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Verona 10/17

Mineral Wealth



IN THE
FRISCOBELT



ST. LOUIS - SAN FRANCISCO RY.

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INDUSTRIAL DEVELOPMENT DEPARTMENT

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*The assistance of the State Geological Survey of Lawrence,
Kansas, in compiling the information contained herein is
acknowledged with appreciation.*

THE COUNTIES IN KANSAS served by the Frisco Lines are shown in the following summaries to possess a great variety of mineral wealth. A few of these materials are now being extensively produced, some are being produced on a small scale, and others are awaiting development. The list of available materials is impressive and the products that could possibly result from the processing of combinations of them is virtually unlimited.

It is practically impossible to list all of the products that possibly could be produced from these basic raw materials, but a few classes of them will be pointed out.

Fuel is food for industrial machines. Without such food, industry cannot become established or live. The importance of the supply of coal, oil and gas occurring in these Kansas counties cannot be overstated.

Water is essential to nearly all industry. Although adequate supplies occur at many places in these counties, it should be emphasized that where wells are necessary the availability and quality at any particular location should be ascertained in advance of plant construction. This department and the State Geological Survey will gladly furnish data on the subsurface formations and available water.

Location, markets, taxation, transportation costs, competition and the human equations of opportunism, initiative and enterprise are outside the scope of this summary of mineral wealth.

**List of Counties Served by the
FRISCO LINES
and
Principal Economic Minerals Found Therein**

<i>Counties</i>	<i>Minerals</i>
1. Bourbon	1. Chat
2. Butler	2. Clay
3. Cherokee	3. Coal
4. Cowley	4. Gravel
5. Crawford	5. Helium
6. Elk	6. Iron Oxide
7. Ellsworth	7. Lead
8. Greenwood	8. Limestone
9. Harvey	9. Natural Gas
10. Johnson	10. Oil
11. Labette	11. Pyrite
12. Linn	12. Rock Asphalt
13. Miami	13. Salt
14. Montgomery	14. Sand
15. Reno	15. Sandstone
16. Rice	16. Stone
17. Sedgwick	17. Tripoli
18. Wilson	18. Volcanic Ash
19. Wyandotte	19. Water
	20. Wool Rock
	21. Zinc

WYANDOTTE COUNTY

Limestone. The 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 Captain Creek. A cement plant located near Bonner Springs is using the Wyandotte limestone, Bonner Springs shale and the lower part of the Plattsburg limestones.

Oil and Gas. A limited amount of natural gas from shallow sands has been produced in several fields. The production now is less than a few years ago. The deeper potential oil-bearing formations in the county have not been adequately tested. Recent developments in other fields are an impetus to more extensive exploration in northeastern Kansas counties.

Sand and Gravel. This county is the leading producer of sand and gravel in Kansas. Several companies dredge these materials from the bed of Kansas River between Kansas City, Kans., and Muncie. The chief products are structural, paving and engine sand. Other types are also being marketed. Molding sand is being produced near Kansas City.

Wool Rock. High quality rock wools have been blown from samples collected in a quarry near Rainbow Ave. and Douglas Street in Kansas City, Kansas; from a quarry near Morris and from a quarry east of Bonner Springs.

JOHNSON COUNTY

Limestone. A series of important limestones including the Winterset, Drum, Iola, Wyandotte, Plattsburg and Stanton formations outcrops in this county. These limestones have been exploited in the northern and southwestern parts of the county for many years.

Oil and Gas. About twelve gas fields are scattered over the county, all producing from shallow sands. Several new wells have been drilled in recent months. The newest development has been in the Prairie Center field a few miles west of Olathe. The Dallas oil and gas field 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. Scattered gas wells have been drilled in the southeastern part of the county. Only two deep tests have been drilled in the county. One of these reached the pre-Cambrian granite at 2400 feet and was abandoned at 2421 feet. The other was drilled 220 feet into the "Siliceous lime" to a total depth of 1,785 feet.

Sand and Gravel. A large quantity of sand and gravel is dredged from the bed of Kansas River. Near Holliday is a deposit of glacial gravel which has been extensively exploited. Structural, paving and engine sand; structural and paving gravel are also produced in this section.

Wool Rock. An enormous quantity of raw material is available in Johnson County for the manufacture of rock wool.

MIAMI COUNTY

Clay. The reserves of red-burning brick clay in this county are large. Considerable quantities have been quarried at Paola and used in the manufacture of bricks.

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. Many quarry sites can be found in the county, especially in the central and western parts.

Oil and Gas. The first prospecting for oil and gas in Kansas took place near Paola in 1860. Paola was the first city in Kansas to be supplied with natural gas. Miami County has been a relatively small producer of oil and gas for many years. Generally the wells in this district have initial production of less than 100 barrels a day, and soon decline to but a few barrels. A discovery was made in 1926 which increased the county's production from 13,153 barrels in 1925 to 752,102 barrels in 1927. The wells vary in depth from 325 to 400 feet and had initial productions ranging from 20 to over 250 barrels per day. Repressuring operations in several fields have stepped up production. Drilling in the eastern half of the county resulted in the discovery of additional smaller fields. 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 500 feet. These wells yield up to one-half million cubic feet of gas daily. Miami county lies between the Forest City basin and the Chautauqua arch, and from a regional standpoint is well situated in regard to oil and gas accumulation.

