
27. Quincy
28. Gilroy
29. Neal
30. Tonavay
31. Utopia
32. Eureka
33. Sallyards
34. Wilkerson
35. Teichgraber
36. Jackson
37. Blankenship
38. Stanhope
39. Reece
40. Gibson
41. Toronto
42. Brinegar
43. Climax
44. Willard
45. Beaumont
46. Severy

Natural Gasoline. Four plants produce gasoline from natural gas from the Madison, Seeley, Teeter, and Thrall fields at Madison, Hamilton, (two plants) and Kembro. The Kembro plant and one Madison plant use the compression process. The other plants produce natural gasoline by absorption,

Limestone. The Flint Hills cross Greenwood County from north to south. A succession of massive limestone beds outcrop across the county for its entire length and are well exposed in many places. Limestone was quarried and crushed for use as road metal and in concrete aggregate in Greenwood County during 1935.

Water. Greenwood County is drained by the Verdigris River and its tributaries. Municipal and industrial supplies of water are obtained mainly from the surface waters or from shallow wells into the relatively narrow flood plains which occur in this part of the state. Ground water also occurs in fractures in some of the limestone formations, but this water is mineral ized where tapped at any great distance from the outcrop.

HAMILTON COUNTY

Sand and Gravel. Central Hamilton County is crossed from west to east by the Arkansas River. Sand and gravel deposits are common along this stream, and a small amount of gravel was produced for structural purposes during 1935.

Water. Abundant water is available across central Hamilton County by means of shallow wells into the Arkansas River flood plain. The Tertiary rocks north of the river furnish local supplies of water. Some wells obtain water from the Codell sandstone. Artesian water was struck at Coolidge on Arkansas River near the Colorado line by a well drilled to the Dakota sandstone. South of the river the Dakota lies at moderate depths and is the main aquifer in that area. It yields abundant water of excellent quality.

Undeveloped Mineral Resources. An oil test was drilled to a depth of 5,488 feet in sec. 5, T. 26 S., R. 41 W. in 1923. This well was the deepest well in the state at the time of its completion. No oil or gas were found. At the present time a well is drilling about 2 miles away in sec. 30, T. 25 S., R. 41 W. The structure on which this well is being drilled has been mapped and checked by core drill and seismograph. It is planned to carry the well into Ordovician sediments which were not tested by the older well. The southeastern part of Hamilton County was being actively leased in 1936.

Several exposures of volcanic ash have been found in Hamilton County. The largest one of these is in sec. 13, T. 26 S., R. 41 W. It is doubtful if the ash deposits in Hamilton County have commercial possibilities at the present time due to the compact nature of the ash, the small size of the deposits, and their relative inaccessibility.

Building stone has been quarried in Hamilton County in the past to supply local needs. Dakota sandstone has been quarried in the southwestern part of the county, Greenhorn limestone north of the towns of Kendall, Syracuse, and Coolidge, and Fort Hays limestone along Bridge Creek northeast of Coolidge.

HARPER COUNTY

Water. The bed-rock formations of Harper County consist mainly of red sandstones and shales with a few thin gypsum beds. What water does occur in the bed-rock is highly mineralized.

Fortunately, the Permian formations are veneered in many places in the county by younger rocks in which potable water occurs. The northwestern part of the county is covered by Tertiary rocks which carry water in the more permeable layers. To the south and east, much of the county is mantled with Quaternary terrace deposits, remnants of older flood plains. Gravel-filled channels occur in these terrace deposits, in which water, sufficient for local needs, is available at relatively shallow depths.

Undeveloped Mineral Resources. Much of Harper County is leased for oil and gas. Leasing was especially active in the northwestern and southeastern parts of the county during 1936. Harper is surrounded by producing counties, but attempts to obtain oil or gas have so far been unsuccessful. Three deep tests have been drilled during the last 3 years, and shows of oil have been reported. The location and depths of these wells follow:

Location	Date	Depth
Sec. 17, T. 31 S., R. 9 W.	September, 1934	4816
Sec. 17, T. 33 S., R. 6 W.	September, 1935	5078
Sec. 17, T. 35 S., R. 8 W.	August, 1936	6004

A fourth test in sec. 4, T. 34 S., R. 8 W., is now drilling below 5202 feet.

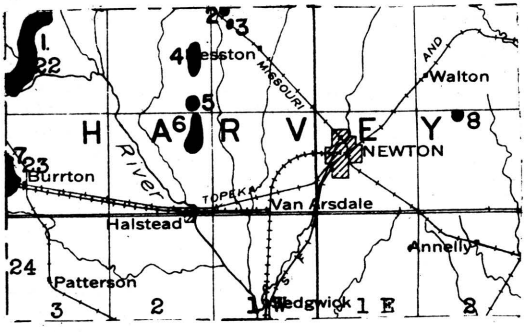
For many years a plant at Anthony obtained salt from brine wells. The company recently went out of business.

Two deposits of volcanic ash occur about 2 miles east of Anthony. One of these deposits was worked in 1927 and the greater part of the ash removed.

Sand and gravel deposits are common along Bluff Creek and its tributaries. Some of these are terrace deposits.

HARVEY COUNTY

Oil and Gas. The first commercial oil pool of Harvey County, the Walton, was discovered in December, 1923. This pool lies near the eastern boundary of the county and produces from formations in the Kansas City-Lansing groups. The next major discovery in the county was 8 years later, when the discovery well of the Hollow-Nikkel field was completed. This field lies in the northwestern corner of the county and extends northward



OIL AND GAS FIELDS

1. Hollow - Nikkel
2. Showalter
3. Hesston
4. Sperling
5. Halstead
6. Halstead
7. Burrton
8. Walton

into southern McPherson County. Some very large oil and gas wells have been completed during the drilling of this field. Production is now being obtained from four horizons, the Kansas City-Lansing, the "Mississippi lime", the Hunton formation, and the "Wilcox" sand. The most prolific source of oil and gas is the Hunton, which is reached at depths in the neighborhood of 3,500 feet. Other Hunton lime and "Mississippi lime" pools occur in the central and northern parts of the county.

Production in Harvey County rose from 5,400 barrels in 1931 to a peak of 3,425,895 barrels in 1934. The production for 1936 was 1,592,304 barrels. Most of this came from the Hollow-Nikkel pool.

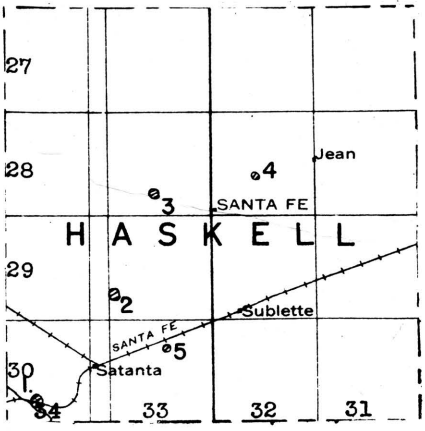
Water. All of Harvey County except the eastern end is floored with river alluvium deposited either by the Arkansas River or by an ancient stream that one time entered the Arkansas River from the north. Large quantities of water are stored in both the older ("Equus beds") and modern river deposits. The city of Newton lies just east of the Equus-bed area, but obtains its water from wells a few miles westward drilled into this very important water-bearing formation. The eastern end of Harvey County is underlain by bed-rock formations of Permian age which carry mineralized water.

HASKELL COUNTY

Oil and Gas. Haskell County contains five isolated gas wells as follows:

Location	Depth	Production
Sec. 28, T. 28 S., R. 33 W.	2,771 ft.	3,000,000 cu. ft.
Sec. 21, T. 28 S., R. 32 W.	2,745 ft.	2,000,000 cu. ft.
Sec. 30, T. 29 S., R. 33 W.	2,747 ft.	2,400,000 cu. ft.
Sec. 29, T. 30 S., R. 34 W.	2,640 ft.	13,600,000 cu. ft.
Sec. 10, T. 30 S., R. 33 W.	2,650 ft.	500,000 cu. ft.

In all probability, all of these gas wells belong in one great gas field that extends northeastward from the Hugoton area. Producing gas wells occur to the northward in southwestern and western Finney County. The eastern limit of the gas



GAS FIELDS

1. Satanta
2. Elliot
3. "Larson"
4. "Nilson"
5. "Meredith"

field is not known. During 1936 leasing was active in western Haskell County.

Water. Haskell County is floored with Tertiary rocks, in the more porous parts of which usable ground water occurs. Shallow wells and wells of moderate depth produce a sufficient quantity of water for local and municipal use.

Undeveloped Mineral Resources. One deposit of volcanic ash of unknown extent has been reported from the southwestern corner of Haskell County.

Sand and gravel deposits occur in southwestern Haskell County along Cimarron River, and near the northwestern corner of the county.

HODGEMAN COUNTY

Water. The uplands of Hodgeman County are covered with the Ogallala formation of Tertiary age. The valleys of Sawlog and Buckner creeks and Pawnee River cut through the Tertiary rocks and expose the underlying Cretaceous formations. Ground water is available in Hodgeman County from the stream alluvium, the Ogallala formation, and the much deeper Dakota sandstone. The municipal water supply of Jetmore comes from drilled wells about 50 feet deep into the stream alluvium of Buckner Creek. Individual wells from the same source supply the inhabitants of Hanston, farther down the creek. The Ogallala formation yields sheet water practically everywhere in Hodgeman County, except around the margins where drainage has taken place, at depths not exceeding 100 feet. As a general rule, the alluvium and Tertiary wells produce hard water due to the high calcium-carbonate content of the enclosing rock.

In the southern part of Hodgeman County, along the eastern edge of T. 24 S., R. 23 W., wells obtain artesian water near the top of the Dakota at a depth of about 200 feet. The Dakota water is softer than that from the younger formations in most instances.

Undeveloped Mineral Resources. Central Hodgeman County is crossed from south to north by the Bazine anticline. Three oil tests have been drilled on this anticline. The northernmost one of these wells, in sec. 19, T. 21 S., R. 22 W., obtained small shows of oil and gas, and was abandoned at a total depth of 4,391 feet in the lower part of the Pennsylvanian series. A second well was drilled in sec. 30, T. 22 S., R. 23 W. to a depth of 5,120 feet. It penetrated the Ordovician rocks, but did not encounter any shows of oil or gas. A well in sec. 22, T. 24 S., R. 23 W., in the southern part of the county, was drilled to a depth of 4,080 feet, but did not go deep enough to test the "Oswald lime". Because only one well has reached the Ordovician rocks, Hodgeman County cannot be considered to have been adequately tested for oil and gas.

The sand and gravel deposits of Hodgeman County are largely unexploited. Beds of unconsolidated sand and gravel occur along the slopes south of Pawnee River in the western half of the county. Other deposits occur in the stream alluvium along Buckner Creek.

In past years many thousands of stone fence posts have been quarried from the "fence post" limestone and lower limestone beds in the Greenhorn formation. Some of this rock has also been used in the construction of residences and buildings.

JACKSON COUNTY

Limestone. A series of thick and persistent limestones crosses Jackson County from northeast to southwest. Among these limestones are the Howard, Burlingame, Emporia, Tarkio, Americus, Neva, and Cottonwood formations. In many parts of the county the bed-rock is obscured by a thick mantle of glacial drift. Two operators reported production during 1935 of limestone in Jackson County for use as road metal and in concrete.

Water. Jackson County is drained by southward-flowing tributaries of Kansas River, in the valleys of which flood-plain deposits yield local water supplies. Water is available in many places in the uplands from glacial drift, and in some instances from bed-rock formations. However, wells drilled into bed-rock at some distance from the outcrop may strike mineralized water.

Undeveloped Mineral Resources. Three shallow tests have been drilled in Jackson County, none of which reached the "Mississippi lime", and two deep tests which reached Siluro-Devonian rocks. One of the latter was in sec. 3, T. 8 S., R. 14 E. The other was drilled in sec. 27, T. 7 S., R. 15 E. The latter well was reported to have had a show of oil at the top of the Siluro-Devonian at a depth of 2,639 feet. Jackson County lies on the flank of the Forest City basin. It has not yet been adequately tested.

A fine sand of possible glacial origin, about 2 miles north of Birmingham, on State Highway 16, has been exploited to some extent.

JEFFERSON COUNTY

Coal. The coal at the top of the Severy shale, immediately beneath the Howard limestone, that is mined in the Osage County

COAL SHAFT MINES

district is also present in western and northern Jefferson County. Two mines operated near Valley Falls during 1936, producing 630 tons of coal. One of these mines ceased operating in June.

Water. The Kansas River, with its broad flood plain, forms the southern boundary of Jefferson County. Drainage is southward into this river. Water is available at shallow depths in the flood plains of Kansas River and its major tributaries. It is also possible in parts of Jefferson County to obtain water from wells into the glacial drift that mantles the uplands in the northeastern part of Kansas. The deeper bed-rock waters are invariably mineralized, but local supplies can be secured from fractured limestones near the outcrop.

Undeveloped Mineral Resources. Five wells have been drilled for oil or gas in Jefferson County. The formations encountered are described in Bulletin 20 of the State Geological Survey of Kansas. Three of these wells were abandoned while still in the Cherokee shale, a fourth well penetrated 70 feet into the St. Peter ("Wilcox") sandstone, and the fifth well went several hundred feet into pre-Cambrian rock, encountering a very thick section of "Siliceous lime" immediately above the pre-Cambrian. Several shows of oil and gas were reported in these wells. Most of the wells were drilled without regard to the presence or absence of structures favorable to the accumulation of oil and gas, and in consequence the county has not been adequately tested as yet.

The Oread, Lecompton, Deer Creek, and higher limestones cross Jefferson County from northeast to southwest. The Oread has been quarried near the southeastern corner of the county, and numerous quarry sites are present to the north in the higher limestones.

JEWELL COUNTY

Water. Most of Jewell County is floored with shale and chalk of Upper Cretaceous age. These formations are too tight to yield water in any quantity. Unfortunately, in this part of the state the deeper Dakota formation carries water too saline for use. Some local and municipal supplies are obtained from shallow wells dug or drilled into the narrow alluvial deposits of the small streams which drain the county. In many cases considerable testing has been necessary before a gravel bed carrying sufficient water has been encountered. Other local aquifers are the gravel bed at the base of the Sanborn loess formation, and the Codell sandstone which underlies the Niobrara formation.

Undeveloped Mineral Resources. The volcanic ash reserves of Jewell County are exceptionally large. A widespread group of deposits occur in the vicinity of Burr Oak, especially 2 or 3 miles to the northwest. The aggregate tonnage here is probably in excess of 100,000 tons. A single isolated deposit has been reported in southwestern Jewell County in sec. 29, T. 5 S., R. 9 W.

Central Jewell County is crossed from southwest to northeast by the Fort Hays chalk member of the Niobrara formation. So far, no market has been developed for Kansas chalk, but the problem is being studied by the State Geological Survey.

No deep oil and gas tests have been drilled in this vicinity. Jewell County lies near the center of the Salina Basin and wells will have to go to a considerable depth to reach the formations productive of oil to the south and southwest. For this reason, the oil companies have been slow to test this part of the state.

Sand and gravel occur along Republican River in the northeastern corner of Jewell County. A deposit of limestone gravel has been mapped by State Highway engineers in the western part of the county.

JOHNSON COUNTY

Oil and Gas. Several parts of Johnson County have produced oil and gas. The Craig gas field, in which over 60 wells have been drilled, is in T. 12 S., R. 23 E. The gas occurs in two horizons, a sand in the upper part of the Marmaton group, and a sand in the Cherokee shale about 50 feet below the Fort Scott limestone. The Dallas oil and gas field, in T. 13 S., R. 25 E., extends across the state line into Missouri. Gas occurs in an upper Marmaton sand and oil in the Bartlesville sand at a depth of about 500 feet. A smaller oil field occurs a few miles westward on the east side of T. 13 S., R. 24 E. Scattered gas wells have been drilled in the southeastern part of the county. Only two deep tests have been drilled in Johnson County. One of these, in sec. 12, T. 14 S., R. 22 E., reached the pre-Cambrian granite at 2400 feet and was abandoned at 2421 feet. The other, in sec. 4, T. 14 S., R. 24 E., was drilled 220 feet into the "Siliceous lime" to a total depth of 1,785 feet. Johnson County lies high on the flanks of the Forest City basin and should have some "Siliceous lime" tests drilled on anticlinal structures.

OIL AND GAS FIELDS

1. Craig gas
2. Dallas
3. (Not named)
4. Stillwell gas

Limestone. A series of important limestones, including the Winterset, Drum, Iola, Wyandotte, Plattsburg and Stanton formations, outcrops in Johnson County. These limestones have been exploited in northern and southwestern Johnson County for many years due to the proximity of the Kansas City metropolitan area. During 1935 limestone was quarried mainly for use in road metal and concrete, and to a lesser extent as riprap.

Sand and Gravel. A large quantity of sand and gravel is dredged from the bed of Kansas River in Johnson and Wyandotte

Counties. In addition, near Holliday is a deposit of glacial gravel which has been extensively exploited. Producers of sand and gravel in Johnson County in 1935 reported the production and sale of structural sand, paving sand, engine sand, structural gravel, and paving gravel.

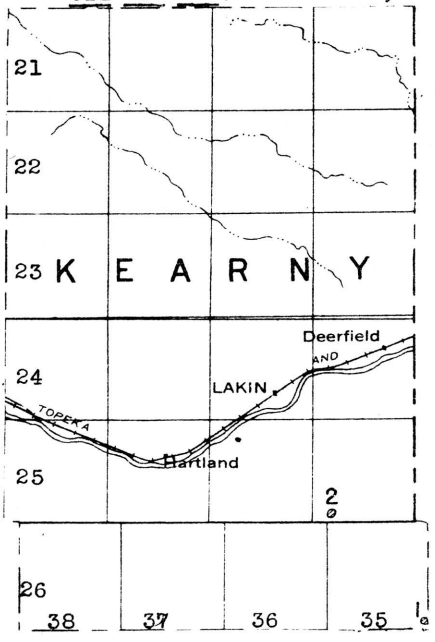
Water. A number of wells sufficient to supply local needs obtain water from bed-rock formations in Johnson County. Some of the limestones, such as the Plattsburg, are sufficiently jointed or cut by solution channels to produce water when wells penetrate these openings. Even some of the shale formations in this county contain sandy beds which carry water. However, the most abundant bed-rock aquifer in Johnson County is the Stranger sandstone which covers the uplands in the western part of the county. A number of farm and municipal wells produce from this formation.

Abundant water is available in the northern part of the county from the flood plain of Kansas River. In most places this valley fill contains coarse sand or gravel layers which are filled with water. The very narrow flood plains built by the short northward-flowing tributaries of Kansas River are much less reliable as sources of ground water. Water has been found in some of these alluvial deposits, however.

Undeveloped Mineral Resources. Rock samples collected in the limestone mine one-half mile west of Morris were blown into fine white rock wool in the experimental plant at the University of Kansas. An enormous quantity of raw material is available in Johnson County for rock wool manufacture.

KEARNY COUNTY

Oil and Gas. In March, 1937, a wildcat in sec. 36, T. 26



GAS FIELDS

1. "Jones"
2. "Campbell"

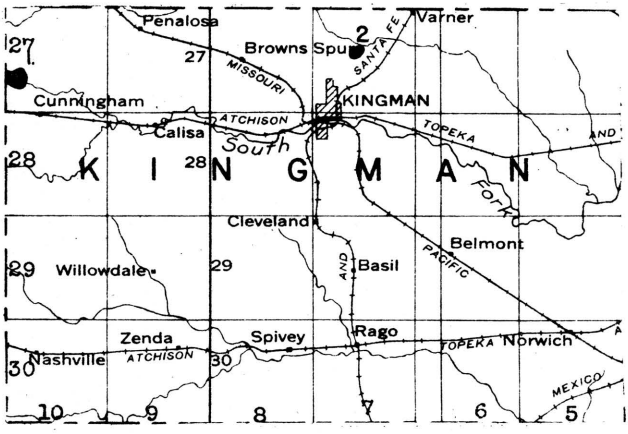
S., R. 35 W. produced 2½ million cubic feet of gas at a depth of 2815 feet. Two months later a 1½ million foot gas well was completed in sec. 32, T. 25 S., R. 35 W., at a depth of 2793 feet. These wells probably lie on the northern extension of the Hugoton gas area. Gas has been found to the northeast in western Finney County and in all probability southeastern Kearny County is underlain by gas. The northern and western limits of the field in this county are entirely unknown, as no other wells have been drilled to the gas horizon. A considerable part of northwestern Kearny County has been recently leased, following seismograph surveys in that area.