LINN COUNTY

Coal, has been mined intermittently in Lynn County for many years. During the last few years a marked increase in mining has taken place in the district. Both shaft and strip mines are in operation. 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. Production in 1942 amounted to 731,690 tons.

Oil and Gas. Linn County lies in the shallow oil and gas district of eastern Kansas. It has had a small production for many years, decreasing considerably in the last decade. 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 in 1927 and 1928. The gas sand lies in the lower part of the Cherokee shale at depths from 650 to 700 feet. Production varies from a quarter of a million to over four million cubic feet. Another gas field was opened in 1929 along the Linn-Anderson County line. Scattered small fields occur in the vicinities of Centerville, Mound City, Pleasanton and LaCygne. Practically all of the production so far discovered in the county comes from sands in the lower part of the rocks of the Penn-

sylvanian age. A few years ago a small amount of oil was discovered in the top of the "Mississippi lime" in the Blue Mound field. Formations below the "Mississippi lime" have not been adequately exploited. 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 production of this mineral in Kansas comes from Linn County. An asphalt bearing sandstone in the Bourbon rocks crosses the county from the northeastern corner to the center of the south boundary. The higher Swope limestone and the Pawnee limestone, lower in the geologic sections, are likewise asphalt bearing in places. Quarries are located in asphaltic sandstone a short distance northwest of Pleasanton and in asphaltic limestone about two miles north and three and one-half miles southwest of LaCygne.

Sand and Gravel. The Marais deCygnes River cuts across the northeastern part of the county, with a flood plain averaging from one to two miles in width. Sand and gravel are present in the flood plain and in the bed of the stream. A relatively large tonnage has been produced in this section. Flint gravel has been taken intermittently from several deposits.

Zinc and Lead. A local deposit of zinc and lead ore occurs about a mile southeast of Pleasanton.

BOURBON COUNTY

Clay. Brick and pottery are made in Fort Scott from local clay deposits. Other shales and clays occur in the county.

Coal. The upper Cherokee coals occur at and near the surface in southeastern Bourbon County. There are a number of strip mines now producing in this section. Mulberry coal, extensively mined in Linn County, is also present in Bourbon County and was mined in the northern part. Shallow strip mines could be developed in several places. The county produced 189,644 tons in 1942.

Limestone. 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 formation is extensively exposed over the eastern part of the county. Crushed limestone is being produced in the eastern part of the county for railroad ballast and agricultural limestone.

Oil and Gas. The Moran and other eastern Allen County pools extend across the line into western Bourbon County. The Walnut-Helper oil field lies across the western end of the line separating Crawford from Bourbon County. Some small and isolated oil fields also occur in the 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. 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.

KANSAS MINERAL WEALTH

Several gas fields have been developed in eastern Bourbon County. 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 pressure of thirty-four pounds.

Rock Asphalt. 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.

Sandstone. A local sandstone occurring in the Bandera shale is quarried near the town of Bandera, mainly for flagging. This sandstone is rather unique as it can be quarried as large uniform slabs a few inches in thickness. It also constitutes a beautiful and economical building stone.

Wool Rock. Experiments by the State Geological Survey have shown that satisfactory rock wool can be blown from the rock that is being quarried in the vicinity of Fort Scott.

CRAWFORD COUNTY

Clay. 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 at one time producing brick, stoneware, pottery and other ceramic products.

Coal. The greatest mineral resource in the county is coal, its production being nearly half of the state's total production for 1942. The Cherokee field is approximately 32 miles long and from 3 to 12 miles wide, extending through Cherokee and Crawford Counties, Kansas, into Barton County, Missouri. The most important seam is the Weir-Pittsburg, which has an average thickness of 36 inches. The other important seams are Lightning Creek or Mineral seam which is 22 inches thick and the Limestone or Pioneer seam which is 18 inches thick. The other seams which are of almost negligible importance are from 12 to 14 inches thick. Kansas coal, while generally considered an excellent industrial coal, is widely used as domestic fuel. Modern preparation facilities have extended its use, practically all mines being equipped with screens which separate the coal into as many as eight or ten sizes. Because of the level terrain and the uniform dip of the coal seams, this field has some of the foremost and economical stripping operations in the country. Three seams are mined by this method regularly and two others occasionally. During 1942 twenty-one strip mines were in operation, producing 1,412,972 tons. During this same period twenty-eight shaft mines in the county produced 433,412 tons, making the county's total production 1,846,384 tons. All of this coal is bituminous in character. Adequate reserves and favorable labor conditions assure Kansas and the Missouri Valley a plentiful supply of good coal for many years to come.

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 is quarried in the northern part of this county for use in road metal and concrete.

Oil and Gas. Several small oil and gas fields occur near the western boundary of the county. One field, the Walnut-Hepler, lies partly in southwestern Bourbon and partly in northwestern Crawford Counties. Smaller fields have been developed a few miles south of Walnut. The oil and gas occur in sands lying at a depth of about 600 feet. A relatively new discovery, the McCune field, lies in the southwestern part of the county.

CHEROKEE COUNTY

Chat is mixed through the zinc and lead ore which occurs in this county and is separated from them during the milling process. It will be found in great quantities through the mining district and is used for railroad ballast, road surfacing and in concrete aggregate.

Coal. The Cherokee formation, with several commercial beds of coal, crosses Cherokee County from the northeast to the southwest. The coal is mined by both the open cut and underground methods. The county produced 1,279,620 tons in 1942.

Iron Oxide. The county has a potential source of iron in the mine waters of the lead and zinc area. Waters in the Baxter Springs area contain as much as 6,000 parts per million of iron and several tons of iron hydroxide are deposited daily in settling ponds and river channels. The Geological Survey reports a plant treating 5,000,000 gallons of mine water daily, containing 1,000 parts per million of iron, if operated at 100 per cent efficiency, would produce the equivalent of 10,845 tons of iron oxide a year. Cement plants are using iron to produce certain kinds of cement and iron hydroxide from mine waters could be used.

Lead occurs with zinc ore which is mined extensively in this county which goes to make up the "Tri-State-District" of Missouri, Kansas and Oklahoma.

Limestone. The only thick limestones to outcrop in the county are the Mississippian in the southeast corner and the Fort Scott in the northwest corner.

Pyrite. A new industry in Kansas was established in 1935 when a concentrating plant to extract pyrite from mine refuse was constructed at West Mineral. The iron sulphide (pyrite and marcasite) occurring in coal had hitherto been wasted. The plant has a capacity of 50 tons of refuse per hour and produces a product containing about 48% sulphur.

Sand and Gravel are sporadically produced in the county. The deposits are formed through the weathering and transportation of chert occurring in the Mississippian limestone.

Sandstone. Several sandstone beds occur in the Cherokee formation and some have been exploited.

KANSAS MINERAL WEALTH

Tripoli, a substance consisting essentially of silica and used mainly as a polishing and filtering material, occurs and is processed in a mill located near Baxter Springs.

Zinc. The outstanding zinc-producing district of the United States lies in what is known as the "Tri-State-District" of Missouri, Kansas and Oklahoma. The Kansas portion of this district is 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.

LABETTE COUNTY

Coal. Eastern Labette County lies in the southeastern Kansas coal district. During 1942 there was produced in the county 11,833 tons. It is known that a considerable reserve of coal could be exploited in this area by shaft mining.

Limestone. The Fort Scott, Pawnee, Altamont, Bethany Falls, Winter-set and Drum limestones cross the county from the northeast to the southwest. The last named is confined in its outcrop to the very northwestern corner. The stone is used in road metal and concrete.

Oil and Gas. The county has produced oil for a great many years and still has a substantial production. Most of the fields are in the western part 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 one hundred wells were drilled to depths of from 150 to 700 feet. Initial production ranged from a few thousand to three million cubic feet. Producing formations include the Fort Scott limestone, sands in the Cherokee shale (including the Bartlesville) the top of the Mississippi lime and the Arbuckle limestone which produces oil in the Chetopa field.

Sand and Gravel deposits occur along Neosho River in northeastern Labette County, but most of it is still undeveloped.

Wool Rock. Extending from southwest to northeast across the county are outcrops of material chemically suitable for making rock wool. A small plant manufacturing rock wool is located east of Parsons.

MONTGOMERY COUNTY

Clay products have been manufactured from local clays at Independence, Cherryvale, Sycamore and Coffeyville. Paving brick was made at Independence. High grade fire brick, roofing tile and other products are being made at Coffeyville.

Limestone. A series of thick limestones cross the county from north to south. Especially prominent are the Drum and Stanton formations. 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 are enormous.

Oil and Gas. Every township in this county either has or is producing 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. Early in 1936 a field was discovered a few miles northwest of Dearing. Production comes mainly from sands in the lower Pennsylvanian, including especially the Bartlesville sand in the Cherokee shale. Depth of these wells range 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 a regional dip to the westward. Some shale gas is found in the Fort Scott formation. It is thought there are possibilities of deeper production from the upper part of the "Siliceous lime." Four fields have been discovered in this "pay" in adjoining counties to the west and northwest. A strike in this formation was made in 1935 in the northern part of the county.

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

Wool Rock was successfully blown from cement plant quarry samples at Independence. The county has a large quantity of rock that could be utilized in the manufacture of rock wool.