Water. The entire surface of Kearny County is covered with Tertiary rocks, sand dunes, and the flood plain of Arkansas River, which crosses the central part of the county from west to east. Sheet water is present over most of the county at moderate depths.

KINGMAN COUNTY

Oil and Gas. Kingman County has had two discoveries. The first was on January 25, 1926, when a well drilled to a depth of 3,853 feet, in sec. 16, T. 27 S., R. 7 W., was completed with an initial production of 120 barrels a day from the top of the "Mississippi lime". A few days later this well was deepened to a depth of 3,894 feet, following which oil flowed over the top of the crown block at the rate of 804 barrels a day. The output of oil rapidly diminished and the amount of water increased, and by September of the same year the well was producing only 12 barrels of oil and 100 barrels of water per day. It was plugged in September, 1927, after having produced about 27,000 barrels of oil, all of which flowed naturally. This discovery was responsible for the drilling of some thirty wildcat tests, including direct offsets, all of which were failures.

The second Kingman County discovery was in January, 1931, when an oil well was drilled in sec. 30, T. 27 S., R. 10 W. This led to the development of the Cunningham field in western Kingman County, adjacent to the Pratt County line. Both the Kansas City "lime", at a depth of 3,400 feet, and the "Siliceous lime" at 4,125 feet are productive in this field. About 34



OIL AND GAS FIELDS

1. Cunningham
2. Kingman

wells were producing in 1936, with a total production for the year of 213,381 barrels.

Natural Gasoline. Gasoline is extracted from the gas process in a plant at Cunningham.

Water. The valleys of Chikaskia Creek and the south fork of Ninnescah River have eroded below the veneer of Tertiary rock in parts of eastern Kingman County, exposing the underlying red beds. Usable water is available in this area only in valley fill and low terrace deposits. Water is available over most of the balance of the county from sand and gravel layers in the Tertiary rocks.

Undeveloped Mineral Resources. Sand and gravel occur along south fork of Ninnescah River southwest of Kingman.

KIOWA COUNTY

Water. The northern part of Kiowa County is covered with dune sand. Comanchean sandstones and shales, and Permian red beds are exposed in the valley of Medicine Lodge River in the southeastern corner of the county. The rest of Kiowa County is floored with the Ogallala formation of Tertiary age. Sheet water occurs at relatively moderate depths beneath most of the county, except in the southeastern corner. Domestic and municipal supplies are obtained from wells.

Undeveloped Mineral Resources. The discovery of oil in the Morrison field of eastern Clark County led to considerable leasing activity in western Kiowa County in 1936. However, no deep tests have as yet been drilled in this county. The next few years will no doubt see some exploratory wells drilled. Kiowa County lies between the Morrison field on the southwest and the McCarty field in Edwards County to the north. Oil and gas production is also found to the southeast in Barber County.

Sand is abundant in some parts of Kiowa County and has been produced in the past.

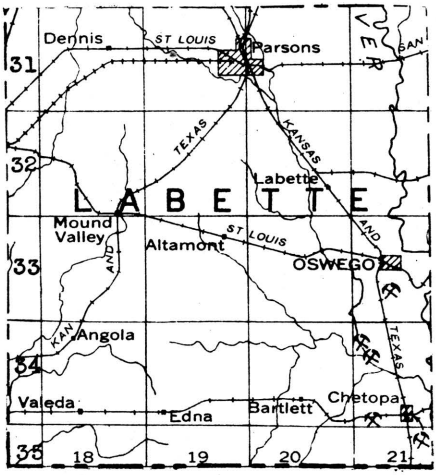
LABETTE COUNTY

Oil and Gas. Labette County has produced oil for a great many years and still has an annual production of about 5,000 barrels. Most of the fields are in the western part of the county in the vicinities of Dennis and Mound Valley, and along the Montgomery County line. Southwestern Labette County was the scene of an active and successful drilling campaign for gas in 1928 and 1929. Over 100 wells were drilled to depths ranging from 150 to 700 feet. The initial production of these wells ranged from but a few thousand cubic feet up to 3 million. Cherryvale, Parsons, and other towns in the vicinity are supplied with gas from this district.

Producing formations in Labette County include the Fort Scott limestone, sands in the Cherokee shale, (including the Bartlesville), and the top of the "Mississippi lime".

Coal. Eastern Labette County lies in the southeastern Kansas coal district. During 1936 5 strip mines between Chetopa

and Oswego produced 13,703 tons of coal in this county.



Limestone. Labette County is crossed from northeast to southwest by the Fort Scott, Pawnee, Altamont, Bethany Falls, Winterset and Drum limestones. The last named is confined in its outcrop to the very northwestern corner of the county. Three operators reported limestone production from quarries in the northern part of Labette County during 1935. This stone was used in road metal and concrete.

Water. Labette County is largely dependent upon surface water for abundant supplies. The only valley fill of any magnitude is along the eastern border of the county neighboring Neosho River. Chetopa, near the southeastern corner of the county, has a deep well into the "Mississippi lime".

Undeveloped Mineral Resources. Sand and gravel deposits occur along Neosho River in northeastern Labette County.

LANE COUNTY

Limestone. A bed of algal limestone which occurs at the top of the Tertiary rocks in parts of Lane County has been quarried to some extent for road material.

Water. Lane County is covered with the Ogallala formation of Tertiary age except along the northern edge and in the stream valleys in the eastern part of the county, where the Niobrara formation of Upper Cretaceous age is exposed. Sheet water is present at a relatively shallow depth throughout most of the Ogallala area, except around the edges where drainage has taken place.

Undeveloped Mineral Resources. One deep test has been drilled in Lane County, about 2 miles south of the Cove County line in sec. 16, T. 16 S., R. 28 W. It encountered a show of oil in Lansing "lime" between 4,050 and 4,055 feet. The well was abandoned at 5151 feet, total depth.

Sand and gravel deposits have been found in various parts of Lane County where local streams have reworked the Tertiary sediments.

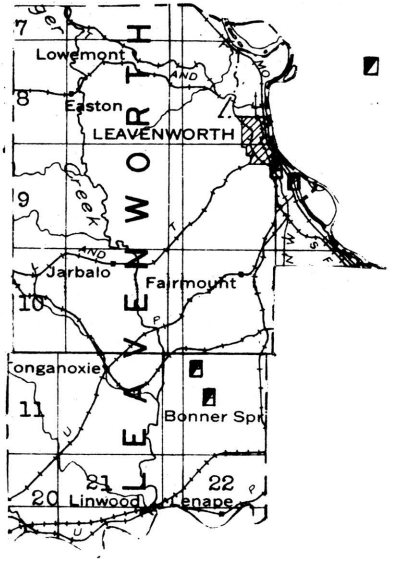
LEAVENWORTH COUNTY

Oil and Gas. Leavenworth County has one producing gas field at the present time. This field lies north and northeast of Linwood for a distance of about 4 miles. Most of the gas comes from the "Squirrel sand" in the upper part of the Cherokee shale at a depth of about 700 feet. A lesser amount of gas is obtained from the Peru sand in the upper part of the Marmaton group.

Leavenworth County at one time had another gas field, the Six Corners, in the southwestern corner of the county. This field was practically exhausted by 1927, at which time it was purchased by the Empire Oil and Refining Company for use in underground gas storage.

Two wells have been completed below the Mississippian in this county. One of these was drilled in 1887 at Leavenworth, and penetrated 246 feet of "Siliceous lime", with a total depth of 2,116 feet. The other well, drilled in 1930, was located in the Linwood district, in sec. 18, T. 12 S., R. 22 E. It went 101 feet into Ordovician limestone, and was abandoned at a total depth of 1,546 feet.

Coal. A prospect hole, drilled in the hope of picking up the coal beds which outcrop to the east in northwestern Missouri, was commenced at Leavenworth in 1860 and in 1865 encountered a bed 2 feet in thickness at a depth of 713 feet. A shaft was sunk to the seam in 1870, exploitation began, and has been carried on intermittently ever since. During 1936, 3 deep mines were in operation in Leavenworth County, with a total



COAL SHAFT MINE

yield for the year of 111,509 tons. A fourth deep mine, at Leavenworth, operated in 1935, but not in 1936. One mine is operated by the Kansas State Penitentiary at Lansing.

Limestone. The Plattsburg-Stanton limestones are well exposed in the bluffs of Missouri River on the east side of Leavenworth County. The uplands farther to the west and southwest are capped by the Oread limestone. Both of these limestone groups have been exploited in northeastern Leavenworth County, and additional quarry sites occur in the southwestern part of the county. In 1935 three operators reported limestone production. The U. S. Army Engineering Department, one of the three operators, used stone for riprap. The balance of the stone quarried was used in road metal and concrete.

Sand and Gravel. Sand and gravel were dredged from the stream bed of Missouri River by one operator during 1935. This material was used for structural purposes.

Water. Abundant supplies of water are available in eastern Leavenworth County from the Missouri River and from shallow wells into the valley fill of this stream. Water is also available in the central part of the county from the coarse layers in the fill of Big Stranger Creek. The water-filled flood plain of the Kansas River runs along the southern boundary of the county. Water is much more difficult to obtain in the upland parts of the county. Some good wells have been dug or drilled into the Stranger sandstone, which outcrops in the eastern part of the county. In a few localities deposits of glacial gravel contain sufficient ground water to supply local needs.

LINCOLN COUNTY

Sandstone. The largest sandstone producer in Kansas is the Quartzite Stone Company, with a quarry a short distance southeast of Lincoln Center. The stone is not a true quartzite, but is a sandstone which is so tightly cemented by calcium carbonate that it has the appearance of quartzite. This stone is a local phase in the Dakota formation. The sandstone produced from the Quartzite Stone quarry during 1935 was used in concrete and to a relatively minor extent as filter stone. "Fencepost" limestone quarries are numerous in the northern and southwestern parts of Lincoln County.

Water. Local and municipal supplies of water are available in the belt of Dakota outcrop by means of wells dug or drilled into the sandy layers of that formation. In the upland areas, where the younger Cretaceous formations overlie the Dakota sandstone, deep wells have found salt water in some of the sandy layers. It has been possible, however, in some instances, to case off higher salty aquifers and to penetrate lower potable water sands.

Undeveloped Mineral Resources. A deposit of volcanic ash has been reported in sec. 27, T. 13 S., R. 10 W., in the southwest corner of Lincoln County. This may be the deposit where the volcanic ash being shipped from Wilson, in northwestern Ellsworth County, is obtained.

About fifteen tests for oil and gas have been drilled in Lincoln County during the last 20 years. However, most of these

were located on pronounced domes in the outcropping Cretaceous rocks, and subsequent investigation has shown that these domes are due to initial dip over buried Permian hills, and consequently they do not continue downward into the formations that are potentially oil-bearing. Because no deep tests have been drilled on favorable subsurface structures, the county may be considered to be untested.

Limestone gravel is abundant in western and southern Lincoln County.

Investigations recently conducted by the Kansas Geological Survey have shown that satisfactory rock wool can be blown from a mixture of Dakota "quartzite" and Greenhorn limestone.

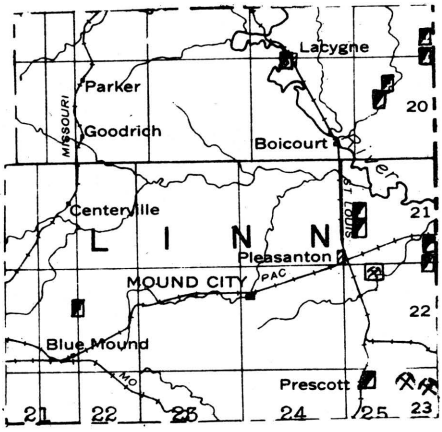
LINN COUNTY

Oil and Gas. Linn County lies in the shallow oil and gas district of eastern Kansas. It has had a relatively small production for many years. During the last 10 years production has decreased from 89,208 barrels in 1926 to 38,969 barrels in 1935. The principal oil field is the Parker-Goodrich "string" in the northwestern part of the county. This field is a continuation of the Bush City "shoestring sand" oil field of Anderson County. An old gas field, the Blue Mound, was extensively drilled during 1927 and 1928. This field lies in the northeastern part of T. 22 S., R. 22 E., and the western part of T. 22 S., R. 23 E. The gas sand lies in the lower part of the Cherokee shale at depths of 650 to 700 feet. Production varies from a quarter of a million to over 4 million cubic feet. Another gas field was opened in 1929 along the Linn-Anderson county line in T. 21 S., R. 21 E. Scattered small fields occur in the vicinities of Centerville, Mound City, Pleasanton, and LaCygne.

All of the production so far discovered in Linn County comes from sands in the lower part of the Pennsylvanian. The formations below the "Mississippi lime" have not been adequately tested. Linn County lies high on the north flank of the Chautauqua arch, and tests located on well-defined anticlines should be drilled to the "Siliceous lime".

Rock Asphalt. The only rock asphalt production in Kansas comes from Linn County. One plant located at Pleasanton reported production during 1915. According to an unpublished report by Dr. John W. Ockerman on file in the office of the Kansas Geological Survey, an asphalt-bearing sandstone, known as the Bourbon, crosses Linn County from the northeastern corner to the center of the south boundary. The higher Swope limestone, which crosses central and western Linn County from north to south, is likewise asphalt-bearing in places. Quarries are located in asphaltic sandstone a short distance northwest of Pleasanton, and in asphaltic limestone about 2 miles north, and 3½ miles southwest, of LaCygne.

Coal. Coal has been mined intermittently in Linn County for many years. During the last few years a marked increase in mining has taken place in this district, and in 1936 15 deep and 3 strip mines were in operation in the county, producing a total of 36,636 tons. The coal occurs in the Bandera shale in the Marmaton group. It is mined in the vicinities of Prescott, Pleasanton, Boicourt, LaCygne, and Blue Mound.



COAL SHAFT MINE

COAL STRIP MINE

LEAD AND ZINC SHAFT MINE

Zinc and Lead. One shaft mine located two miles southwest of Pleasanton exploits a local deposit of zinc and lead ore.

Stone. The limestones exposed in Linn County range from the Fort Scott to the Plattsburg. The very important Altamont, Bethany Falls, Winterset, Drum, and Iola formations are present in this series. The County Commissioners reported production of limestone used in road metal and concrete during 1935. One quarry is near the northeast corner of the county. Sandstone has also been quarried in this county, but no production was reported during 1935.

Sand and Gravel. The Marais de Cygnes River cuts across the northeastern part of Linn County, with a flood plain averaging from 1 to 2 miles in width. Sand and gravel are present in the flood plain and in the bed of the stream. A relatively large tonnage of paving gravel was reported by a Linn County producer in 1935.

Water. LaCygne obtains its water supply from shallow wells into the alluvium of Marais de Cygnes River. For municipal and industrial supplies elsewhere than in the northeastern part of the county, crossed by the Marais de Cygnes River, it has been necessary to use surface water. Local supplies of water can be obtained in many parts of the county from chert gravels in the narrow flood plains of the tributary streams, and from fractured limestone formations near the outcrop.

LOGAN COUNTY

Water. Only northern, northeastern, and southwestern Logan County is capped by the Tertiary Ogallala formation. The Smoky Hill River has eroded below the Tertiary capping in the rest of the county, exposing the underlying Upper Cretaceous Pierre shale and Niobrara chalk. The Tertiary-Cretaceous contact contains many springs, due to the escape of sheet water from the Ogallala formation. For that reason, the Ogallala is not water-bearing in many instances close to the edge of its outcrop. A few springs and local wells obtain water from fractures in the Pierre shale. Another source of water is the flood plain of

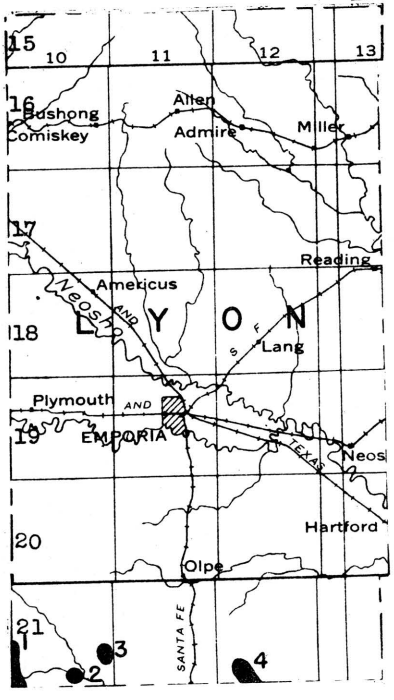
Smoky Hill River, which crosses the county from west to east. Small amounts of water are also available in the narrow alluvial deposits of the tributary streams. Deep wells drilled to the Dakota formation in the southern part of the county have encountered brackish water which was unfit even for stock use.

Undeveloped Mineral Resources. During the fall of 1935 a deep test was drilled in southeastern Logan County in sec. 13, T. 15 S., R. 33 W. This well encountered "Siliceous lime" at 5,260 feet, granite wash at 5,660 feet, and was abandoned as a dry hole in the granite at 5,756 feet. A second deep test was started in the county in October, 1936, in sec. 12, T. 15 S., R. 35 W. This well encountered difficulties and was abandoned at 3,909 feet. Subsequently the rig was skidded and a new hole started. Most of Logan County has been mapped by seismograph surveys, and leasing was very active in the southwestern part during 1936. With the exception of the southeastern corner, Logan County has not been adequately tested for oil and gas.

There are at least two deposits of volcanic ash in Logan County. One of these is about 1½ miles north of the Smoky Hill River in the southern part of T. 14 S., R. 33 W. The ash bed is from 5 to 6 feet thick and its outcrop can be traced about 250 feet. Another deposit is in the northeast corner of sec. 11, T. 13 S., R. 35 W. This ash bed is about 9 feet thick with an overburden of 10 feet. Another outcropping occurs a few yards to the south and across the valley.

Logan County abounds with sand and gravel deposits, especially the north central and southeastern parts.

LYON COUNTY



OIL FIELDS
1. Atyeo
2. Ritchey-Moore
3. Bradfield
4. Frankhauser

Oil and Gas. A low-gravity oil pool, the Bradfield, was discovered near the southeastern corner of T. 21 S., R. 10 E., in 1922. Some wells had an initial production as high as 1,000 barrels a day. The oil was produced from an Ordovician sand at depths of 2,200 to 2,500 feet. The production from this field in 1925 was 27,515 barrels. Production jumped in 1926 to 625,931 barrels, due to the extension of Bartlesville "shoestring sand" pools northward from Greenwood County into southern Lyon County. The county production reached a peak in 1927, with a yield of 715,131 barrels. A decline followed, and the yield in 1935 was but 80,718 barrels. However, the following year, production rose to 138,830 barrels.

The principal fields in Lyon County, both of them extensions from Greenwood County, are the Ateyo, in the very southwestern corner of the county, and the Fankhouser, in the southern part of T. 21 S., R. 12 E.

Limestone. A series of limestones, ranging from the Topeka to the Wreford, crosses Lyon County from northeast to southwest. Among these formations are the Howard, Burlingame, Emporia, Americus and Cottonwood limestones. The Tarkio and Emporia limestones outcrop in the vicinity of Emporia. Three producers reported quarrying limestone during 1935. Most of this stone was used in road metal and concrete, but some was also used for rough construction and rubble. One quarry is a short distance southwest of Emporia. Additional quarry sites occur in northeastern and south central Lyon County.

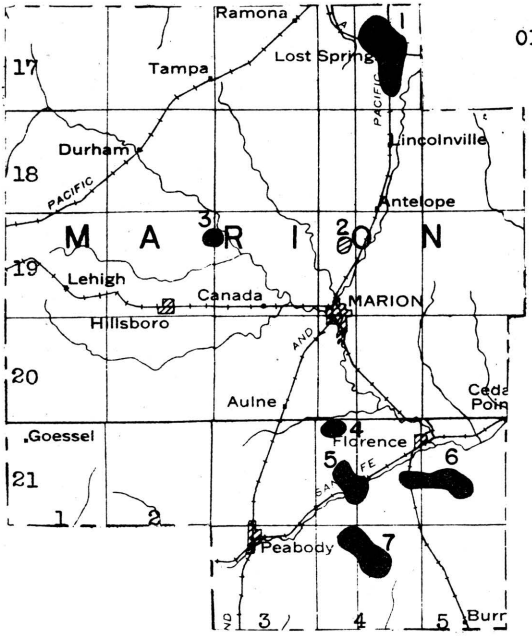
Water. The main supply of water in Lyon County comes from the flood plains of the Cottonwood and Neosho rivers, which join a few miles east of Emporia, or from the streams themselves. Local supplies of water can be obtained in some parts of the county from the chert gravels in the tributary valley fills and from fractured bed-rock limestone. However, during times of drought these sources of water supply may fail. The deeper bedrock waters are invariably mineralized.