WILSON COUNTY

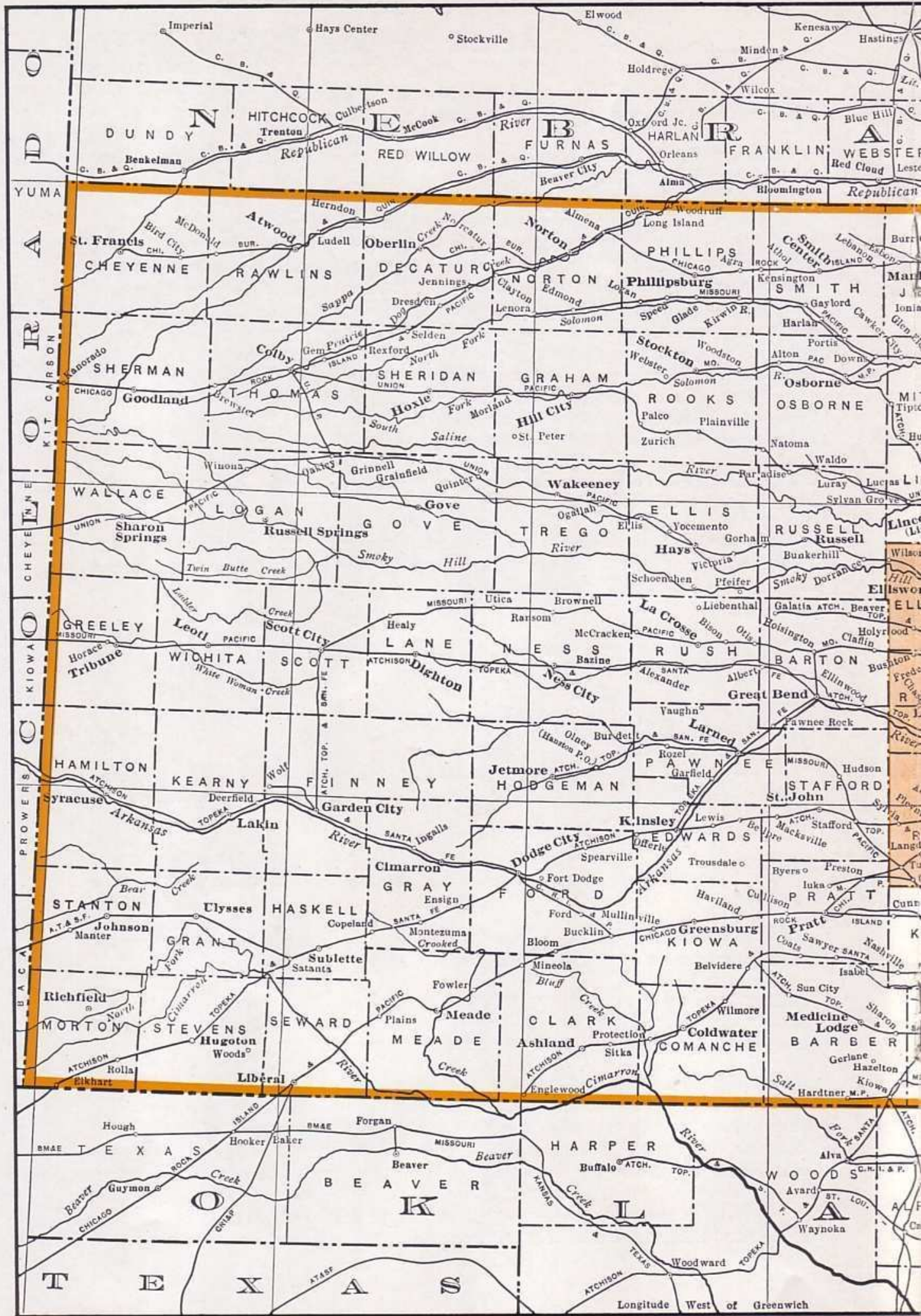
Clay. A plant at Buffalo burns locally mined clay to produce brick. Other plants formerly operated in the county. Clay used at Buffville fired to a buff color.

Coal. The Thayer coal district of western Neosho county extends across the line into southeastern Wilson county. During 1942 one mine produced 1,318 tons.

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

Limestone of commercial importance which crosses Wilson County from north to south, includes Iola, Plattsburg and Stanton formations. The Stanton limestone is quarried at the Fredonia cement plant.

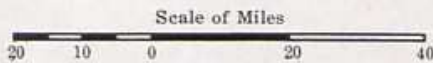
Oil and Gas. The first commercial oil well in Kansas was drilled near Neodesha nearly fifty years ago. Subsequently exploration spread over the entire county. Every township has produced oil or gas at one time or another. Neodesha, Altoona, Fredonia, Buffalo and Vilas have been more or less surrounded by oil and gas fields. In addition to oil wells there are a number of wells at present producing gas. Shale gas occurs in the Fort Worth formation. Other gas and oil wells produce from the lenticular sands in the Cherokee shale. The "Siliceous lime" has not been adequately tested in this county.



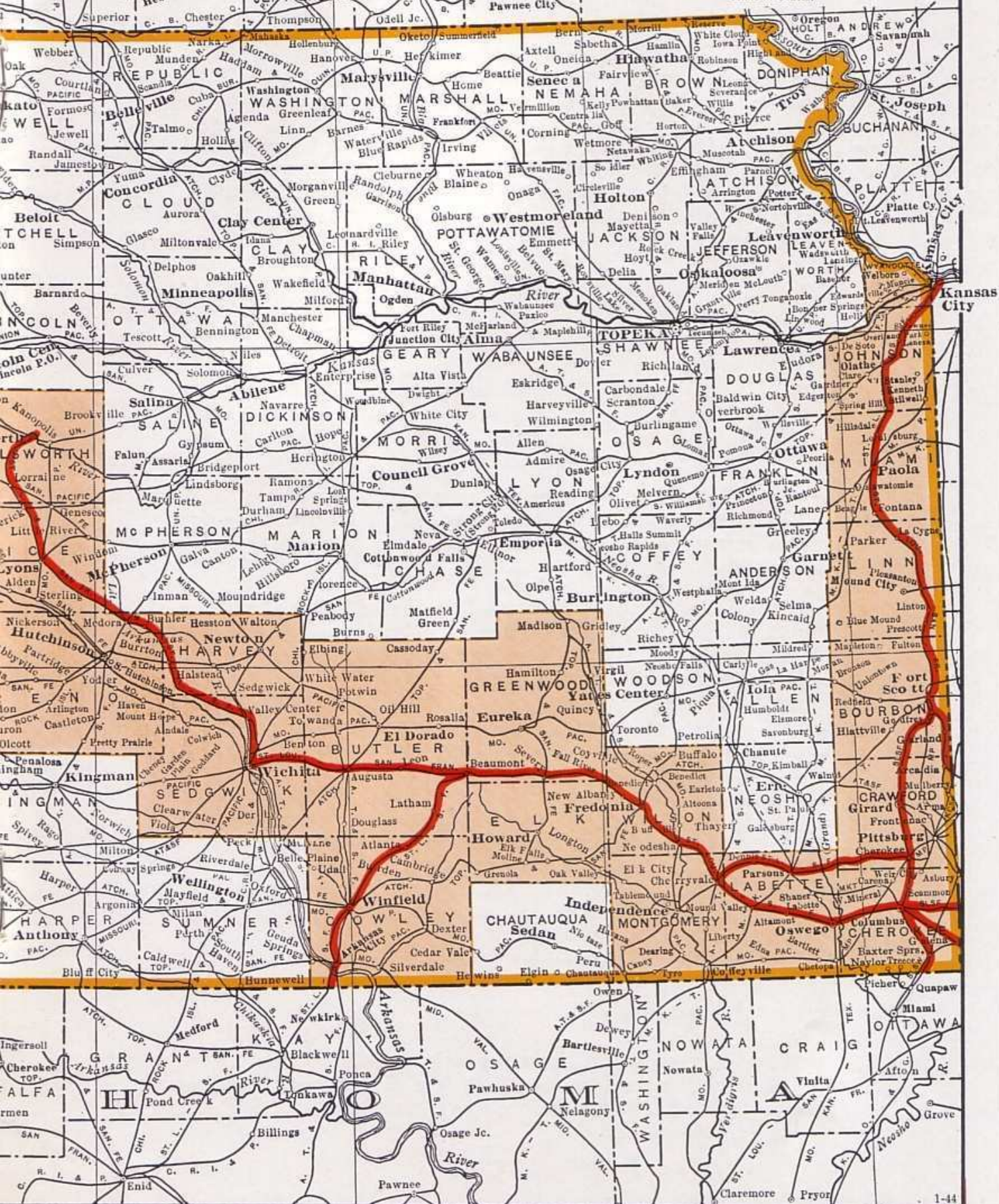
Longitude West of Greenwich

KANSAS

Frisco Lines in red
Counties served in yellow



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ELK COUNTY

Limestone including that belonging to the Deer Creek formation is to be found in the county. One of the largest quarries in the State mines rock from the upper part of the Deer Creek formation.

Oil and Gas. This county has been a producer of oil and gas for many years, the greatest development taking place shortly after 1924. The major concentration of oil and gas fields is in the southern and western half of the county. The Longton field is in the southeastern part of the county. Other important oil and gas fields include the Webb, Moline, Ferguson and Bush-Denton. While the peak production of nearly 900,000 barrels was reached in 1927 only 369,000 barrels were produced in 1941. As a rule the fields in the eastern part of the county produced from the "Mississippi lime" while those in the western part obtain from a half dozen sandstones in the Kansas City and Marmaton groups and in the Cherokee shale. Two fields have recently drilled into the "Siliceous lime" with successful results. One the Key pool and the other the Shambough pool, in the northwestern corner of the county. The "Siliceous lime" occurs at a depth of about 2,900 feet in this part of the county.