MARION COUNTY

Oil and Gas. The discovery of oil in the Elbing pool in northwestern Butler County in 1919 led to the discovery soon afterwards of the Peabody pool in southern Marion County. During the next few years the Covert-Sellers and the Florence-Urschel pools to the north and northeast were likewise discovered and developed. The oil occurs in Ordovician rocks at an average depth of about 2,400 feet.

Three pools were subsequently discovered in central and northern Marion County. One of these, the Propp gas field, was discovered with a 4,000,000 foot gas well in April, 1926. The wells in this pool produce from the "chat" horizon in the "Mississippi lime". The Lost Springs oil pool, in the northeastern corner of the county, was discovered by a well drilled in November, 1926. This pool produces oil from the Mississippian "chat". About 9 miles to the west of the Propp gas field, the discovery oil well of the Hillsboro field was completed in October, 1928. This well first produced from the "Mississippi lime", but as subsequent wells in the field obtained better production from the Viola, the discovery well was later deepened to the Ordovician rocks.

Marion County reached a production peak about 15 years ago when the Ordovician fields in the southern part of the county were at flush production. Subsequently production has declined to 410,476 barrels (1936).



OIL AND GAS FIELDS

1. Lost Springs
2. Propp Gas
3. Hillsboro
4. Remple
5. Covert-Sellers
6. Florence
7. Peabody

Limestone. Eastern Marion County is crossed from north to south by the Florence flint, Fort Riley, Winfield, and Herington limestones. The Fort Riley has been extensively quarried in the vicinity of Florence. Higher limestones are available for quarrying southwest of Marion. The county produced a considerable tonage of crushed limestone during 1935 for use as road metal and in concrete.

Water. The city of Marion uses surface water for its supply, while Hillsboro, Peabody, and Florence obtain water from shallow wells. Cottonwood River runs across eastern Marion County. Water is present in the alluvium of this stream, and in the valley fills of some of its tributaries. However, the tributary flood plains are very narrow and the amount of water stored in them is limited. Wells drilled into the Florence flint obtain water from crevices in some parts of the county.

MARSHALL COUNTY

Gypsum. Gypsum is mined by the Certain-teed Products Corporation south of Blue Rapids in Marshall County. The greater part of the gypsum mined is calcined before being sold. This gypsum occurs near the upper part of the Big Blue series of Permian age, and is stratigraphically lower and older than the gypsum in the Red Beds of Barber County.

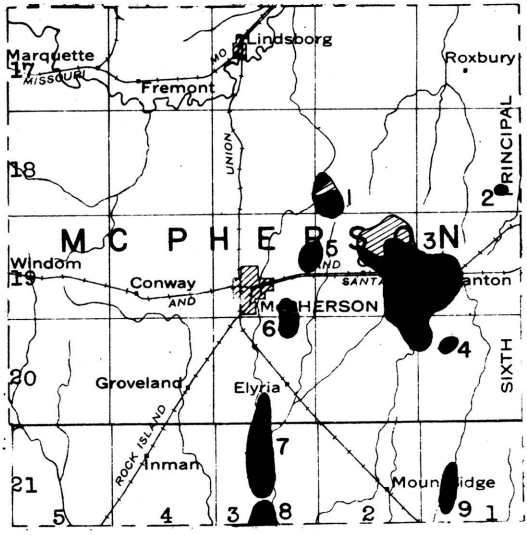
Limestone. Marshall County is crossed from north to south by a series of limestones, including the Americus, Neva, Cottonwood, Wreford, and Fort Riley. Quarry sites occur near Marysville and Blue Rapids. Two operators reported production of limestone during 1935. The stone was used for road metal and concrete.

Sand and Gravel. Marshall County is one of the most important sand and gravel districts in the state. Several large deposits occur near Blue Rapids, and other deposits are exploited near Frankfort and Marysville. The sediments were originally deposited by rivers draining the great continental ice-sheet in Pleistacene time. Some of this material has subsequently been reworked and redeposited by more recent streams. The chief product of the Marshall County deposits during 1935 was paving gravel. Structural gravel ranked second. Other but relatively insignificant products were structural sand and engine sand.

Water. For the larger supplies of water Marshall County is dependent upon surface waters, and shallow ground water occuring in the flood-plains of the Big Blue and Little Blue rivers and Vermillion Creek. Local water supplies are obtained in the upland areas by wells into the mantle rock. Some of the limestones carry usable water in fractures near the outcrop, but deep bed-rock water is invariably mineralized.

McPHERSON COUNTY

Oil and Gas. The first successful well drilled in McPherson County was a gas well, completed in September, 1926. This well was drilled in sec. 29, T. 18 S., R. 2 W., to a depth of 2,927 feet. It had an initial yield of 7½ million cubic feet of gas from just below the top of the "Mississippi lime". This discovery led to the development of the McPherson gas field, which was the largest gas field in Kansas at one time. Nearly two years later, on July 7, 1928, the first oil well in Mc-



OIL AND GAS FIELDS

1. McPherson
2. N. Canton
3. Ritz-Canton
4. Wenger (abandoned)
5. Chindberg
6. Johnson
7. Voshell
8. Hollow-Nikkel
9. Graber

Pherson County was completed in the McPherson field, in sec. 31, T. 18 S., R. 2 W. Subsequently seven more oil and gas fields were discovered in this county, in addition to the Hollow-Nikkel field which extends northward from Harvey County into southern McPherson County. The production for McPherson County during 1936 was 4,464,439 barrels. Over half of this came from the Ritz-Canton field.

Pertinent data in regard to the oil and gas fields of McPherson County are tabulated below. The location of the fields is given on the accompanying map.

Name of pool	Date of discovery	Producing formation	Average depth
Chindberg	Oct.,1929 (gas)	Mississippian "chat"	3,010'
	Dec.,1933 (oil)	Kansas City "lime"	2,360'
Graber	May, 1934	Hunton "lime"	3,330'
Johnson	Feb., 1932	Mississippian "chat"	3,000'
McPherson	Sept., 1926 (gas)	Kansas City "lime"	2,350'
	July, 1928 (oil)	Mississippian "chat"	2,950'
Ritz-Canton	Jan., 1929	Mississippian "chat"	2,950'
		Viola "lime"	3,410'
		"Wilcox sand"	3,450'
Voshell	Aug., 1929	Mississippian "chat"	3,100'
		Viola "lime"	3,330'
		Wilcox "sand"	3,360'
		"Siliceous lime"	3,400'

The Ritz-Canton field covers 17,330 acres. It was originally four fields, the Ritz, Canton, Galva, and Decker, which were connected together by the drilling of intermediate wells. A one-well "chat" pool, lying northeast of the Ritz-Canton pool and discovered in 1936, has been named the North Canton.

Natural Gasoline. Two plants located in the city of McPherson obtain gasoline from natural gas by the absorption process.

Sandstone. Sandstone cemented with calcium carbonate similar to the "quartzite" of Lincoln County occurs in northeastern McPherson County. One operator reported sandstone production for use as road metal in 1935.

Sand and Gravel. All except the eastern, northern and western edges of McPherson County is floored by an ancient river deposit known as the McPherson formation, or Equus beds. The channels of this ancient river are filled with sand and gravel. A deposit of this type was worked during 1935 by one operator in McPherson County. Structural sand, paving sand, and paving gravel were marketed.

Water. The Equus beds contain one of the best ground water supplies in the state of Kansas. Abundant water is available over most of the Equus bed area at depths ranging from 80 to 200 feet. Ample water is present for both municipal and industrial use.

Undeveloped Mineral Resources. Clay has been mined in the northern part of the county and made into brick at Lindsborg. This plant has not been in operation for about five years. Clay beds from which brick and other clay products can be made have been investigated in the vicinity of McPherson.

North-central McPherson County contains a number of deposits of volcanic ash. Most of these are in the vicinity of Johnstown, between McPherson and Lindsborg. A few tons have been shipped from one of these deposits.

Satisfactory rock wool has been blown from rock specimens collected in McPherson County near the city of McPherson.

MEADE COUNTY

Volcanic Ash. Meade County is the leading volcanic ash producing county of Kansas, with a yield in 1935 greater than all of the other counties combined. At least twelve separate deposits occur in this county. The largest are in the northern part about 7½ miles west of Fowler. A spur connects the Cudahy deposit with the Rock Island Railroad at Fowler. Other large deposits lie west and south of Meade. Four operators reported volcanic ash production in Meade County during 1935. The largest of these is the Cudahy Packing Company, which makes Old Dutch Cleanser from volcanic ash.

Water. Meade County is covered with Tertiary rocks, except in the river valleys in the eastern and southeastern parts of the county. Throughout the greater part of the Tertiary-covered area, sheet water is available at moderate depth. The city of Meade lies in a local artesian basin. Water entering the Tertiary rocks around the rim of this basin obtains sufficient head to flow from wells drilled near the central part of the basin. An abundant supply of water is available.

Undeveloped Mineral Resources. Only one deep test for oil or gas has been put down in Meade County. This well was drilled in sec. 9, T. 33 S., R. 28 W., in 1928, and was abandoned at a depth of 4,650 feet. Meade County lies in the deeper part of the Dodge City basin, and tests drilled to the Ordovician must go to a considerable depth. The Morrison gas and oil field lies east of Meade County in eastern Clark County and to the west, in western Seward County, are two gas fields which are a part of the great southwestern Kansas gas district.

Sand and gravel deposits, formed through the reworking of Tertiary sediments by recent streams, are abundant throughout most of Meade County. These have not been exploited to any extent as yet.

MIAMI COUNTY

Oil and Gas. The first prospecting for oil or gas in Kansas took place near Paola, in Miami County, in 1860. Also Paola was the first city in Kansas to be supplied with natural gas, which was piped from a field 7 miles to the north in 1884. Miami County has been a relatively small producer of oil and gas for a great many years. Until ten years ago the leading districts were in the western half of the county, in which occur the Paola and Rantoul fields. The individual wells in this district have initial productions of less than 100 barrels a day, in most instances, and soon decline to but a few barrels.

A new discovery was made in Miami County in November, 1926, which caused an increase in the county's production from 13,153

barrels in 1925 to 752,102 barrels in 1927. The discovery well of this field was drilled in sec. 20, T. 16 S., R. 24 E. Subsequent drilling showed the producing formation to be a shoestring sand with a northeast-southwest trend, curving from sec. 14 to sec. 29, all in T. 16 S., R. 24 E. The wells vary in depth from 325 to 400 feet, and had initial productions ranging from 20 barrels to over 250 barrels. The producing sand lies within the Marmaton group. The Big Lake pool has made a remarkable return to the operators in respect to the original invested capital. In less than a week's time some wells were drilled connected to the pipe line, and all costs paid from the first production.

Repressuring operations were started several years ago in this field, after production had declined considerably. It was noted that within a week after repressuring commenced most wells were capable of producing double their former capacity.

The Big Lake discovery led to considerable drilling in the eastern half of Miami County with the result that a few additional, but much smaller, fields were discovered.

The oil and gas wells in Miami County produce from sands in the Marmaton group and in the underlying Cherokee formation. In addition "shale gas" is obtained from wells drilled into the Fort Scott at depths of 450 to 550 feet. These wells yield up to one-half million cubic feet daily.

A few wells have been drilled in Miami County into the Mississippian and older formations, but without success as yet. However, before the possibilities of deeper production are condemned in this county, additional tests located on well-defined subsurface anticlines should be drilled to the "Siliceous lime". Miami County lies between the Forest City basin and the Chautauqua arch, and from a regional standpoint is well situated in regard to oil accumulation.

The production peak for Miami County was reached in 1927. Subsequently the yield has declined, and in 1925 was 205,472 barrels.

Limestone. Important limestones outcropping in Miami County include the Bethany Falls, Winterset, Drum, Iola, Wyandotte, Plattsburg, and Stanton. An enormous reserve of stone is available. Two operators reported a small production of crushed limestone for use in road metal and concrete during 1935. Many quarry sites can be found in Miami County, especially in the central and western parts.

Clay. Clay has been quarried at Paola and used in the manufacture of bricks, but the plant is not operating at present. The reserves in red-burning brick clay in Miami County are large.

Water. Miami County is dependent upon surface waters for municipal and industrial supplies. The deeper bed-rock formations invariably carry mineralized water. Local supplies can be obtained from gravel beds in the relatively narrow valley fills, and from creviced limestones near the outcrop.

MITCHELL COUNTY

Water. Mitchell County is crossed from west to east by Solomon River. The river itself and the underflow in its wide flood plain furnish water to a number of towns and farms. The only bed-rock aquifer in the county with any great volume of water is the Dakota sandstone, and it carries mineralized water in central and western Mitchell County. Local supplies of water in the upland areas are obtained mainly from narrow alluvial deposits in the tributary valleys.

Great Spirit (Waconda) spring is an artesian spring near Cawker City from which flows highly mineralized water. It is exploited by a health resort and by bottling and shipping the mineral water.

Undeveloped Mineral Resources. A number of tests have been drilled for oil and gas in Mitchell County, but, as in the case of Lincoln County, most of these tests were located on prominent domes in the Cretaceous rocks which do not carry below into the Permian and underlying formations. Mitchell County has not been adequately tested for oil and gas in respect to the deeper subsurface structural geology. A wildcat well is now drilling in sec. 16, T. 85, R. 10 W. It was down 3011 feet at last reports.

The topmost ledge of the Greenhorn formation, known as the "fencepost" limestone or "post rock", has been quarried for many miles along the outcrop, especially north and south of Solomon River in Mitchell County. This stone has been used in fenceposts, dwellings, and buildings. The courthouse at Beloit is built of this rock.

On the north side of Solomon River Valley in eastern Mitchell County is a series of low terrace gravel deposits, which were laid down by an ancestor of the present Solomon River. Erosion by tributaries of the present river has cut this once continuous gravel deposit into a series of isolated deposits, which have been exploited for road material and structural purposes. Other terrace and flood plain deposits occur farther upriver, and accumulations of limestone and flint gravel are abundant on the uplands in the southern half of the county.

A 14 inch bed of lignite coal occuring about 30 feet below the top of the Dakota formation was mined years ago along Salt Creek and its tributaries in southern Mitchell County.

MONTGOMERY COUNTY

Oil and Gas. Gas has been produced in Montgomery County since 1881 and oil since 1903. Every township in the county either is producing or has produced oil or gas. The greatest concentration of fields is south and southwest of Independence, in the vicinities of Bolton, Wayside, Havana, Dearing, and Coffeyville. Another group of fields lies in the vicinity of Cherryvale, in the northeastern part of the county. Production comes mainly from sands in the lower Pennsylvanian, including especially the Bartlesville sand in the Cherokee shale. Depth to production ranges from 600 to 1,200 feet. The deeper wells are on the west side of the county, where the Bartlesville sand is lower due to regional dip to the westward. Some shale gas is found in this county in the Fort Scott formation.

Renewed interest has been shown in drilling in Montgomery County during recent years, and several new strikes have been the result. Early in 1936 a field was discovered in the NE. cor. of T. 34 S., R. 15 E., a few miles northwest of Dearing. Montgomery County is thought to have possibilities of deeper production from the upper part of the "Siliceous lime". Four fields have been discovered recently in this "pay" in Chautauqua and Elk counties to the west and northwest. A "Siliceous lime" strike was reported in 1935 from northern Montgomery County.

Montgomery County reached a production peak in 1926 with 721,252 barrels. The production for 1935 was 279,902 barrels.

Limestone. A series of thick limestones crosses Montgomery County from north to south. Especially prominent are the Drum and Stanton formations. A considerable tonnage of stone was quarried in Montgomery County during 1935 for use as road base, road metal, and concrete.

Cement. The Drum limestone is quarried southeast of Independence and used with alluvial clay from the nearby Verdigris River bottom in the manufacture of Portland cement. The reserves of cement rock in this county are enormous.

Clay. Clay products are manufactured from local clays at Independence, Cherryvale, and Coffeyville. Paving brick is made at Independence, bricks and retorts used in the zinc smelter at Cherryvale, and brick and tile at two plants in Coffeyville. Two glass factories are located at Caney.

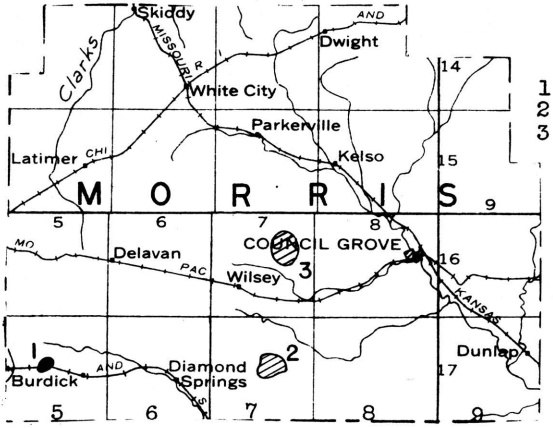
Water. The larger communities and industries of Montgomery County are dependent for water upon surface supplies. Bed-rock water is invariably mineralized where tapped at any great distance from the outcrop.

Undeveloped Mineral Resources. Rock wool was successfully blown from samples collected in the cement plant quarry at Independence. Montgomery County has a large quantity of rock that could be utilized in rock wool manufacture.

Sand and gravel deposits occur along Verdigris River, especially in the vicinity of Coffeyville.

MORRIS COUNTY

Oil and Gas. Morris County contains two gas fields. One of these, the Heigle or Wilsey, was discovered in November, 1927. It lies in the north-central part of T. 16 S., R. 7 E. A few wells produce from the McKissick Grove shale at a depth of 450 feet, but the chief production comes from near the top of the Lansing group at an average depth of 1,450 feet. The second gas field is the Wilde, in the north-central part of T. 17 S., R. 7 E. This field was discovered in October, 1929. Gas comes from three horizons: (1) Willard shale at a depth of 600 feet; (2) Lawrence shale at a depth of about 1,200 feet; and (3) the Lansing group at 1,400 feet.



OIL AND GAS FIELDS

1. Nelson
2. Wilde
3. Wilsey

Limestone. Several limestones cross Morris County from north to south. The most important of these from an economic standpoint is the Fort Riley, which has been quarried at Helmick, Parkerville and White City. One operator reported production of several thousand tons during 1935 for use in road metal and concrete.

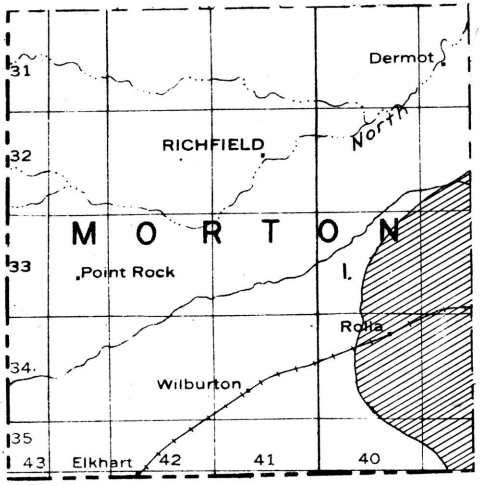
Water. The Neosho River has its headwaters in Morris County. Its flood plain is narrow, and although filled in part with chert gravel, does not contain an abundant supply of water during drought years. Fortunately, some of the bed-rock limestones carry water of usable quality, even at depths in excess of 100 feet. The most important of these formations is the Wreford, which underlies most of the county, and into which some good wells have been drilled. Other bed-rock aquifers are the Florence flint and the Kinney limestone. The latter is a thin limestone in the Matfield shale formation.

Undeveloped Mineral Resources. A few sand and gravel deposits have been found along Neosho River and its tributaries.

MORTON COUNTY

Oil and Gas. A number of gas wells have been drilled in eastern Morton County, which lies in the southwestern Kansas (Hugoton) gas field. The first gas well in Morton County was completed in April, 1930 with an initial production in excess of 14,000,000 cubic feet from a depth of 2,652 to 2,933 feet. Although at least two wells have drilled several hundred feet below the Permian gas-producing formations, the strata which are so productive of oil and gas farther to the east have not yet been adequately tested in this part of the state.

Water. Almost all of Morton County is floored with partially consolidated continental deposits of Tertiary age. Underneath is the Dakota sandstone formation, which is also an important aquifer in this part of the state. Moderately deep wells furnish municipal and local supplies in Morton County.