GREENWOOD COUNTY

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

Oil and Gas. This county is outstanding for "shoestring" sand production. The north half of the county is crisscrossed by the 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 this county, especially in the northeastern and south-central parts. A few pools produce from Lower Pennsylvanian horizons. The first important oil well in the county was drilled in 1921. Other new discoveries followed rapidly, and by 1926 the county was the leading producer in the state with a production in excess of 17,000,000 barrels. By 1941 it had dropped to 3,545,000 barrels. An extensive repressuring project is being carried on in the Madison field. Four plants produce gasoline from natural gas of the Madison, Seeley, Teeter and Thrall fields. Two of these plants are at Hamilton and one each at Madison and Kembro. Both the compression and absorption processes are used.

BUTLER COUNTY

Limestone. A seventy foot limestone series which includes the Florence limestone, limestones within the Oketo shale and the lower Fort Riley, lies at or close to the surface across the county from north to south. The reserves are practically inexhaustible.

Oil and Gas. Kansas first became recognized as an important oil state when a 20,000 barrel well was brought in, in what is now the El Dorado field in 1917. Even today this field is an important one. Since that time many oil and gas fields have been discovered in the county. The Augusta field produces from an anticline that is only slightly smaller than the El Dorado. 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 which immediately overlie the buried summits of the granitic mountains. In the western and northwestern part of the 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 produce from the "shoestring" sand bodies which lie on the Sallyards trend of Greenwood County. A plant at El Dorado produces gasoline from natural gas by the compression method, while another one at Gordon produces gasoline from gas by the absorption method.

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

SEDGWICK COUNTY

Clay. Local clays have been utilized in Wichita in two plants, one making face brick and the other producing brick and tile.

Limestone. Most of the 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. Limestone has been produced for road metal and concrete.

Oil and Gas was first produced commercially in the county in 1928 with the opening of the Valley Center field. Although the county has a score or more of oil and gas fields the Valley Center pool is still the largest. The total production in 1941 was 1,106,670 barrels. The Sedgwick County fields produce from a variety of formations, including the "Oswald lime," "Viola lime," Kansas City "lime," "Wilcox sand," "Mississippi lime," Penn. basal sand, top of Simpson, "Siliceous lime," Mississippian "chat" and Misener dolomite. 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.

Sand and Gravel is available in large quantities in this county from the bed of the Arkansas River and terrace deposits. Production of a large tonnage of sand is used mainly for structural, paving, blast, engine and railroad ballast purposes.

KANSAS MINERAL WEALTH

Wool Rock. An exceedingly fine white rock wool was blown from samples collected in the Wichita area by the State Geological Department.

HARVEY COUNTY

Oil and Gas. The first commercial oil pool was discovered in this county in 1923. It lies near the eastern boundary and produces from formations in the Kansas City-Lansing groups. The next major discovery was made in 1931. This field lies in the northwestern corner and extends northward into McPherson County. Some very large oil and gas wells have been found in 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 found at depths around 3,500 feet. Other Hunton lime and "Mississippi lime" pools occur in the central and northern parts of the county. This county produced 687,600 barrels of oil in 1941.

RENO COUNTY

Helium is being extracted from locally derived natural gas at a plant near Cunningham, Kansas.

Oil and Gas was first produced commercially in the county in 1927, however it was not until 1932 that the county became an important producer through the deepening of a gas well in the Burrton pool. Subsequently this pool has become the largest in the state, with a yield of 5,250,000 barrels in 1936 which dropped to 3,237,603 barrels in 1941. Natural gasoline is produced from gas coming from this field by the absorption process.

Salt. Up to 500 feet of salt underlies the central part of this county. Three plants are reported producing salt by both brine wells and underground mining. The total production in 1935 was 241,388 tons. This amounted to about 40 per cent of the total salt production for the state.

Sand and Gravel. A large supply of sand and gravel is available in the bed of the Arkansas River which flows across the northeastern part of the county. Normally several thousand tons are produced each year.

Volcanic Ash. A deposit of volcanic ash has been reported 1½ miles south of Arlington. The size of this deposit is not known.

RICE COUNTY

Clay. Large deposits of plastic fire-clay and siliceous fire-clay occur in central and north central Kansas; particularly in Ellsworth and Rice counties. These clays are suitable for use in manufacturing fire-brick and other refractories, pottery, stoneware, glazed and unglazed tile and facing bricks. The clays fire to light colors ranging from nearly white to dark buff. (State Geological Survey, Bulletin 41, Part 3).

Oil and Gas. While oil was first produced in this county in 1924 with the discovery of the Welch pool in the southeastern part, large scale development of the county's oil and gas resources did not take place until 1929 when the Raymond pool in the western part was discovered. Subsequently about two dozen new fields have been discovered, mainly west and north of Lyons. The Raymond pool continues to be important. Rice County led the state in 1936 with a production of 11,427,072 barrels, or about 20 per cent of the state's total. Production in 1941 was 7,686,178 barrels. The county lies on the southeastern "nose" of the Central Kansas Uplift. Most of its production is obtained from Ordovician rocks.

Salt. Rice County is underlain with salt beds exceeding 300 feet in thickness. Two operators are reported producing both evaporated and rock salt. The mines and brine wells are near Lyons. A third mine in the eastern part of the county at Little River has been idle some time, but can be reopened at any time on short notice.