GAS FIELD

1. Hugoton

Undeveloped Mineral Resources. Sand and gravel are abundant along Cimarron River, which crosses Morton County from southwest to northeast.

NEMAHA COUNTY

Limestone. Nemaha County is covered in part with glacial drift. Beneath this drift and exposed in the larger stream valleys are limestones and shales belonging to the Wabaunsee Admire, and Council Grove groups. Among the limestones available for quarrying are the Tarkio, Americus, Neva, and Cottonwood. During 1935 a relatively large tonnage of limestone was quarried in Nemaha County for use in road metal and concrete.

Water. In common with other glaciated counties in northeastern Kansas, the valleys of even the smaller tributary streams are filled with alluvium in which reworked glacial gravel deposits occur. Sufficient water is available in many of these alluvial deposits to supply local and town demands. Sabetha, however, in the northeastern corner of the county, obtains its municipal supply from impounded surface water.

Undeveloped Mineral Resources. Two small deposits of volcanic ash occur in western Nemaha County in T. 4 S., R. 11 E., just east of the Marshall County line. The ash is only about 1½ feet thick. Sand and gravel occur near Seneca, and elsewhere along Nemaha River.

NEOSHO COUNTY

Oil and Gas. Neosho County has produced oil and gas for many years. The greatest development has taken place in the northwestern quarter of the county, in the vicinity of Chanute. This is a continuation of the Humboldt district in southwestern Allen County. Other fields occur near Erie and Thayer. Most of the wells produce from sands in the Cherokee shale formation. However, a "Mississippi lime" sand gas pool was discovered 3 miles southeast of St. Paul during 1928. At about the same time

shale gas was discovered in eastern Neosho County in the vicinities of Kimball and St. Paul.

There has recently been a revival of drilling activity in the Chanute area and a number of relatively small wells have been completed. The possibilities for "Siliceous lime" production in this county have not been sufficiently investigated as yet.

The oil production for Neosho County during 1935 was 177,077 barrels.

Coal. The Thayer coal bed, with a maximum thickness of 2½ feet, occurs in the Chanute shale, and has been mined near Thayer in western Neosho County. During 1936, ten small shaft mines were intermittently in operation in this coal field, with a total aggregate production of 500 tons.

Limestone. Various rock formations cross Neosho from northeast to southwest. The youngest and stratigraphically highest limestone in the county is the Iola, which is quarried at the cement plant near Chanute. Other limestones which cross the county are the Drum, Swope, Hertha, Lenapah, and Altamont. Two operators reported relatively small limestone production during 1935. This stone was used for road materials and, to a minor extent, as agricultural limestone.

Cement. One of the largest cement plants in the state is located at Chanute in northwestern Neosho County. This plant quarries Iola limestone and Lane-Bonner Springs shale for its cement rock. A large reserve is available.

Water. Neosho County is crossed from the northwest to the southeast by Neosho River. The larger municipal and industrial supplies in the county are obtained from this stream. However, local supplies are available in some parts of the county from stream alluvium. The deeper bed-rock water-bearing formations carry water too highly mineralized for use.

Undeveloped Mineral Resources. Tests in the laboratories of the State Geological Survey have shown that satisfactory rock wool can be blown from formations in Neosho County. Samples were taken at the cement plant quarry at Chanute.

Many deposits of sand and gravel of commercial value occur along Neosho River, especially in the southeastern part of the county.

NESS COUNTY

Oil and Gas. Ness County has two oil wells a little over a mile apart. The first one of these wells, the Aldrich, in sec. 7, T. 18 S., R. 25 W., was completed in November, 1929. It produces from basal conglomerate at a depth of 4,225 feet. The second well, the Thompson, was completed in July, 1936. This well is in sec. 13, T. 18 S., R. 26 W. It produces from the "Siliceous lime" at a depth of 4,500 feet. These wells are not on pipe line and the oil that has been produced has been trucked from the well to a pipe line. Drilling between these wells may prove that both belong in a single pool. The Thompson well had an initial production of 684 barrels. The initial production of the Aldrich well was 128 barrels. The latter has not yet been

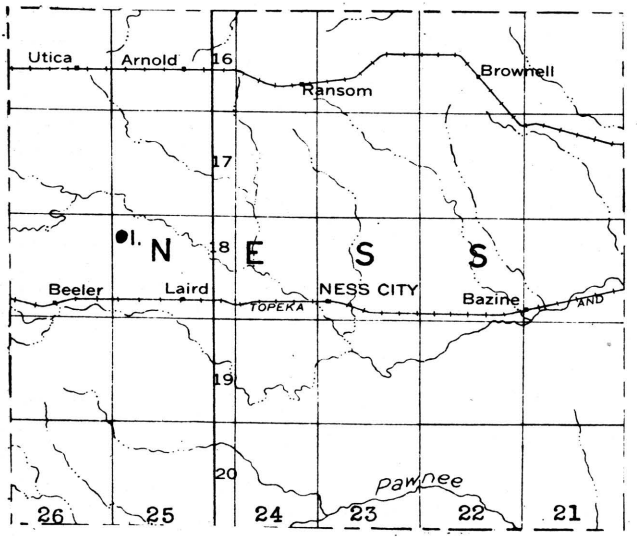
drilled to the "Siliceous lime".

A well drilled in sec. 35, T. 18 S., R. 21 W., east of Bazine and near the Rush County line, had a 20-barrel show of oil at a depth of 4,182 feet from the basal conglomerate of the Pennsylvanian series.

Another dry hole was completed in June, 1931, in sec. 25, T. 17 S., R. 25 W. at a depth of 4807 feet. This well found the base of the Pennsylvanian at 4418 feet and the top of the "Siliceous lime" at 4709 feet. It had 500 feet of oil standing in the hole between 4374 and 4376 feet.

Recent deep tests in Ness County are given in the table below:

Location	Date	Depth
Sec. 16, T. 19 S., R. 21 W.	February, 1933	4777
Sec. 21, T. 19 S., R. 23 W.	March, 1934	5052
Sec. 34, T. 18 S., R. 21 W.	December, 1936	4696



OIL AND GAS FIELD

1. Aldrich

Water. Ness County is well supplied with ground water. The uplands in the northern and western parts of the county are capped with the Ogallala formation of Tertiary age, in which sheet water occurs at depths not exceeding 100 feet. The town of Ransom has a municipal water supply from this aquifer. Individual wells in Arnold and Brownell and a great many farm wells on the uplands likewise penetrate the sheet water zone near the base of the Ogallala formation. A deeper aquifer in this county is the Dakota sandstone, which contains potable water in this part of the state. An 800-foot well furnishes the municipal supply for Utica. Ness City obtains its municipal supply from the same formation at a depth of about 450 feet. In the larger stream valleys water is obtainable in the alluvium at depths up to 50 feet.

Undeveloped Mineral Resources. A small deposit of volcanic ash occurs in the northwest corner of Ness City. The ash bed is only about 2 feet thick and the lateral extent is probably small.

Sand and gravel deposits are numerous along Walnut Creek and its tributaries, especially in the west central part of the county.

NORTON COUNTY

Volcanic Ash. Volcanic ash has been produced in Norton County for a good many years. So far production has been confined to deposits in the vicinity of Calvert, a few miles east of the town of Norton. Other deposits are known not only in the vicinity of Calvert but also south and west of Norton, especially in the vicinity of Dellvale. Over a score of volcanic ash deposits are known in Norton County.

Water. Norton County, except for the southeastern corner where erosion has exposed the underlying Niobrara chalk, is covered with the Ogallala formation. Sheet water is available in these Tertiary rocks, except adjacent to the stream valleys where drainage has taken place. The valleys are floored with narrow flood plains in which wells strike water-bearing gravel at shallow depths in most instances. The municipal supplies of Norton and Almena are obtained from such wells.

Undeveloped Mineral Resources. The Central Kansas Uplift, a large subsurface structural arch which is responsible for the accumulation of oil in Rooks, Ellis, Russell, Rush, Ellsworth, Barton and Rice counties, extends northwestward through Rooks, Graham and Norton counties into Nebraska. Several wells have been drilled in western and northern Norton County to the pre-Cambrian surface, but without obtaining commercial supplies of oil or gas as yet. Two dry holes were drilled during 1936. One of these, in sec. 11, T. 3 S., R. 25 W., was completed in February at a depth of 3800 feet. The other, in sec. 22, T. 3 S., R. 23 W., was abandoned in April at a depth of 3692 feet.

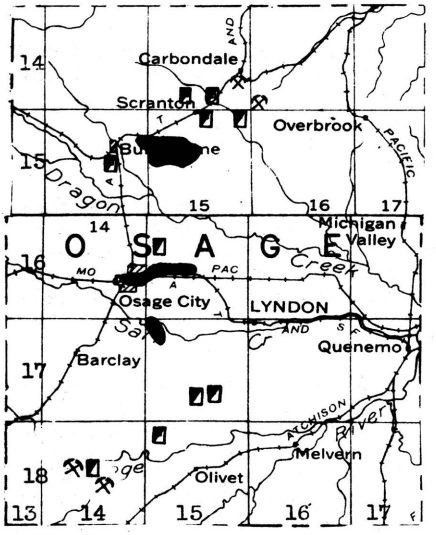
A renewal of activity in Norton County is forecast by recent leasing activity in the southeastern corner of the county.

Sand and gravel deposits are abundant in Norton County, especially in the northeastern part along Prairie Dog Creek.

OSAGE COUNTY

Coal. Coal was discovered in Osage County in 1869 and mining has been carried on in that district ever since. The coal occurs near the top of the Severy shale, but a short distance below the Howard limestone. The coal-bearing formations cross the Shawnee-Osage County line north of Carbondale and continue in a southwesterly direction, crossing into Coffey County just north of Lebo. Coal has been mined at various points along this belt, including Carbondale, Scranton, Burlingame, Osage City, Barclay, and east and southeast of Reading. In common with other coal-mining districts in Kansas, this district has been unusually active during the last few years. During 1936, 37 shaft and 12 strip mines were in operation in Osage County, pro-

ducing 89,865 tons of coal.



COAL MINING DISTRICT
COAL SHAFT MINE
COAL STRIP MINE

Water. Municipalities in Osage County are dependent upon surface water for supply. Smaller amounts of water are available in permeable layers in the valley fill of such streams as the Marais de Cygne. The deeper bed-rock waters are mineralized as a general rule.

Undeveloped Mineral Resources. Osage County has no oil or gas fields, although a number of tests have been drilled in various parts of the county. It is very doubtful, however, that enough tests have been drilled on well-defined anticlines to the "Siliceous lime" to positively disprove the presence of oil or gas in this county.

All of the limestones belonging in the Shawnee and Wabaunsee groups outcrop in Osage County. Many quarry sites are available.

A deposit of flint gravel occurs in south-central Osage County.

OSBORNE COUNTY

Volcanic Ash. The Kansas Geological Survey has record of two volcanic ash deposits in southwestern Osborne County. One of these is in sec. 34, T. 9 S., R. 15 W., and the other is in sec. 24, T. 10 S., R. 15 W. The production statistics of the U. S. Bureau of Mines for 1935 record a small shipment of volcanic ash from Natoma, a station on the Colby branch of the Union Pacific Railroad in southwestern Osborne County.

Water. Towns and farms along the Solomon River, which crosses northern Osborne County from west to east, obtain abundant water either from the river itself or by means of shallow wells into the flood plain. Likewise, valley-fill water is available in many other parts of the county along tributaries of

either Solomon River or, in the southern part of the county, Saline River. The uplands of western and south-central Osborne County are covered with the Niobrara chalk. At the base of this formation is a sandstone of variable thickness, known as the Codell, which contains sufficient water for local use in some parts of the county. The outcrop of this rock is generally marked by springs.

Undeveloped Mineral Resources. The northern end of the Fairport pool of Russell County comes within about a mile of southwestern Osborne County. Likewise, the eastern edge of the Laton field in Rooks County is only about a mile from the west boundary of Osborne County. Many wells have been drilled in southwestern Osborne County because of this production to the south and west. So far drilling has not resulted in the discovery of any commercial oil or gas fields. Osborne County lies on the east flank of the Central Kansas Uplift.

Building stone has been quarried from the Fort Hays member of the Niobrara formation in Osborne County. The courthouse at Osborne, and other buildings in the county, are made with this rock.

Sand and gravel deposits are abundant along the tributaries of Solomon River. In addition many deposits of high terrace limestone gravel have been discovered in widely scattered parts of the county, some of which have been exploited for use in road surfacing.

OTTAWA COUNTY

Water. Practically all of Ottawa County is floored by the Dakota formation. Over most of the county sufficient quantities of water for farm, municipal, and industrial use are available at relatively shallow depths from sandstone layers in this formation.

Undeveloped Mineral Resources. The nearest oil fields of importance are to the south in McPherson County and to the southwest in Ellsworth County. No deep test wells have been drilled in Ottawa County in recent years. The county lies on the south flank of the Salina Basin between the Central Kansas Uplift and the Granite Ridge.

Sandstone has been quarried in Ottawa County in past years.

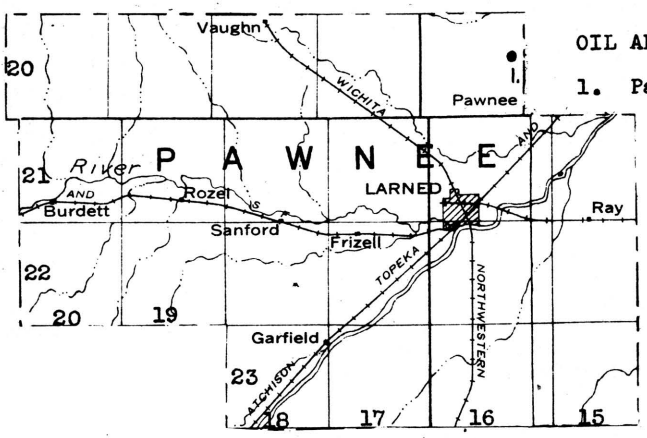
PAWNEE COUNTY

Oil and Gas. Pawnee County has one oil field, known as the Pawnee Rock. This field was discovered in September, 1936, by a well drilled in sec. 13, T. 20 S., R. 16 W. This well is producing from the "Siliceous lime" at a depth of 3,840 feet. To date no offset wells have been drilled. The outlet for the oil is by truck. A second well, drilled 2½ miles to the southwest, was dry and abandoned at a depth of 4,140 feet. A test has just been completed in sec. 29, T. 21 S., R. 19 W., western Pawnee County. This well was abandoned as a dry hole at a depth of 4530 feet. A tabulation of other deep tests in Pawnee County follows:

Location	Date	Depth
Sec. 27, T. 20 S., R. 18 W.	January, 1931	4807
Sec. 15, T. 23 S., R. 17 W.	May, 1935	4384
Sec. 22, T. 21 S., R. 17 W.	December, 1935	4152
Sec. 16, T. 23 S., R. 15 W.	February, 1936	4200

The well drilled to 4807 feet had no shows of oil. It encountered the "Oswald lime" at 3680 feet, conglomerate between 4095 and 4160 feet, and the top of the "Siliceous lime" at 4671 feet.

Pawnee County lies on the southwest flank of the Central Kansas Uplift. It is high enough on the flank so that depths to the "Siliceous lime" are not excessive. Almost the entire county has been core drilled, and leasing was very active in the eastern end and northwestern corner during 1936. Additional tests will undoubtedly be drilled in this county during the next few years.



Sand and Gravel. Eastern Pawnee County is crossed from southwest to northeast by the wide flood plain of Arkansas River. Sand is present both in the flood plain and in the river bed. One operator reported the production of several thousand tons of paving sand from near Larned during 1935.

Water. All except the northwestern part of Pawnee County is mantled with terrace deposits (ancient river deposits), dune sands, or flood-plain sediment. In addition, the bed rock beneath much of the mantle rock is Dakota sandstone, which is tapped in some parts of the county by moderately deep wells and usable water obtained. The mantle-rock deposits contain sufficient water for local needs at shallow depths.

PHILLIPS COUNTY

Water. Northern and northwestern Phillips County is capped with the Ogallala formation of Tertiary age in which sheet water is abundant, except around the edges. In addition the northwestern corner of Phillips County is crossed by the valley of Prairie Dog Creek, in the flood plain of which water is available at shallow depths. Southern Phillips County is crossed

from west to east by the North Fork of Solomon River. Municipalities along this stream obtain water from shallow wells into the river alluvium. Practically all of the remainder of the county is floored with chalk and chalky shale of Niobrara age. Water is not abundant in this formation except in the Codell sand at the base. The city of Phillipsburg, which is situated in the chalk area, uses surface water for its municipal supply.

Undeveloped Mineral Resources. The thickest bed of bentonite known in the state occurs in Phillips County in the NE. ¼ of sec. 35, T. 1 S., R. 20 W., 1½ miles south of Long Island. This bed is 5 feet thick. Bentonite is used mainly in rotary-drilling mud and in filtering oil.

Phillips County lies high on the northeast flank of the Central Kansas Uplift. The nearest oil production is about a mile south of the county line in the Faubin pool of northern Rooks County. Several tests have been drilled in Phillips County during past years, but without discovery of a commercial oil or gas field as yet. One well was drilled during 1932 in sec. 25, T. 5 S., R. 18 W., to a depth of 3440 feet. The top of the "Oswald lime" was encountered at 3075 and the "Siliceous lime" at 3425 feet. Good oil shows appeared at depths of 3097, 3137, 3195, and 3380 feet. A well in section 24 of the same township was drilled to a depth of 3455 feet in May, 1934, but without success. Considerable leasing took place in southwestern Phillips County during the past year.

At least one large deposit of volcanic ash occurs in Phillips County. This deposit is southwest of Speed, about 1½ miles north of the Rooks County line. The tonnage has been estimated at one-half million. This ash is of unusually high quality, with 60 per cent passing through the 200-mesh screen.

The Materials Department of the State Highway Commission has mapped several workable sand and gravel deposits in southern and western Phillips County.

POTTAWOTOMIE COUNTY

Water. Pottawotomie County is bounded on the west by Big Blue River, and on the south by Kansas River. Abundant supplies of water are available in the flood plains of these streams and their larger tributaries. Surface waters are impounded for the municipal supply at Onaga. In the upland areas successful wells have been dug or drilled into a number of bed-rock aquifers. As a general rule this water is hard, but potable. Adequate farm supplies have been obtained in wells ranging from but a few feet to nearly 200 feet, from the following bed-rock formations: Florence flint, Wreford, Cottonwood, Neva, and lower Elmdale shale.

Undeveloped Mineral Resources. Both sand and gravel deposits, and limestone beds, have been exploited in Pottawotomie County. The sand and gravel occur along the Big Blue and Kansas rivers, especially along the latter. The limestones are drift-covered in some parts of the county, but are well exposed, and have been quarried along the north side of Kansas River valley in the vicinities of Wamego and St. George. The Tarkio limestone is especially well exposed.

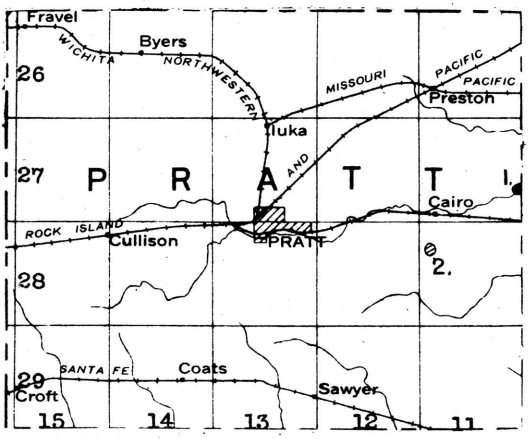
PRATT COUNTY

Oil and Gas. The western edge of the Cunningham pool of Kingman County extends over the line into eastern Pratt County. Several oil wells have been drilled in sec. 25, T. 27 S., R. 11 W., Pratt County. As in the case of the wells on the Kingman County side of the line, oil is obtained from both the Kansas City "lime" and the "Siliceous lime". A large amount of gas accompanies this oil.

A one-well gas pool was discovered in February, 1936, about 6 miles southwest of the Cunningham field. The well had an initial yield of about 14 million feet of gas. It was drilled to a depth of 4435 feet.

A number of tests have been drilled in other parts of Pratt County which encountered good shows of gas and oil. One well 9 miles east of Pratt had 1½ million cubic feet of gas in the Viola lime at 4,259 feet. A well in the northwestern part of the county, in sec. 7, T. 26 S., R. 15 W., had a show of gas in the "Oswald lime" at a depth of 3870 feet, an oil show at 3935 feet, and a million feet of gas at 4300 feet. This test was dry and abandoned at a depth of 4956 feet. A well in sec. 15, T. 27 S., R. 14 W. had a small show of oil in the base of the Kansas City "lime" from 4094 to 4098 feet, and the well was eventually abandoned at 4355 feet. About 3 miles west of the western edge of the Cunningham field (as now outlined), in sec. 28, T.27 S., R.11 W., a well was drilled to a total depth of 4427 feet in 1933. Several showings of oil and gas were encountered.

A leasing campaign recently took place in southwestern Pratt County, following extensive core drill and seismograph surveys.



OIL AND GAS FIELDS

1. Cunningham
2. "Gilchrist" gas

Water. Practically all of Pratt County is covered by Tertiary river deposits and dune sand. Over most of the county sheet water is available at a relatively moderate depth.

Undeveloped Mineral Resources. The State Geological Survey has two records on file of volcanic ash deposits in Pratt County. One of these is in the SW. cor. of sec. 23, T. 27 S., R. 11 W. This deposit has an unusually high content of clay.

It is doubtful if it has commercial possibilities. The other deposit is in sec. 22, T. 27 S., R. 12 W. This ash bed varies in thickness from 2 to 7 feet, and its owner estimates that 30,000 tons are available beneath an overburden ranging from 2 to 6 feet.

Pratt County is largely covered with Tertiary stream sediment in which workable deposits of sand and gravel are numerous.

RAWLINS COUNTY

Water. Most of Rawlins County is veneered with the Tertiary formation of Ogallala age. The county is drained from southwest to northeast by Little Beaver Creek, a tributary of the Republican River. Large quantities of water are available at shallow to moderate depths, both in the valley fills and the Ogallala formation. Some use is being made of sheet water for irrigation in this part of the state.

Undeveloped Mineral Resources. Several deposits of volcanic ash occur in Rawlins County, of which the largest are in the vicinity of Beardsley. Two deposits in this neighborhood have been exploited in the past, but no production was reported from this area during 1935.

The Wray or Beecher Island gas field in Colorado, near the northwestern corner of Kansas, is the nearest field to Rawlins County. The closest production in Kansas is some distance to the southeast in Rooks and Trego counties. Only one deep test has been drilled in Rawlins County, so the oil and gas possibilities of this area are still largely unknown. This well was drilled in sec. 3, T. 2 S., R. 35 W., in 1932. It was abandoned at a depth of 3939 feet in the Pennsylvanian after encountering oil shows at 3369, 3520, and 3737 feet. There is no reason known at the present time why storage of oil and gas cannot occur in the buried rocks in this district. The formations which produce most of the gas and oil to the southeast are deeply buried beneath Rawlins County, but there is a possibility of oil and gas in higher formations, including those of Cretaceous age.

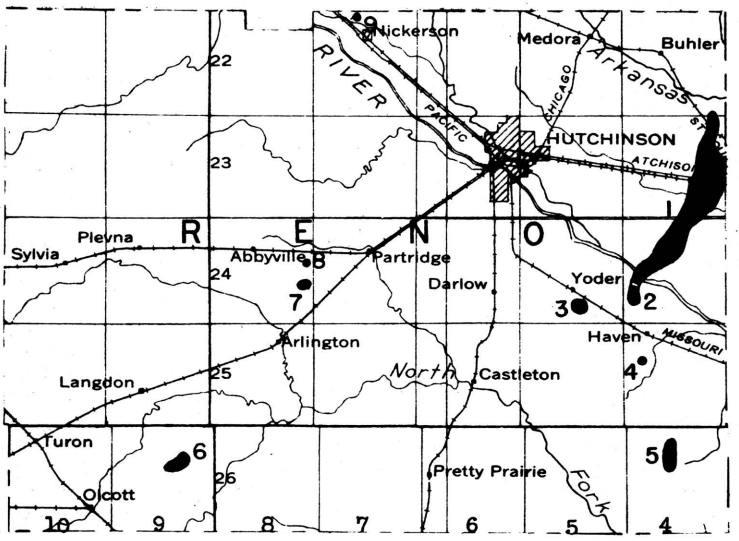
A sand and gravel deposit has been mapped along Little Beaver Creek west of Atwood. Outcrops of "Mortar beds" along the same creek northeast of Atwood may be quarried in the future for stone.

RENO COUNTY

Oil and Gas. Reno County first entered the producing column in 1927, with the completion of the discovery well of the Abbyville pool. However, it was not until 1932 that the county became an important producer, through the deepening of a gas well drilled the year before in the Burrton pool. Subsequently, the Burrton pool has become the largest pool in the state, with a yield of over 5¼ million barrels during 1936. Four additional fields were discovered between 1934 and 1936. Some facts in regard to Reno County fields are given in the following table.

Name of field	Discovery date	Producing formation	Depth
Abbyville	Jan., 1927	Kansas City "lime"	3,540 ft.
Burrton	April, 1931	Mississippian "chat"	3,370 ft.
		Hunton "lime"	3,590 ft.
		"Siliceous lime"	3,780 ft.
Haven	Sept., 1935	Mississippian "chat"	3,380 ft.
Hilger	April, 1934	Viola "lime"	4,000 ft.
Yoder	Oct., 1935	Mississippian "chat"	3,450 ft.

The Reno County production in 1936 was 5,984,634 barrels. Most of this came from the Burrton pool. Eastern Reno County has been core drilled and western Reno has been both core drilled and surveyed by seismograph. Leasing was active during 1936 in both parts of the county.



1. Burrton
2. Haven
3. Yoder
4. Havan (Abandoned)
5. Hilger
6. Lerado
7. Abbyville
8. "Love"
9. "Payne"

Natural Gasoline. The Empire Oil and Refining Company has a natural gasoline plant, which produces gasoline from gas obtained in the Burrton field by the absorption process.

Salt. Up to 500 feet of salt underlies the central part of Reno County. Three plants, the Barton Salt Company, the Carey Salt Company, and the Morton Salt Company, reported production in this county during 1935. Salt was obtained by both brine wells and underground mining. The quantity produced from brine wells was greater than the rock salt mined. The total production for Reno County during 1935 was 241,388 tons of salt, valued at $798,529. This was about 40 per cent of the total salt production for the state.

Sand and Gravel. The Arkansas River flows across northeastern Reno County from northwest to southeast. A large supply of sand is available in the bed of this river and along some of

its tributaries. One operator reported the production during 1935 of several thousand tons of structural and engine sand in this county.

Water. Except along the north fork of Ninnescah River in southern Reno County, where Permian rocks are exposed, the bed rock is mantled with flood-plain alluvium, terrace sands and gravels, dune sand, and Tertiary deposits. It is possible almost anywhere in the flood plain of Arkansas River, and in the dune-sand areas, to obtain an abundant supply of water at shallow depths. The Tertiary cover is thin and is not everywhere water bearing. The only bed-rock aquifers present are the Cheyenne sandstone of Comanchean age, which lies between the Tertiary sediments and the Permian formations in the western part of the county, and Permian shale where fissured. Water from the latter source is mineralized in most cases.

Undeveloped Mineral Resources. A deposit of volcanic ash has been reported 1½ miles south of Arlington in the SW. ¼ of sec. 14, T. 25 S., R. 8 W. The size of this deposit is not known.

REPUBLIC COUNTY

Limestone. The Greenhorn limestone, which includes the thin but widely used "fence-post" bed, outcrops in eastern and southern Republic County. One operator reported the production of several thousand tons of limestone for use as road metal and in concrete during 1935.

Water. Western Republic County is crossed from north to south by the Republican River. Gravel is abundant in the wide flood plain of this river, and a large supply of water is available almost anywhere in the river "bottoms". A large part of northern Republic County is covered by a Tertiary silt, sand, and gravel deposit, known as the Belleville formation. An excellent supply of water is available in this formation, although it may be necessary to drill to a depth of about 200 feet in order to penetrate the main aquifer. The Dakota sandstone underlies the entire county, and outcrops in the southeastern corner. A large quantity of water is stored in the sandstone beds of this formation, but unfortunately in some parts of the county it is too highly mineralized for even stock use.

Undeveloped Mineral Resources. No tests drilled for oil and gas in Republic County have reached the Ordovician rocks. This county is situated on the east flank of the Salina Basin, and wells drilled to test the lower formations will have to go to considerable depths.

Sand and gravel occur along Republican River and have been dredged near Scandia. Deposits also occur in the basal part of the Tertiary sediments in the northern part of the county. Some of these, north of Belleville, have been exploited.

The Cretaceous (Dakota) coal that is mined in northern Cloud County extends into southern Republic County.

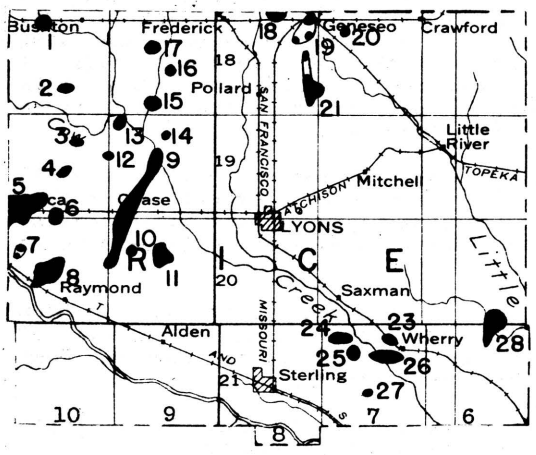
RICE COUNTY

Oil and Gas. Rice County became an oil producer in 1924 with the discovery of the Welch pool in the southeastern part of the county. This was the year following the discovery of the Fairport pool in Russell County, and for some years these two fields were the only oil fields in western Kansas. It is interesting to note, however, that gas was discovered in 1888 in a 1,230 foot well drilled in Lyons. This gas was piped to a hotel and near-by dwellings and used for some months before an explosion put a stop to the local gas industry for a period of over 35 years.

The large-scale development of oil and gas resources of Rice County did not take place until the summer of 1929 when the Raymond field in the western part of the county was discovered. Subsequently about two dozen new fields have been discovered, mainly west and north of Lyons. Rice County led the state during 1936, with a production of 11,427,072 barrels, or about 20 per cent of the state's total. One of the Rice County fields, the Silica, produced over 3 3/4 million barrels during 1936, and the Chase pool produced nearly 3 1/2 million barrels of oil. The Raymond pool, a relatively old pool for this vicinity, continues to be important, yielding over a million barrels during 1936.

Rice County lies on the southeastern "nose" of the Central Kansas Uplift. Most of its production is obtained from Ordovician rocks. A compilation of the oil and gas fields of this county follows:

Name of field	Discovery date	Producing formation	Depth
Bowman	Aug., 1936	"Siliceous lime"	3,290 ft.
Brandenstein	Nov., 1933	Kansas City "lime"	3,018 ft.
Chase	Dec., 1932	"Siliceous lime"	3,200 ft.
Doran	Oct., 1936	"Siliceous lime"	3,300 ft.



OIL FIELDS

1. Stumps
2. Orth
3. Brandenstein
4. Bowman
5. Silica
6. Schartz
7. Wenke
8. Raymond
9. Chase
10. Empire
11. Keesling
12. Doran
13. Haferman
14. Soeken
15. Ploog
16. Rickard
17. Gouldner
18. Edwards
19. Geneseo-Townsite
20. Galt
21. Geneseo
22. "Pulliam"
23. Wherry
24. Saxman
25. Theede
26. Hauschild
27. Ponce
28. Welch

Name of field	Discovery date	Producing formation	Depth
Edwards	Mar., 1936	"Siliceous lime"	3,330 ft.
Empire	June, 1936	"Siliceous lime"	3,275 ft.
Galt	Oct., 1935	"Siliceous lime"	3,225 ft.
Geneseo	May, 1934	"Siliceous lime"	3,255 ft.
Gouldner	July, 1935	Kansas City "lime"	3,000 ft.
		"Siliceous lime"	3,162 ft.
Haferman	Aug., 1936	"Siliceous lime"	3,245 ft.
Hauschild	May, 1936	Conglomerate	
Keesling	Aug., 1935	"Siliceous lime"	3,255 ft.
Orth	July, 1932	"Siliceous lime"	3,237 ft.
Ploog	July, 1930	"Siliceous lime"	3,250 ft.
Ponce	June, 1936	Mississippian "chat"	3,400 ft.
Raymond	July, 1929	Kansas City "lime"	3,140 ft.
		Conglomerate	3,280 ft.
		"Siliceous lime"	3,350 ft.
Rickard	Sept., 1935	"Siliceous lime"	3,350 ft.
Saxman	Dec., 1936	Mississippian "chat"	3,350 ft.
Schartz	July, 1936	"Siliceous lime"	3,300 ft.
Silica	Oct., 1931	"Siliceous lime"	3,000 ft.
Soeken	Jan., 1937	"Siliceous lime"	3,309 ft.
Stumps	May, 1935	"Siliceous lime"	3,940 ft.
Theede	Jan., 1937	Conglomerate	3,355 ft.
Welch	Jan., 1924	Mississippian "chat"	3,400 ft.
Wenke	Mar., 1935	"Siliceous lime"	3,370 ft.
Wherry	Sept., 1933	Mississippian "chat"	3,375 ft.

Salt. Rice County is underlain by salt beds with an aggregate thickness exceeding 300 feet. Two operators reported production of both evaporated and rock salt during 1935. The mines and brine wells are located in and near Lyons. A third mine in the eastern part of the county at Little River has not operated for some years. However, it is being kept in condition and can be re-opened at any time should market conditions justify it.

Water. The Dakota formation is exposed at the surface in northeastern Rice County. Practically all of the remainder of the county is covered by mantle rock, including flood-plain alluvium, terrace deposits, and dune sand. Ordinarily sufficient water can be obtained from the mantle-rock deposits, but in very dry years water becomes unobtainable in some places. The best bed rock aquifer is a sandstone bed in the lower part of the Dakota formation. Unfortunately, this sandstone is lenticular and some wells have missed it. It yields a good supply of water in dry and moist years alike.

Undeveloped Mineral Resources. Sand and gravel are abundant in the broad flood plains of Arkansas River and Cow Creek in the southern half of Rice County.

The Dakota formation which outcrops in eastern and northeastern Rice County is a potential source of stone.

RILEY COUNTY

Limestone. A series of limestone beds from the Americus to the Fort Riley crosses Riley County. The most exploited is the Cottonwood, which is well exposed, and has been quarried extensively, in the vicinity of Manhattan. Cottonwood limestone has been used as a building stone, and many dwellings and buildings

in Manhattan, including those on the College campus, are built with this stone. One operator reported production of building stone, including rough architectural and dressed stone, in Riley County during 1935. The same operator produced some flagstone. Riley County is one of the few places in the state where building stone, once an important industry in Kansas, has been quarried in recent years.

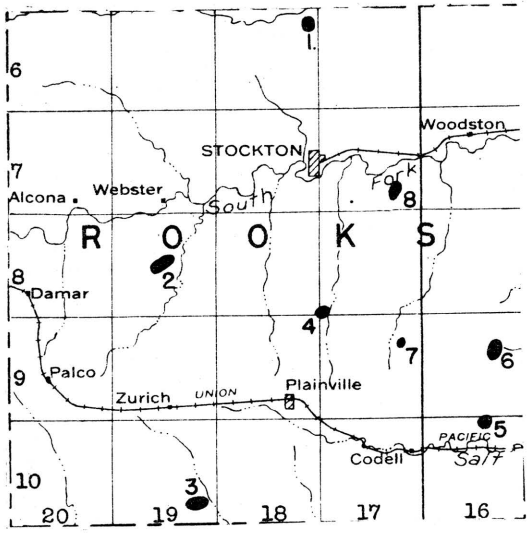
Sand and Gravel. A large supply of sand and gravel is available in Riley County in the beds and flood plains of the Kansas and Big Blue rivers. Dredging operations have been carried on at Manhattan and near the northeastern corner of the county. A small production was reported during 1935.

Water. Flood plains constitute a very important source of water in Riley County. In the vicinity of Manhattan, where the Kansas and Big Blue rivers merge, it is possible to obtain a large supply of water at almost any point on the valley floor at shallow depths. The upland areas are limited in water supply, and those desiring water must either seek it in the narrow flood plains of the tributary streams or attempt to develop a bed-rock supply. Some of the massive limestones, such as the Wreford, are extensively fractured and carry a fair supply of water in the openings.

Undeveloped Mineral Resources. Eastern Riley County overlies the Granite Ridge, and wells have encountered pre-Cambrian formations at relatively shallow depths. The sedimentary section is much thicker, however, in western Riley County and a test located on a local structure there might encounter oil or gas in paying quantities. A very short distance to the west of Riley County, in Clay County, a 20-barrel oil well was drilled about 10 years ago.

ROOKS COUNTY

Oil and Gas. The discovery well for Rooks County was drilled in July, 1927, in sec. 11, T. 9 S., R. 16 W. The pool



OIL FIELDS

1. Faubion
2. Webster
3. Zurich
4. Dopita
5. Kruse
6. Laton
7. "Westhusin"
8. "Kiskadden"

thus discovered was named the Laton. Subsequently five other pools have been discovered in this county, and one of them, the Faubin, is the northernmost pool in the state. So far all of the fields discovered in Rooks County are small, with from one to four producing wells in each pool. The total production for the county during 1936 was 40,831 barrels. A tabulation of the Rooks County fields follows:

Name of field	Discovery date	Producing formation	Depth
Dopita	July, 1934	"Siliceous lime"	3,415 ft.
Faubin	March, 1936	Kansas City "lime"	3,058 ft.
Laton	July, 1927	"Oswald lime"	3,292 ft.
Webster	Oct., 1930	Kansas City "lime"	3,225 ft.
		Conglomerate	3,450 ft.
Westhusin	Sept., 1936	"Oswald lime"	3,200 ft.
Zurich	Sept., 1935	Kansas City "lime"	3,300 ft.

Southern and western Rooks County have been both core drilled and surveyed by seismograph parties. Leasing has been active recently in the western and northwestern parts of the county.

Sand and Gravel. The south fork of Solomon River extends across Rooks County from west to east. The flood plain of this river contains sand and gravel in commercial amounts at numerous places. Some sand and gravel have also been obtained from low terraces along Solomon River and Bow Creek, in the northwestern corner of the county. In addition are scattered sand and gravel deposits of the high-terrace type, in which limestone pebbles derived from the Niobrara formation are abundant. One operator reported production of structural gravel in Rooks County during 1935.

Water. The uplands in northwestern and southwestern Rooks County are covered with the Ogallala formation. Water is fairly abundant in the Tertiary rocks, except along the valley edge where drainage has taken place. The rest of the county is underlain with Niobrara chalk, and to a much lesser extent with the Carlile shale. The Codell sandstone at the base of the Niobrara formation carries water, as do sand lenses in the much deeper Graneros shale. The sands in the Dakota are full of water, but in many parts of the county this water is too salty to be used. A consistent supply of water is obtainable at shallow depths in the flood plain of the south fork of Solomon River. A less consistent supply is available in the narrower flood plains of tributary streams.

Undeveloped Mineral Resources. At least two deposits of volcanic ash occur in Rooks County. One is in sec. 7, T. 8 S., R. 16 W., about 6 3/4 miles south of Woodston, and the other is about 1 1/2 miles southeast of Webster. So far as is known, these deposits have not been exploited to any extent as yet. Both are several miles from the railroad.

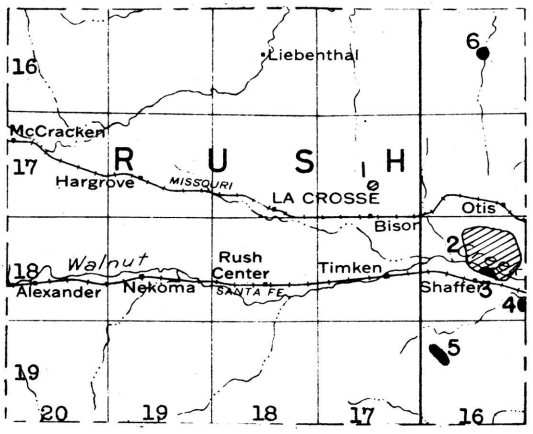
Tertiary "mortar beds" and massive ledges of Fort Hays limestone constitute potential sources of stone in this county.