Sand and Gravel are abundant in the broad flood plains of the Arkansas River and Cow Creek in the southeastern half of the county.

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

ELLSWORTH COUNTY

Oil and Gas. The discovery oil well of Ellsworth County was completed in 1930. Now there are eight oil fields in the county. These are all in the southern and southwestern part. 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. Production for the county in 1941 was 3,214,400 barrels. The county also has two gas fields, the Satran and the Ellsworth. The producing sand occurs at a depth of a little less than 1,400 feet.

Salt. Two mines at Kanopolis in Ellsworth County produce many thousand tons of salt annually. It lies at a depth of about 860 feet. It is a part of the great salt body that underlies central and southwestern Kansas.

Sand and Gravel deposits are abundant along Smoky Hill valley from near the northwestern corner, to the southeastern corner of the county.

Volcanic Ash. At least two deposits of volcanic ash occur in this county. They lie east and southeast of Kanopolis.

COWLEY COUNTY

Helium in natural gas was discovered several years ago in the Dexter field. A helium extraction plant operated for a while at Dexter. This gas runs about 2 per cent helium.

KANSAS MINERAL WEALTH

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. The Fort Riley limestone has also been quarried in the vicinity of Winfield and Arkansas City.

Oil and Gas. One or more oil and gas fields has been found in almost every township in Cowley County. The greatest concentration however, occurs in the northwestern half, where such large fields as the Rainbow Bend, Winfield, State and Weathered occur. Production horizons include a shallow gas sand in the uppermost Pennsylvanian rocks; formations in the Shawnee group at depths around 1,500 feet; formations in the Kansas City group at depths around 1,900 feet in the eastern part of the county, and around 2,500 feet near Winfield; the Bartlesville sand, which produces oil in the Rainbow Bend and other prolific fields at depths around 3,000 feet; and the Ordovician "Siliceous lime" which lies at a depth of about 3,500 feet. A relatively small amount of oil is obtained from the "Mississippi lime" in the eastern and southern part of the county. While oil production reached a peak in 1926 of 4,000,000 barrels, it dropped to 2,787,000 barrels in 1941.

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

Wool Rock. High quality of rock wool has been blown from samples collected at the Silverdale quarry, and from two localities in the vicinity of Winfield.

WATER DATA

The accompanying map shows the rivers and principal streams in the State of Kansas through which the surface waters of the State drain. Water in many of these streams may be impounded to provide the requirements of large industrial plants.

Ground water in large quantities is available from alluvial deposits in the territory adjacent to Frisco Lines in most parts of Ellsworth, Rice, Reno, Harvey, Sedgwick and Cowley Counties. As to the ground water situation in the Counties of Butler, Cowley, Greenwood, Elk, Wilson, Montgomery, Crawford, Linn, Miami, Johnson and Wyandotte, we quote from State Geological Survey, Bulletin 41 (1942) Part 2, Pages 58 and 59:

"Most of the ground water in this area is obtained from limestones of Pennsylvanian or Permian age and from shallow alluvium along stream valleys. In a narrow belt that trends a little east of north, to west of south and passes through Woodson County, many wells obtain water from Pennsylvanian sandstone. Most of the wells in the southeastern region are relatively shallow, although many of the wells that tap limestone or sandstone are several hundred feet deep."

Except as noted below "the southeastern region, as a whole, is lacking in ground-water reservoirs capable of yielding large supplies of water. In the past

there have been dry years when it was difficult or even impossible, in many parts of this region, to obtain sufficient ground water for stock use."

Very large supplies of ground water are available from the alluvium of the Kansas River Valley in Johnson and Wyandotte Counties.

"During years of fairly abundant rainfall and stream flow, supplies of 100,000 to 200,000 gallons a day could be obtained from wells in alluvium of the Neosho River valley in the southern part of the region; comparable if not somewhat large supplies probably could be obtained from the alluvium of the Marais des Cygnes (Osage) River valley near the Missouri state line. Supplies of as much as 100,000 gallons a day probably could be obtained from wells along the sandstone belt, and perhaps at a few other places, but in most other parts of the region the available supply is much smaller. Doubtless somewhat larger supplies than those indicated above would be available for a period of a few years."

"The ground waters of this region range greatly in quality. Water from the alluvium and some of the bedrock formations generally is satisfactory for domestic and stock use, but waters from the permian rocks in the western part of the region and locally from limestones in different parts of the region may be highly mineralized, excessively hard, and unsatisfactory for most purposes. Analyses of water from 26 municipal wells in this region indicate that most of the waters range in hardness from 200 to 600 parts per million, but a few waters have 750 to more than 2,000 parts of hardness. In some waters the hardness is chiefly carbonate hardness, but in others, particularly in the western part of the region, it is mainly non-carbonate hardness. Most of these waters contain less than 50 parts per million of chloride, but a few contain more than 100 parts and a few, particularly from deep sources, may contain more than 1,000 parts of chloride. Most of the waters contain less than 0.15 part per million of iron, but some contain from 1 to 10 parts or more."