Oil and Gas. The discovery well for Rush County was the Bison gas well drilled in sec. 27, T. 17 S., R. 17 W. in November, 1928. This well produced from conglomerate at a depth of 3,575 feet. Subsequent offset drilling failed to enlarge the field, and it is reported as not producing at the present time. The second discovery was an oil well in sec. 17, T. 19 S., R. 16 W. This well, the Greenwalt, was completed in October, 1931, in the "Siliceous lime" at a depth of 3,263 feet. It was abandoned in August, 1934.

One of the important gas fields of central-western Kansas, the Otis, was discovered by a well in eastern Rush County completed in March, 1930. Subsequent drilling has shown the gas area to be at least 4,800 acres in extent. The producing formation is a basal Paleozoic sand at a depth of about 3,600 feet. During the development of this field an oil well was completed in the southern part, in August, 1934. Subsequently, seven other wells in the field have struck oil, and several more are drilling. The pool apparently is not as extensive as the gas-producing area.

The Winget pool, near the northeastern corner of the county was discovered by a well completed in December, 1936. This well is producing from the Kansas City "lime". At the present time three offset wells are being drilled.

The Albert pool of western Barton County extends across the Rush County line into sec. 36, T. 18 S., R. 16 W., a short distance southeast of the present limit of the Otis field.



OIL AND GAS FIELDS

1. Bison
2. Otis gas
3. S. Otis
4. Albert
5. Greenwalt
6. Winget

Water. Most of Rush County is floored with the Carlile shale, which is too dense a formation for the storage of any appreciable quantity of water. However, the entire county is underlain by the Dakota sandstone, which carries potable water in this part of the state, and which is tapped for the water supplies of La Crosse and other communities. South-central Rush County is crossed from west to east by Walnut Creek, in the flood plain of which water is available at shallow depths.

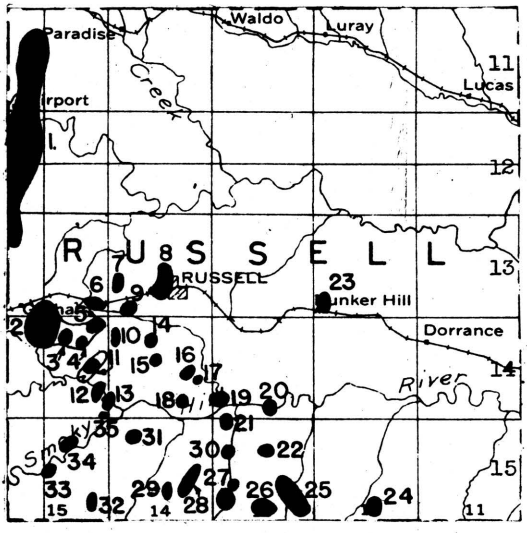
Undeveloped Mineral Resources. An excellent quality white,

rock wool has been blown from a mixture of Greenhorn limestone and sand sampled in the northern part of Rush County. The same rocks are available elsewhere in the county, much closer to rail transportation and gas fuel.

Sand and gravel occur along Smoky Hill River in northern Rush County.

RUSSELL COUNTY

Oil and Gas. The discovery well of Russell County was also the discovery oil well for western Kansas. This well was completed in the latter part of 1923 in what later became known as the Fairport pool. At that time the closest field of importance was 135 miles to the southeast in Butler County. Other discoveries in western Kansas came slowly during the ensuing decade. Now, however, Russell County has three dozen oil fields beside the Fairport, most of which have been discovered in the last two or three years. At first the complete development of the fields discovered was held up through lack of outlet, but recent pipe-line extensions and new construction have made marketing of Russell County oil possible, so at present the Russell-Ellis district is being rapidly explored and developed. During 1936, Russell County was second only to Rice County in the total oil production, with a yield of 7,074,226 barrels.



OIL AND GAS FIELDS

1. Fairport
2. Gorham
3. E. Gorham
4. Cramm
5. Sullivan
6. Dillner
7. Atherton
8. Russell
9. S. Atherton
10. Milberger
11. Niedenthal
12. Harbaugh
13. Big Crk.
14. Williamson
15. Fink
16. Gurney
17. Gurney
18. South Gurney
19. Hall
20. Letch
21. Berrick
22. Anschutz
23. Bunker Hill
24. Dubuque
25. Sellens
26. Eichman
27. Trapp
28. Ochs
29. Karst
30. Coralena
31. Gideon
32. Boxberger
33. Steinert
34. Donovan
35. South Neidenthal

A compilation of the Russell County fields follows:

Name of field	Discovery date	Producing formation	Depth
Anschutz	April, 1936	Topeka "lime"	2,858 ft.
		"Siliceous lime"	3,327 ft.
Atherton	July, 1935	"Oswald lime"	3,030 ft.
		"Siliceous lime"	3,290 ft.
South Atherton	March, 1936	"Oswald lime"	3,120 ft.
		"Siliceous lime"	3,307 ft.
Benso	Feb., 1936	"Oswald lime"	3,100 ft.
Herrick	Dec., 1935	"Oswald lime"	2,925 ft.
Boxberger	Dec., 1935	"Oswald lime"	3,140 ft.
Bunker Hill	Oct., 1935	Kansas City "lime"	2,980 ft.
Coralena	Oct., 1936	Topeka "lime"	2,760 ft.
		"Oswald lime"	2,975 ft.
Cram	Aut., 1935	"Oswald lime"	3,170 ft.
Dillner	May, 1930	"Siliceous lime"	3,300 ft.
Donovan	Feb., 1935	Kansas City "lime"	3,125 ft.
Dubuque	Oct., 1935	"Siliceous lime"	3,275 ft.
Dumler	Dec., 1936	Topeka "lime"	2,770 ft.
		"Oswald lime"	3,110 ft.
Eichman	April, 1935	"Siliceous lime"	3,335 ft.
Fairport	Nov., 1923	"Oswald lime"	3,010 ft.
		"Gorham sand"	3,220 ft.
		Granite wash	3,260 ft.
Fink (abandoned)	Feb., 1935	"Oswald lime"	3,112 ft.
Gideon	June, 1930	Conglomerate	3,270 ft.
Gorham	Oct., 1936	"Oswald lime"	3,040 ft.
		Conglomerate	3,300 ft.
Gurney	Feb., 1935	"Oswald lime"	2,980 ft.
		Granite wash	3,220 ft.
Gurney (South)	Sept., 1936	"Oswald lime"	3,011 ft.
		"Gorham sand"	3,192 ft.
Hall	May, 1931	"Oswald lime"	2,950 ft.
		"Siliceous lime"	3,375 ft.
Harbaugh	March, 1936	"Oswald lime"	3,140 ft.
		"Siliceous lime"	3,200 ft.
Big Creek	July, 1935	"Oswald lime"	3,005 ft.
		"Siliceous lime"	3,175 ft.
Karst	Oct., 1935	"Siliceous lime"	3,310 ft.
Letch	June, 1936	Kansas City "lime"	3,850 ft.
Millberger	May, 1935	"Siliceous lime"	3,310 ft.
Neidenthal	Aug., 1934	"Siliceous lime"	3,250 ft.
Ochs	Oct., 1929	"Siliceous lime"	3,352 ft.
Peterson	Nov., 1936	"Siliceous lime"	3,293 ft.
Rude	Dec., 1930	"Siliceous lime"	3,350 ft.
Russell	Feb., 1934	Kansas City "lime"	3,200 ft.
		"Siliceous lime"	3,275 ft.
Sellens	June, 1929	Kansas City "lime"	3,100 ft.
		"Siliceous lime"	3,350 ft.
Steinert	July, 1929	Kansas City "lime"	3,075 ft.
Sullivan	Feb., 1925	Topeka "lime"	2,785 ft.
		Kansas City "lime"	3,075 ft.
		Tarkio "lime"	2,526 ft.
		"Erlich sand"	3,060 ft.
		"Gorham sand"	3,315 ft.
		"Siliceous lime"	3,225 ft.
Trapp	March, 1936	"Siliceous lime"	3,250 ft.
Trapp North	June, 1936	Kansas City "lime"	3,050 ft.
		"Siliceous lime"	3,075 ft.
Williamson	Feb., 1936	Tarkio "lime"	2,525 ft.
		"Gorham sand"	3,294 ft.

The original Fairport field was considerably revived a few years ago by "acidizing" the wells. The yield of many wells was temporarily restored to the original "flush" figure.

Water. The uplands in Russell County are floored with the relatively "tight" Carlile shale and Greenhorn limestone. The underlying Graneros shale and Dakota sandstone are exposed in the stream valleys that cross the county from west to east. In northern and eastern Russell County the Dakota sandstone is a satisfactory aquifer. In western Russell County, however, some of the sand layers within this formation carry salt water. The city of Russell obtains its municipal supply from impounded surface water.

Undeveloped Mineral Resources. A 5-foot bed of volcanic ash is exposed in the southwest corner of sec. 19, T. 14 S., R. 13 W. So far as is known, this deposit has never been exploited commercially.

Sand and gravel (including limestone gravel) deposits are exceptionally abundant in Russell County. These occur not only along the Smoky Hill and Saline Rivers and their tributaries, but also in terrace deposits on the uplands.

SALINE COUNTY

Sand and Gravel. Sand and gravel deposits are abundant in the flood plains and channels of the Smoky Hill and Saline rivers which cross Saline County. One operator reported production of structural sand, paving sand, engine sand and paving gravel from near Salina during 1935.

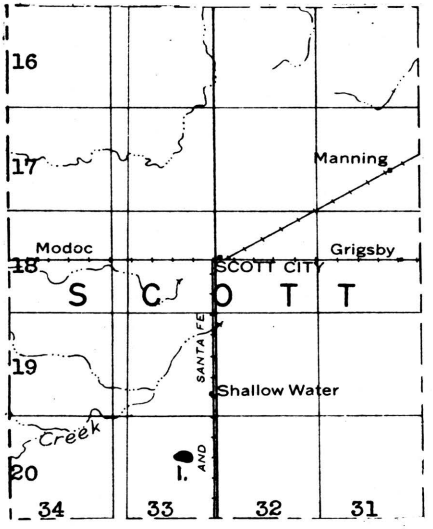
Water. A large and continuous supply of potable water is available in the valley fill of Smoky Hill and tributary rivers, including the Saline. This valley-fill material covers nearly half of the county, and although it does not everywhere yield abundant water supplies, a water-bearing gravel can be struck by relatively shallow wells in most places. The remaining half of the county, with the exception of the eastern edge, is floored with the Dakota formation, in which sandstone beds yielding potable water occur.

Undeveloped Mineral Resources. Attempts to extend oil and gas production northward from McPherson County into Saline County have so far been unsuccessful. Six tests, ranging in depths from 3289 feet to 3579 feet, have been drilled in the last four years. These were all located in the eastern half of the county.

SCOTT COUNTY

Oil and Gas. The western outpost of oil production in Kansas was pushed two counties westward with the discovery of oil in southern Scott County in January, 1935. Subsequently, two other producing wells have been drilled in this field, known as the Shallow Water. The total production for the field in 1936 was 34,050 barrels. The oil is unusually heavy, with a gravity of 26 degrees. It occurs in the Mississippian "lime" between 4,670 and 4,750 feet. At present there is no outlet for the oil other than by truck, but it is reported that a refinery is under construction in Scott City to handle the production

from this field.



OIL AND GAS FIELD

1. Shallow water

Water. Central and southern Scott County lie in the so-called Shallow Water Basin, where a large volume of water is available at depths ranging from 20 to 75 feet. The aquifer is the Ogallala formation of Tertiary age, which covers practically all of the county. The availability of this water at shallow depth has led to pumping and irrigation over a wide belt extending from Scott City southward into northern Finney County. The Shallow Water Basin has been described in Circular 5 of the State Geological Survey of Kansas: "Preliminary report on ground water resources of the Shallow Water Basin in Scott and Finney Counties, Kansas" by Rycroft G. Moss.

Undeveloped Mineral Resources. Sand and gravel occur in the Tertiary sediments of Scott County. One deposit in the south central part of the county has been mapped.

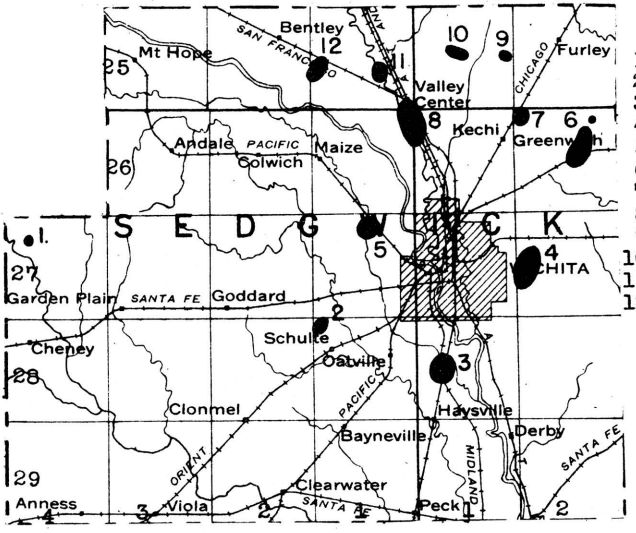
SEDGWICK COUNTY

Oil and Gas. It was not until thirty-six tests had been drilled for oil and gas in Sedgwick County that commercial production was obtained. This well, which opened up the Valley Center field, was completed in August, 1928. Now the county has a dozen oil and gas fields. The total production during 1936 was 2,002,314 barrels. The Valley Center pool is still the largest one in the county, producing over a half million barrels during 1936.

The Sedgwick County fields produce from a variety of formations. A compilation of these fields follows:

Name of field	Discovery date	Producing formation	Depth
Bentley	March, 1934	"Oswald lime"	2,912 ft.
Cheney	Nov., 1935	Viola "lime"	4,020 ft.
Cross	March, 1929	Kansas City "lime"	2,700 ft.

Name of field	Discovery date	Producing formation	Depth
Curry	Oct., 1929	Viola "lime"	3,390 ft.
Schulte	May, 1934	"Wilcox sand"	3,660 ft.
Valley Center	Aug., 1928	Kansas City "lime"	3,660 ft.
Goodrich	Dec., 1928	Kansas City "lime"	2,616 ft.
		"Mississippi lime"	3,020 ft.
		Misener dolomite	3,334 ft.
Kuske	Jan., 1929	"Mississippi lime"	3,064 ft.
Kechi	April, 1929	Penn. basal sand	3,008 ft.
Greenwich	April, 1929	"Mississippi lime"	2,923 ft.
		Top of Simpson	3,168 ft.
		"Wilcox sand"	3,352 ft.
		"Siliceous lime"	3,361 ft.
Eastborough	Aug., 1929	Mississippian "chat"	2,960 ft.
		Misener dolomite	3,250 ft.
Robbins	April, 1929	"Mississippi lime"	3,090 ft.



Natural Gasoline. The largest natural gasoline plant in the state, with a capacity of 40,000 gallons per day, is located in Wichita. This plant uses the absorption process.

Clay. Local clays are utilized in Wichita in two plants, one a face brick plant, and the other a brick and tile plant.

Limestone. Most of Sedgwick County is mantled by Tertiary deposits, Quaternary terrace sands and gravels, and Recent alluvium. The Wellington shale, which includes the Carlton limestone member, is exposed along the eastern end of the county. One operator reported limestone production for use in road metal and concrete during 1935.

Sand and Gravel. A large supply of sand and gravel is available in Sedgwick County from the river bed of Arkansas River and terrace deposits. Four operators reported production during 1935 of a large tonnage of sand, which was used mainly as structural and paving sand. Lesser uses include blast, engine, and

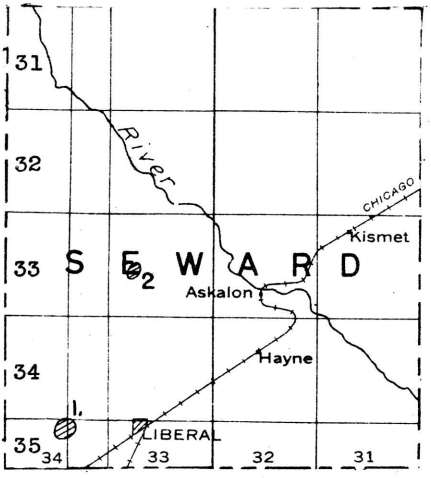
railroad ballast sand.

Water. A large supply of water is available in Sedgwick County in the mantle rock deposits, especially in the flood plain of Arkansas River. Wells dug or drilled into the valley fill rarely fail to penetrate a gravel bed carrying a large supply of water. Unfortunately, in many parts of the county the salt content of this water is high enough to be noticeable to the taste. A much better quality water is available in the northern part of the county where the water in the Harvey and McPherson County Equus beds drains into the Arkansas river valley fill.

Undeveloped Mineral Resources. An exceedingly fine white rock wool was blown from samples collected in the Wichita area by the State Geological Survey in 1936.

SEWARD COUNTY

Oil and Gas. The first producing well in western Kansas was a gas well completed in southwestern Seward County in December, 1922. This well, in sec. 3, T. 35 S., R. 34 W., had an initial production of 5,000,000 cubic feet of gas at a depth between 2,718 and 2,755 ft. Two years later a million foot gas well was drilled in sec. 20, T. 33 S., R. 33 W. These two centers of gas production in western Seward County are now thought to belong in the great southwestern Kansas gas field, which was subsequently developed outward from the vicinity of Hugoton in Stevens County. It is reasonable to assume that all of western Seward County, at least, is underlain by gas-bearing strata. The eastern margin of the gas-producing belt is not known as yet with any certainty. Two wells, one in sec. 33, T. 32 S., R. 34 W. and the other in sec. 14, T. 33 S., R. 33 W., encountered small shows only in the gas sand. The possibilities of deep oil production in Seward County have not yet been thoroughly investigated.



GAS FIELDS

1. Liberal
2. Liberal

Sand and Gravel. Seward County is covered with the Ogallala formation of Tertiary age, with sand dunes here and there. The Cimarron River crosses the county from northwest to southeast. Sand and gravel deposits occur within the Ogallala formation, and are especially abundant in the alluvium and abandoned channels of Cimarron River. One operator reported production of paving gravel during 1935.

Water. Water is available over most of Seward County by means of moderately deep wells into gravel beds in the lower part of the Ogallala formation. Another and shallower source of supply is the alluvium of Cimarron River.

Undeveloped Mineral Resources. A 7½ foot volcanic ash bed occurs in eastern Seward County 4 miles southwest of the town of Kismet, adjacent to the Rock Island Railroad right of way. This deposit was worked about a decade ago.

SHAWNEE COUNTY

Limestone. A series of limestones crosses Shawnee County from north to south. The more important formations in this group include the Lecompton, Deer Creek, Topeka, Howard, Burlingame, Emporia, and Tarkio. Several of these limestones have been quarried in the north central and west central parts of the county. Two operators reported production of limestone for use in road metal and concrete during 1935.

Sand and Gravel. An abundant supply of sand and gravel is available in the bed of Kansas River, which crosses northern Shawnee County from west to east. Three operators dredged sand and gravel during 1935, according to the statistical report of the U. S. Bureau of Mines. The chief products marketed were structural sand, paving sand, structural gravel, and paving sand, and miscellaneous sands were dredged.

Water. Municipal and industrial supplies of water are available in northern Shawnee County from the Kansas River and its wide flood plain, which yields abundant water at shallow depths. The remainder of the county is dependent upon shallow wells into the valley fills of tributary streams. The deeper bed-rock aquifers in this part of the state contain highly mineralized water.

Undeveloped Mineral Resources. Bricks have been made from clay mined a short distance south of Kansas River near the western edge of Topeka. This plant is not operating at present.

Nine wells have been drilled into pre-Pennsylvanian rocks in Shawnee County. Two wells went entirely through the sedimentary series to the pre-Cambrian granite. One of these, in sec. 12, T. 12 S., R. 16 E., encountered the top of the granite at 3,015 feet. The other, in sec. 14, T. 11 S., R. 16 E., entered granite at a depth of 3,010 feet. The "Siliceous lime" was 530 feet thick in the first well, and 440 feet thick in the second. The Simpson ("Wilcox") sandstone in this part of the state is 70 to 100 feet thick. Although so far the wells penetrating the Ordovician formations in Shawnee County have encountered only water, the county cannot be said to have been adequately tested.

SHERIDAN COUNTY

Water. Practically all of Sheridan County is covered with the Tertiary Ogallala formation. Gravel beds in this formation yield abundant quantities of usable water at moderate depths.

Undeveloped Mineral Resources. Except for the eastern end, Sheridan County has not been explored for oil or gas. Two deep tests have been drilled in the eastermost tier of townships. One, in sec. 27, T. 7 S., R. 26 W., was completed in November, 1932, at a depth of 4540 feet. A show of gas was reported at 3625 feet. The other well was drilled in sec. 34, T. 9 S., R. 26 W. It was abandoned in February, 1937, at a depth of 4663 feet. The nearest oil field at the present time is to the southeast in northern Trego County. Leasing was active in the southeastern part of Sheridan County during 1936.

Sheridan County contains at least four deposits of volcanic ash, two in the vicinity of Hoxie and two lying north of Tasco in the east-central part of the county. About 10 years ago some of these deposits were undergoing active exploitation. The amount of volcanic ash remaining is not known.

Recent streams have reworked the Tertiary sands and gravels into commercial deposits, especially in southwestern and east central Sheridan County.

SHERMAN COUNTY

Water. Sherman County is entirely covered by a relatively thick veneer of Tertiary rocks. Local supplies are available at shallow depths, and larger supplies can be obtained by moderately deep wells drilled into the gravel beds that nearly everywhere lie at the base of the Ogallala.

Undeveloped Mineral Resources. The deeper formations beneath Sherman County have not yet been explored for oil and gas. The nearest producing field is the Wray or Beecher Island gas field to the northwest in eastern Colorado, and the nearest deep test was drilled to the southeast in southern Logan County. In northwestern Kansas there is a possibility of production from Cretaceous and Permian rocks, in addition to the deeper formations which are productive to the eastward in Trego, Ellis, Rooks, and Russell counties.

The presence of volcanic ash on the south bank of Smoky Hill River in southeastern Sherman County has been reported.

Sand and gravel occur in the Tertiary sediments that mantle Sherman County. A potentially commercial deposit just west of Goodland has been mapped by the State Highway Commission.

SMITH COUNTY

Stone. Most of Smith County is floored with the Niobrara formation, with the Hays chalk member, which lies at the base of this formation, lying at the surface in the southern and southeastern parts of the county. The Ogallala formation of Tertiary age veneers the surface in the northwestern part of the county, and forms a large outlier northeast of Smith Center. Quartzitic

beds in this outlier have been exploited for road material. Several thousand tons of stone were quarried in Smith County in 1935 for use in road metal and concrete.

Water. The Niobrara chalk and chalky shale which covers most of Smith County does not yield large supplies of water. The town of Smith Center is dependent upon surface water. Other town supplies are obtained by shallow wells into local valley fills. The only large alluvial deposit is along the north fork of Solomon River, in the southwestern part of the county. Other sources of ground water are the gravel zone at the base of the loess which covers much of the county, and the Codell sandstone immediately beneath the Niobrara formation.

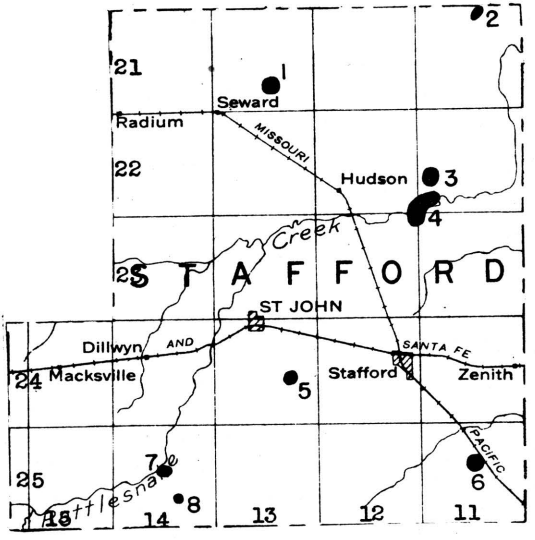
Undeveloped Mineral Resources. Smith County lies between the Central Kansas Uplift on the west and the bottom of the Salina Basin to the east. The Ordovician formations are deeply buried in this part of the state. The county has not yet been adequately tested for oil and gas resources.

One deposit of volcanic ash is known in Smith County. This deposit lies 2 miles west of the town of Kensington, just east of the Phillips County line. According to the owner, the maximum thickness of the ash is 22 feet. As far as is known, no attempts have been made to market this material, although the Rock Island railroad is within a half mile.

Sand and gravel occur along the north fork of Solomon River in southwestern Smith County. High terrace deposits of limestone gravel are also fairly common in the southern part.

STAFFORD COUNTY

Oil and Gas. Oil was first struck in Stafford County in September, 1930 when the Richardson well was completed. Now there are seven pools in the county, with an aggregate production of approximately three-quarters of a million barrels of oil



OIL AND GAS FIELDS

1. Gates
2. Snider
3. Riley
4. Richardson
5. St. John
6. Neola
7. "Jordan"
8. "Kipp"

in 1936. Pertinent data on these pools follow:

Name of field	Discovery date	Producing formation	Depth
Gates	May, 1933	"Siliceous lime"	3,700 ft.
Jordan	Jan., 1937	"Oswald lime"	3,780 ft.
Kipp	Jan., 1937	"Oswald lime"	3,900 ft.
Richardson	Sept., 1930	"Siliceous lime"	3,575 ft.
Riley	July, 1935	"Siliceous lime"	3,600 ft.
Snider	April, 1936	Kansas City "lime"	3,100 ft.
		"Siliceous lime"	3,325 ft.
St. John	May, 1935	Kansas City "lime"	3,600 ft.

Water. Stafford County is almost completely covered with dune sand. Water is available throughout this area at relatively shallow depths.

Undeveloped Mineral Resources. The presence of volcanic ash in southeastern Stafford County, in sec. 28, T. 25, S., R. 11 W., has been reported to the State Geological Survey of Kansas by the owner of the deposit. No data are available as to its extent.

Several sand and gravel deposits occur southwest of St. John where Tertiary rocks project through the general veneer of dune sand.

STANTON COUNTY

Water. Almost all of Stanton County is veneered with the Ogallala formation of Tertiary age. Beneath is the Dakota formation, which carries potable water in this part of the state. Wells of varying depth throughout Stanton County encounter abundant supplies of water in either the coarser sand and gravel beds of the Tertiary, or in sandstone layers in the underlying Dakota.

Undeveloped Mineral Resources. The western edge of the southwestern Kansas gas field is ordinarily drawn across southeastern Stanton County, but no wells have been drilled in this area as yet. A dry hole has been drilled two or three miles southwest of Johnson, in the central part of the county, so it is fairly certain that the gas district does not carry that far west. This well was drilled to a depth of 3,005 feet. The possibilities of oil in the deeper rocks in this county are absolutely unknown. A deep test is now being drilled a few miles north of the Stanton County line in southern Hamilton County.

Local streams have reworked Tertiary sands and gravels in this county into workable deposits. One such deposit occurs in south central Stanton County.

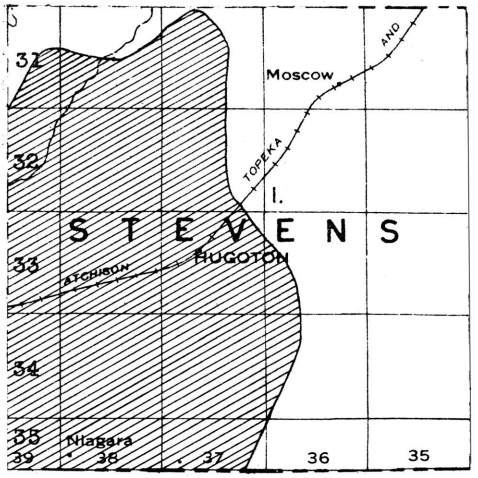
STEVENS COUNTY

Oil and Gas. It is a possibility that every acre of Stevens County is underlain by natural gas. No unproductive wells have been drilled as yet, although over 175 gas wells have been completed in this county since the first well, which had an initial production of 7,000,000 cubic feet, was drilled in 1927 in sec. 31, T. 33 S., R. 37 W. The gas-bearing formations occur

in the Big Blue series of Permian age, The depth to the "pay" zone varies from 2,580 to 2,860 feet. Three different formations have been found to contain gas in this area, but there is some evidence that they are interconnected.

The southwestern Kansas gas field constitutes one of the great gas reserves of the country. It may continue southward across the Oklahoma Panhandle and connect with the enormous Amarillo gas field in Texas. Pipe lines carry gas from Stevens County northwestward to cities in Colorado, and eastward and northeastward to many cities in that direction.

Only one deep test has been drilled in the county, and it is reported to have stopped short of the top of the Mississippian. This well went to a depth of 5,521 feet, and was located near the western boundary of the county. Southwestern Kansas merits deeper testing for oil possibilities.



GAS FIELD

1. Hugoton

Natural Gasoline. A plant near Hugoton extracts gasoline from natural gas by the absorption process. This plant has a capacity of 14,000 gallons a day.

Water. Stevens County is entirely covered with Tertiary rocks. Sheet water is present in the coarser layers at varying depths in different parts of the county. Municipal supplies for Hugoton and Moscow are obtained from moderately deep wells.

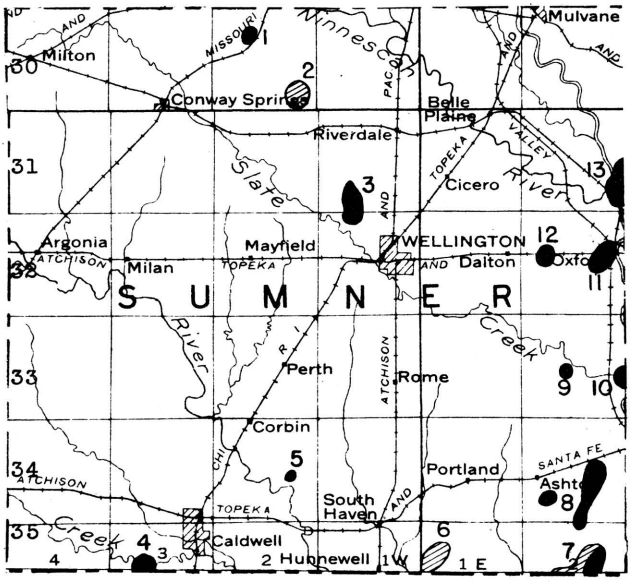
Undeveloped Mineral Resources. Sand and gravel occur along Cimarron River near the northwestern corner of the county.

SUMNER COUNTY

Oil and Gas. Sumner is one of the important oil counties in Kansas, with a total production in 1936 of 3,230,779 barrels. Nearly 2,000,000 barrels of this total came from the Oxford pool on the east side of the county. This pool has given spectacular proof of the oft-quoted theory that deeper oil reserves may underlie present fields. The Oxford pool was originally opened in May, 1927, and for over 8 years the 63 wells

that were eventually drilled produced from shallow formations at about 1,500 feet, and the Stalnaker (Lansing) sand at about 2,050 feet. Then, in 1935, two wells were drilled into the underlying Ordovician rocks, reached at a depth of about 2,900 feet. The first well was a small one, but the second came in for nearly 9,000 barrels a day. This brought about a deepening campaing, and some of the largest oil wells ever drilled in Kansas resulted. One well was credited with an estimated initial production of 37,466 barrels a day. The relatively small Oxford pool became a very important field in Kansas. A compilation of the oil and gas fields of Sumner County follows:

Name of field	Discovery date	Producing formation	Depth
Anson	April, 1928	Howard "lime"	1,940 ft.
Caldwell	April, 1929	"Wilcox sand"	4,772 ft.
Corbin	July, 1927	"Wilcox sand"	4,500 ft.
Latta	June, 1927	"Oswald lime"	3,050 ft.
Wellington	Dec., 1929	Mississippian "chat"	3,662 ft.
Oxford	May, 1927	Emporia limestone	1,075 ft.
		Three Shawnee formations	
		Stalnaker sand	2,050 ft.
		"Siliceous lime"	2,890 ft.
West Oxford	June, 1926	Kansas City group	2,960 ft.
		"Wilcox sand"	3,640 ft.
		"Siliceous lime"	3,670 ft.



OIL AND GAS FIELDS

1. Latta
2. Anson
3. Wellington
4. Caldwell
5. Corbin
6. Hunnewell
7. North Vernon
8. Padgett
9. Rutter
10. West Rainbow Bend
11. Oxford
12. West Oxford
13. Churchill

Name of field	Discovery date	Producing formation	Depth
Rutter	June, 1926	"Mississippi lime"	3,315 ft.
Padgett	May, 1925	"Mississippi lime"	3,455 ft.
		"Wilcox sand"	3,785 ft.
Hunnewell	April, 1927	Lawrence shale	2,275 ft.
		Kanwaka shale	2,148 ft.
North Vernon	June, 1915 (gas)	Severy shale	1,508 ft.
	Nov., 1928 (oil)	Stalnaker sand	2,334 ft.
		"Mississippi lime"	3,300 ft.

Western Sumner County has recently been extensively surveyed by seismograph and core drill, and active leasing was taking place during 1936.

Natural Gasoline. A plant near Oxford extracts gasoline from natural gas by the compression method. This plant belongs to the Shell Petroleum Company, and has a capacity of 3,000 gallons per day.

Limestone. A relatively thin limestone, the Carlton, crosses central Sumner County from north to south. This bed is a member of the thick Wellington shale, which floors the eastern half of the county. The western half is underlain by red beds of Permian age. The county engineer reported a small limestone production during 1935.

Sand and Gravel. Commercial deposits of sand and gravel occur along Arkansas River in eastern and northeastern Sumner County, and in low terraces in the north central and southwestern parts of the county.

Water. Northeastern Sumner County is crossed by the flood plain of Arkansas River, in which sheet water is available at shallow depths. The southwestern part of the county is covered by an old river deposit, in the porous layers of which a fair supply of water is available. The bed rock beneath these terrace deposits, and the Wellington shale in the central and southeastern parts of the county, contain water that is too highly mineralized for use. Local supplies, however, are available in the narrow flood plains of the streams draining the area. For a large supply, such as that required by the city of Wellington, it is necessary to impound surface water.

THOMAS COUNTY

Water. The surface of Thomas County is covered by the Ogallala formation of Tertiary age. Sheet water is available over practically the entire county at moderate depths.

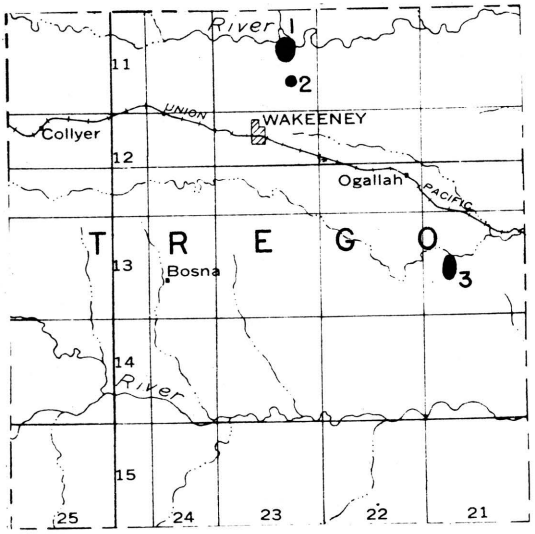
Undeveloped Mineral Resources. No deep tests have been drilled in Thomas County. The nearest production is to the south in Scott County, to the southeast in Trego County, and to the northwest in northeastern Colorado (gas). The southern part of Thomas County has been covered by seismograph surveys, and there has been considerable leasing activity recently in the southeastern part. The next few years should see some deep tests drilled in this part of the state.

Local streams have reworked Tertiary sands and gravels into potentially commercial deposits in many places in Thomas County, especially in the north central and southeastern parts.

Oil and Gas. At the present time Trego County has two producing fields. A third, the Rega, which was the discovery pool of the county (May, 1929), was abandoned in 1932. The one well in this pool produced from the Pennsylvanian basal conglomerate between 3,960 and 3,972 feet. The Wakeeney pool, in secs. 10, 11, 14, and 15, T. 11 S., R. 23 W., was discovered in August, 1934. Oil occurs in the Kansas City "lime" at a depth of a little over 3,600 feet. At the present time there are nine producing wells in this field.

Two miles south of the Wakeeney pool, in sec. 26, T. 11 S., R. 23 W., the discovery well of the Holcomb oil field was completed in April, 1936. This well had an initial production of 616 barrels from the "Oswald lime". At present this field consists of two producing wells.

The production for Trego County in 1936 was 96,542 barrels. Leasing was active in the northwestern part during 1936. A large part of the county has been covered by seismograph surveys.



OIL FIELDS

1. Wakeeney
2. Holcomb
3. Riga

Water. The uplands of Trego County are covered with the Ogallala formation in which water occurs at relatively shallow depths. Valleys, however, are floored with the Niobrara chalk and Carlile shale, which are not water-bearing formations with the possible exception of the Codell sandstone, which, where present, lies at the top of the Carlile shale. Local supplies are available in the flood plains of Smoky Hill and Saline rivers, and in the relatively narrow valley fills of their tributaries.

Undeveloped Mineral Resources. The county engineer of Trego County has reported the presence of two deposits of volcanic ash. One lies near the east side of the county, on the north bank of Smoky Hill River, in either sec. 33 or 34. T. 14

S., R. 21 W. The other is likewise on the north side of the river, in sec. 35, T. 14 S., R. 23 W.

Samples collected from the chalk beds of northern Trego County for the purpose of blowing rock wool have not yet been tested in the experimental plant at the University of Kansas.

Sand and gravel are not only abundant along Smoky Hill River in the southern part of the county, and along Saline River in the northern part, but they also occur in workable deposits on the uplands between the two rivers.

WABAUNSEE COUNTY

Limestone. Wabaunsee County is crossed from north to south by the Emporia, Tarkio, Americus, Cottonwood, and Wreford limestones. One operator reported limestone production for use in road metal and concrete during 1935.

Water. Water is obtained in Wabaunsee County mainly from the flood plain of Kansas River along the north boundary of the county, and from the narrower valley alluvial deposits along the tributary streams. Some of the bed-rock limestones are sufficiently creviced to yield sufficient water for local needs.

Undeveloped Mineral Resources. Several dry holes have been drilled in Wabaunsee County. Two of these were in the northwestern part of the county, immediately above the crest of the Nemaha Granite Ridge. The pre-Cambrian surface was struck at a depth of 958 feet in a well in sec. 26, T. 10 S., R. 9 E., and at 1,180 feet in sec. 1, T. 11 S., R. 9 E. The east flank of the Ridge is very steep, and wells drilled any distance to the east encounter a thick sedimentary section. A well in sec. 15, T. 13 S., R. 12 E. was drilled to a depth of 3,625 feet before reaching the granite surface. A well in sec. 19, T. 12 S., R. 11 E. was drilled to a depth of 3,431 feet. The last 31 feet in this well was in the Ordovician "Wilcox" sandstone. No shows of oil or gas were reported. The ordovician formations have not been adequately tested in other parts of the county. A well in sec. 9, T. 12 S., R. 10 E. encountered a flow of helium gas.

WALLACE COUNTY

Water. The uplands of Wallace County are covered with the Ogallala formation, which contains sheet water in the sands and gravels lying near the base of the formation. Central and eastern Wallace County is floored with the Pierre shale. In this area it is necessary to utilize the water that is stored in the valley fills of Smoky Hill River and tributary streams.

Undeveloped Mineral Resources. No deep tests for oil and gas have been drilled in Wallace County. The nearest production is the Shallow Water field of Scott County to the southeast, and the Wray or Beecher Island gas field to the northwest in eastern Colorado.

Several small deposits of volcanic ash have been found in Wallace County. One of these is in sec. 8, T. 14 S., R. 38 W.

In some parts of Wallace County the Ogallala formation

contains bentonitic clays with a maximum thickness of 30 feet. The largest of these deposits is in sec. 19, T. 12 S., R. 41 W. So far no attempt has been made to exploit this clay, but it has possibilities of utilization in rotary-drilling mud, and as a bleaching agent.

A large deposit of diatomaceous marl, occuring on the Marshall Ranch in northeastern Wallace County, has been described in Bulletin 18 of the State Geological Survey of Kansas. At least two other deposits of this material are known in Wallace County. Diatomaceous marl has potential economic value as raw material in the manufacture of hydraulic lime, a commercial product now being imported into the United States from Europe.

Sand and gravel deposits occur along Smoky Hill River between Sharon Springs and the Logan County line.

WASHINGTON COUNTY

Limestone. Most of Washington County is floored with shales and sandstones belonging to the Dakota formation. However, the Greenhorn formation, with the "fence-post limestone" bed at the top, outcrops in the uplands in western and northwestern Washington County, and the Herington limestone of Permian age crosses eastern Washington County from north to south. The county engineer reported some limestone production for use in road metal and concrete during 1935.

Sand and Gravel. Deposits of sand and gravel occur along Little Blue River in eastern Washington County. Some of these deposits contain reworked sand and gravel of glacial origin. One operator reported the production of a considerable quantity of paving sand, and lesser amounts of structural sand, engine sand, and miscellaneous sand during 1935.

Water. The county seat, Washington, obtains its municipal supply from surface water. Elsewhere in the county, except near the eastern edge, it is possible to obtain sufficient water for local and municipal supplies from sandstone layers in the Dakota formation. The eastern edge of the county is underlain by Permian rocks, and the inhabitants are dependent upon valley fills, such as the flood plain of Little Blue River, for water supplies.

Undeveloped Mineral Resources. Washington County has not yet been adequately tested for oil and gas. The county lies on the east flank of the Salina Basin, but high enough on the flank so that the depths to the Ordovician formations are not excessive.

WICHITA COUNTY

Water. The entire surface of Wichita County is covered with the Ogallala formation. Sheet water is available in the coarser sediments of this formation at moderate depths throughout the county.

Undeveloped Mineral Resources. The Shallow Water oil pool of southern Scott County is only about 9 miles from the eastern

boundary of Wichita County. No deep tests have been drilled in Wichita County as yet. The county has recently been covered by seismograph surveys, and leasing has been very active in the western half.

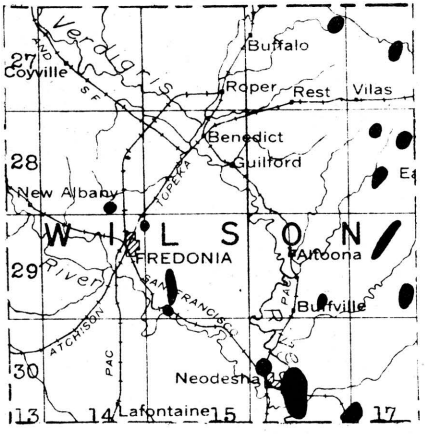
Sand and gravel deposits have been found in western and southern Wichita County.

WILSON COUNTY

Oil and Gas. The first commercial oil well in Kansas was drilled near Neodesha in southern Wilson County nearly 50 years ago. Subsequently exploration spread over the entire county, and a large number of individual oil and gas pools were discovered. Every township in the county has produced oil or gas at one time or another. Neodesha, Altoona, Fredonia, Buffalo, and Vilas are communities that have been largely surrounded by oil and gas fields. The accompanying map shows in a general way the pools in Wilson County which are producing oil at the present time. It is interesting to note that one of these pools near Neodesha is within sight of the first oil well in Kansas. Wilson County produced 89,317 barrels of oil in 1935.

In addition to the oil wells there are about 8,000 wells at present producing some gas. The county is a network of gas lines. About 10 years ago there was considerable drilling for shale gas in eastern Wilson County. The shale gas occurs in the Fort Scott formation. Most of the other gas wells, and the oil wells, in Wilson County produce from lenticular sands in the Cherokee shale.

The "Siliceous lime" has not yet been adequately tested in Wilson County, although some relatively large wells are producing from this formation to the southwest in Elk and Chautauqua counties.



OIL FIELD

Coal. The Thayer coal district of western Neosho County extends across the line into southeastern Wilson County. During 1936, five small drift mines and one strip mine produced 2,162 tons of coal in Wilson County. The strip mine lies 5 miles west of Thayer.

Limestone. Limestones of commercial importance which cross Wilson County from north to south include the Iola, Plattsburg, and Stanton. The Stanton limestone is quarried at The Fredonia cement plant. Two operators reported a relatively small limestone production during 1935.

Clay. Three plants in Wilson County, at Buffalo, Buffville, and Neodesha, burn locally mined clay to produce brick. The clay at Buffville is buff-firing.

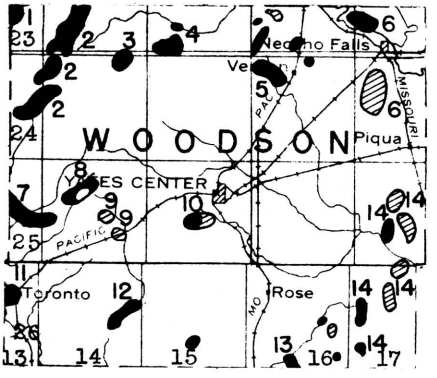
Water. Municipal and industrial supplies of water in Wilson County are obtained mainly from the Verdigris and Fall rivers. Ground water supplies occur in the alluvial deposits of these rivers and their tributaries, and in the shallower bed-rock formations. The Stranger sandstone outcrops in the western part of the county, and is a source of local ground water supplies.

Undeveloped Mineral Resources. Experiments by the State Geological Survey at the University of Kansas have shown that satisfactory rock wool can be blown from raw materials occurring in Wilson County. The formations tested in the experimental plants are those exposed in the brick and cement company quarries at Fredonia.

High terrace flint gravel occurs in deposits of potential commercial importance in southwestern Wilson County.

WOODSON COUNTY

Oil and Gas. Woodson County has a number of scattered oil and gas fields. In the northeastern corner of the county is the Neosho Falls gas district with production coming from a sandy zone in the Winterset limestone at a depth of but 325 feet, and from the "Mississippi lime". Other small pools produce from the Bartlesville sand and the "Mississippi lime". A "Mississippi lime" pool lies just southwest of Yates Center. In the southwestern part of the county are the Big Sandy pool, producing heavy oil from the Bartlesville sand, and the Toronto pool, which extends across into Greenwood County. The largest oil production comes from the west-central part of the county where the southeast trending Bartlesville "shoestring sand" of the Quincy field extends across the line from Greenwood County.



OIL AND GAS FIELDS

1. North Virgil
2. Winterschied
3. Hoagland
4. Wiede
5. Vernon
6. Neosho Falls
7. Quincy
8. Stephenson
9. Batesville
10. Yates Center
11. Toronto
12. Big Sandy
13. Benedict-Buffalo
14. Humbolt

The Batesville pool in Woodson County also lies on this trend. The "Siliceous lime" has not yet been thoroughly tested in this part of the state.

Limestone. Woodson County is crossed from north to south by the Plattsburg, Stanton, and Oread limestones. The county engineer reported limestone production for use in road metal and concrete during 1935. Suitable quarry sites have been found in south-central Woodson County.

Water. The town of Yates Center utilizes impounded surface water for its supply. Valley fills, and sandstones occuring in the Douglas group, are used for local ground water supplies.

Undeveloped Mineral Resources. A flint gravel deposit occurs near the northeastern corner of Woodson County.

WYANDOTTE COUNTY

Oil and Gas. Wyandotte County produces no oil as yet, but has several gas fields. Among these is the Fairfax field, in the industrial district north of Kansas City, Kansas, with about 40 wells producing from two formations in the Marmaton group. The Bethel gas field, west and northwest of the town of Bethel, has about 60 gas wells producing from two sands, one in the Marmaton and the other in the upper Cherokee shale. The Welborn field, northeast of Welborn, and the Dunlap field, about 4 miles north of Bonner Springs, produce from the same formations. Scattered gas wells are found in other parts of the county. The depth to production ranges from about 225 to 700 feet.

The deepest test in the county was drilled north of Bonner Springs in sec. 20, T. 11 S., R. 23 E. to a depth of 2,200 feet. This well was abandoned in the "Siliceous lime" after penetrating it for 660 feet. The Ordovician formations have not been adequately tested in northeastern Kansas.

Limestone. Wyandotte County contains a number of rock quarries exploiting different limestone formations. The most used is the Iola. Other limestones quarried include the Bethany Falls, Farley, Winterset, Drum, and Meadow. Four operators reported limestone production in Wyandotte County during 1935. Most of this stone was used for riprap along the Missouri River, and in road metal and concrete. A relatively insignificant amount was used as rubble.

Cement. A cement plant is located near Bonner Springs in the southwestern part of Wyandotte County. The quarry is in the Wyandotte limestone, Bonner Springs shale, and the lower part of the Plattsburg limestones.

Sand and Gravel. Wyandotte County is the leading producer of sand and gravel in Kansas. Five companies dredge these materials from the bed of Kansas River between Kansas City, Kansas, and Muncie. The chief products are structural, paving, and engine sand. Also marketed are other types of sand, and structural and paving gravel.

Water. Southern and northeastern Wyandotte County has abundant water available in Kansas and Missouri rivers, and in

the alluvial deposits of these streams. The only dependable water supply in the uplands is in the western part of the county, where the Stranger sandstone immediately underlies the surface and carries a large amount of good water. People dwelling in the uplands in the eastern part of the county are dependent upon local gravel deposits in the tributary valleys, or upon wells into bed-rock limestone near the outcrop. The water occurring in the latter environments is not abundant, and wells are prone to run dry during times of drought.

Undeveloped Mineral Resources. During the investigation of the rock wool resources of Kansas, conducted by the State Geological Survey, high-quality rock wools were blown from samples collected in the limestone quarry near the corner of Rainbow Ave. and Douglas in Kansas City, Kansas; from the Union Pacific Railroad quarry west of Loring; and from the quarry of the Lone Star Cement plant east of Bonner Springs. With the large market afforded by the Kansas City metropolitan area, the prospects for successfully making rock wool in Wyandotte County are unusual.

Appendix

ROCK FORMATIONS OF KANSAS
(in order from youngest to oldest)

- Quaternary system
  - Recent series
    - Alluvium
    - Dune sand
  - Pleistocene series
    - Sanborn loess
    - Belleville formation
    - Terrace deposits
      - McPherson formation (Equus beds)
      - Gerlane formation
    - Glacial drift

- Tertiary system
  - Pliocene series
    - Ogallala formation

- Cretaceous system
  - Pierre shale formation
  - Niobrara chalk formation
  - Carlile shale formation
  - Greenhorn limestone formation
  - Graneros shale formation
  - Dakota formation
    - Cheyenne sandstone member

- Permian system
  - Cimarron series
    - Blaine formation
    - Enid formation
  - Big Blue series
    - Sumner group
      - Wellington shale formation
        - Carlton limestone member
      - Donegal limestone formation
        - Hollenberg limestone member
      - Pearl shale formation
      - Nolans limestone formation
        - Herington limestone member
      - Odell shale formation
    - Chase group
      - Winfield limestone formation
      - Gage shale formation
      - Towanda limestone formation
      - Holmesville shale formation
      - Barneston limestone formation
        - Fort Riley limestone member
        - Florence flint member
      - Blue Rapids shale formation
      - Kinney limestone formation
      - Wymore shale formation
      - Wreford limestone formation
    - Council Grove group
      - Speiser shale formation
      - Bigelow limestone formation

Easly Creek shale formation
Bader limestone formation
Stearns shale formation
Beattie limestone formation
Cottonwood limestone member
Eskridge shale formation
Grenola limestone formation
Neva limestone member
Roca shale formation
Red Eagle limestone formation
Johnson shale formation
Foraker limestone formation
Admire group
Hamlin shale formation
Fivepoint limestone formation
West Branch shale formation
Falls City limestone formation
Hawxby shale formation
Aspinwall limestone formation
Towle shale formation

Pennsylvanian system
Virgil series
Wabaunsee group
Brownville limestone formation
Pony Creek shale formation
Caneyville limestone formation
French Creek shale formation
Jim Creek limestone formation
Friedrich shale formation
Grandhaven limestone formation
Dry shale formation
Dover limestone formation
Table Creek shale formation
Maple Hill limestone formation
Pierson Point shale formation
Tarkio limestone formation
Willard shale formation
Elmont limestone formation
Harveyville shale formation
Reading limestone formation
Auburn shale formation
Wakarusa limestone formation
Soldier Creek shale formation
Burlingame limestone formation
Silver Lake shale formation
Rulo limestone formation
Cedar Vale shale formation
Happy Hollow limestone formation
White Cloud shale formation
Howard limestone formation
Severy shale formation
Shawnee group
Topeka limestone formation
Calhoun shale formation
Deer Creek limestone formation
Tecumseh shale formation
Lecompton limestone formation
Kanwaka shale formation
Oread limestone formation
Plattsmouth limestone member

Douglas group
Lawrence shale formation
Stranger formation
Missouri series
Pedee group
Iatan limestone formation
Weston shale formation
Lansing group
Stanton limestone formation
Vilas shale formation
Plattsburg limestone formation
Kansas City group
Bonner Springs shale formation
Wyandotte limestone formation
Lane shale formation
Iola limestone formation
Chanute shale formation
Drum limestone formation
Quivira shale formation
Westerville limestone formation
Wea shale formation
Block limestone formation
Fontana shale formation
Bronson group
Dennis limestone formation
Galesburg shale formation
Swope limestone formation
Ladore shale formation
Hertha limestone formation
Bourbon formation
Des Moines series
Marmaton group
Lenapah limestone formation
Nowata shale formation
Altamont limestone formation
Bandera shale formation
Pawnee limestone formation
Labette shale formation
Fort Scott limestone formation
Cherokee shale
Bartlesville sandstone member

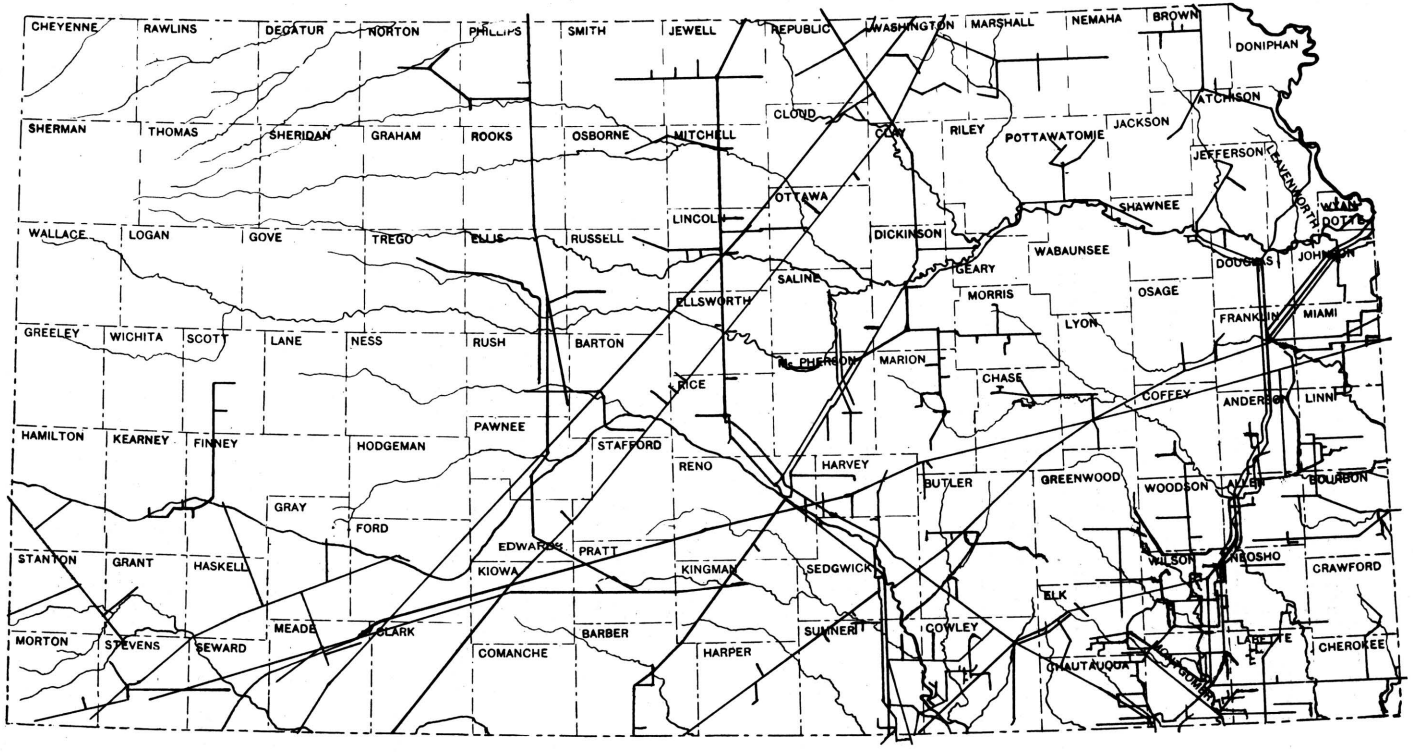
Mississippian system
"Mississippi lime"
Chattanooga shale
Misener "sand"

Siluro-Devonian system
"Hunton lime"

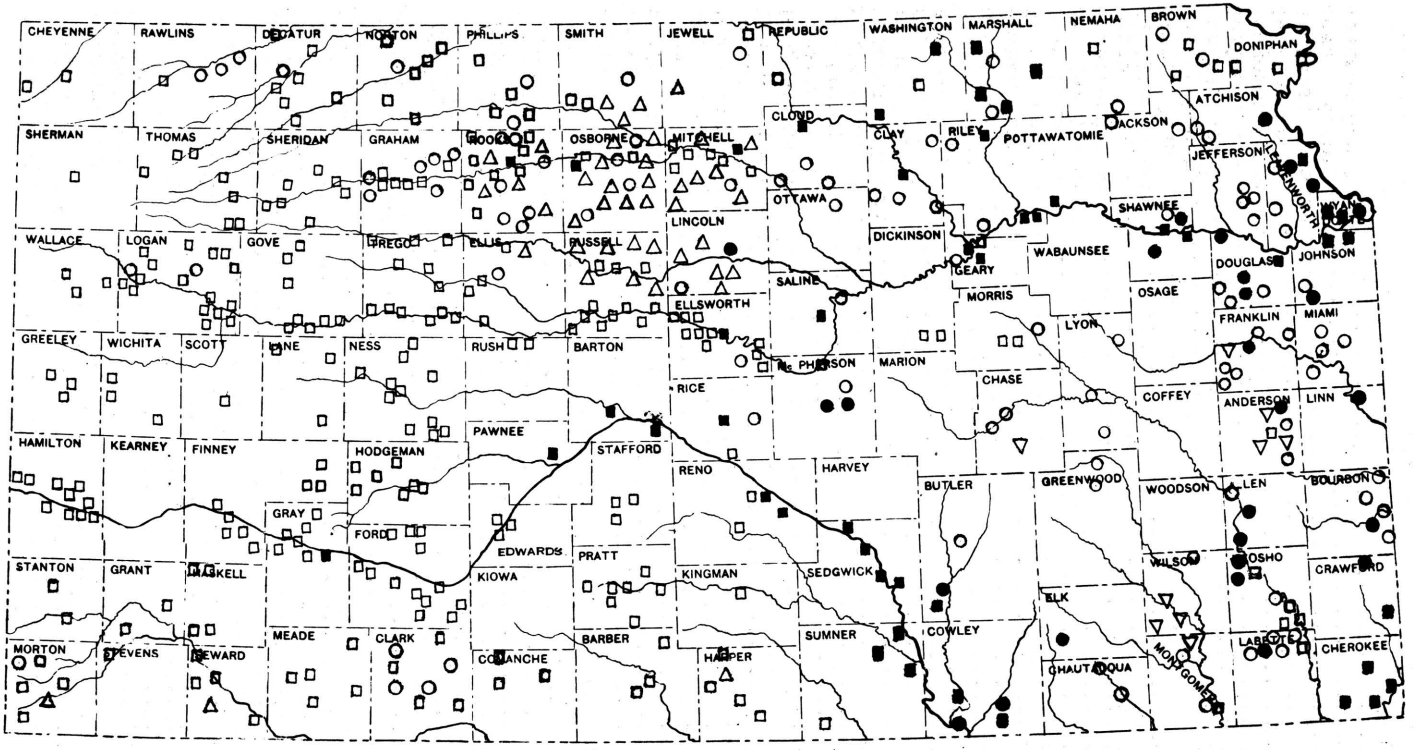
Ordovician system
Maquoketa shale
"Viola lime"
Simpson formation
"Wilcox sand" member

Cambro-Ordovician system
"Siliceous lime" (Arbuckle)

Pre-Cambrian
Granite and other crystalline rocks



GAS PIPE LINES IN KANSAS



- Sand and gravel
- Stone
- Limestone gravel
- Flint gravel

Solid symbols are deposits which have been developed commercially

SAND, GRAVEL, AND STONE DEPOSITS MAPPED BY MATERIALS DEPARTMENT, KANSAS STATE HIGHWAY COMMISSION

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