As to the ground water situation in Bourbon, Crawford, Cherokee and Labette Counties in which moderately large supplies are available from deep wells, we quote further from the above Bulletin, Pages 46, 47 and 48:

"These counties adjoin the eastern and southern state boundaries of Kansas and comprise part of the lead and zinc mining district of southwestern Missouri, southeastern Kansas, and northeastern Oklahoma, this being known as the Tri-State district."

"The principal water-bearing formations in the Tri-State district are, in ascending order: the Lamotte sandstone (Upper Cambrian); Roubidoux sandstone, Jefferson City dolomite, and Cotter dolomite (Ordovician); and Boone limestone (Mississippian)."

"In most of the area water from the Lamotte sandstone is very hard and contains so much chloride that it is not suitable for domestic or industrial use. The Roubidoux sandstone is the deepest formation that yields large quantities of water suitable for domestic or industrial use, and is the most common source of water for municipal and industrial supplies in the Tri-State district. The Roubidoux is about 700 feet below the surface in the eastern part of the area, along the Kansas-Missouri state line, and 1,200 feet or more below the surface in eastern Labette County. Its minimum thickness is about 70 feet and occurs in the northeastern part of the area; its maximum thickness is more than 200 feet and occurs in the southwestern part of the area. The overlying Jefferson City dolomite, Cotter dolomite, and Boone lime-

KANSAS MINERAL WEALTH

stone also yield fairly large supplies of water. All of these formations crop out at the surface in the Ozark region of south-central Missouri, where water enters the permeable beds from local precipitation."

"Most of the wells that tap these formations range in depth from about 600 to about 1,500 feet, depending largely on whether the wells penetrate part or all of the formations down through the Roubidoux sandstone. The water contained in these beds is under sufficient hydrostatic pressure to rise in the wells above the point at which the water is encountered, but at the present time it does not rise sufficiently high to flow at the land surface. The water level in most wells ending in pre-Pennsylvanian formations stands from 75 to 175 feet below the land surface."

"The yields of most of the deep wells range from 100 to 1,000 gallons a minute, but a few wells are reported to yield as much as 1,400 gallons a minute. In general the largest yields are obtained from wells that tap more than one formation, but in some wells it is necessary to case off one or more formations in order to obtain water of satisfactory quality. A test well drilled recently near Parsons is 1,465 feet deep. It yielded 847 gallons a minute, with a draw-down of about 200 feet at the end of a 100-hour pumping test, from all formations included between the top of the Mississippian and the base of the Roubidoux. The static water level in this well is about 176 feet below the land surface."

"In most parts of the Southeastern deep water area yields of 150,000 to more than 1,000,000 gallons a day are available from individual deep wells, and continuous supplies of 500,000 to possibly as much as 5,000,000 gallons a day are available from groups of properly constructed and properly spaced wells. Larger supplies would be available during shorter periods for emergency use."

"Water from wells in pre-Pennsylvanian formations of southeastern Kansas has a considerable range in quality, depending in part upon the geographic location of the well, the number and character of formations tapped by the well, and the manner in which the well is cased. Waters from most wells that tap the Roubidoux and one or more of the overlying formations range in hardness from 200 to more than 400 parts per million (most of which is carbonate hardness) and in general contain only small amounts of iron. A few waters contain more than 1 part per million of iron and a few contain noticeable amounts of hydrogen sulphide. The waters range widely in content of chloride, from as little as 4 parts per million to as much as 1,200 parts. The chloride content of water in the Roubidoux is greater in the western part of the area than it is in the eastern part and seems to become progressively greater with increased depth of the westward-dipping beds. Thus, at Pittsburg the chloride content of water from the Roubidoux is only about 90 parts per million; at Parsons it is 1,200 parts, and farther west it probably is still greater. In many places water in the Pennsylvanian formations contains larger concentrations of sodium chloride (common salt), and in general, wells should be tightly cased through the Pennsylvanian formations. In some places, wells yield salty water that is believed to leak in from Pennsylvanian rocks through leaky or improperly seated casings. In most places the water from deep wells is of satisfactory quality for most industrial uses, but the waters containing large quantities of chloride are suitable only for certain purposes such as cooling or fire protection."

**Basic Geologic Raw Materials for Industrial Chemicals;
Availability in Kansas**

Materials	Fre- quency Index*	Availability	
		Kansas Sources	Sources in Region
Water.....	99	Industrial ground-water supplies in excess of 5 million gallons a day can be obtained in many places. In selected localities supplies in excess of 20 million gallons a day are available. Temperatures generally are below 60° F.	
Coal.....	91	Annual production now runs to nearly 4 million tons, and has been as great as 7½ million tons. All Kansas coal is bituminous. The known reserves are sufficient to allow continuation of the production rate for many years.	
Common salt.....	75	Kansas has practically unlimited reserves of salt; they are estimated at 5,000 billion tons. The present production is about 700,000 tons annually.	Louisiana.
Limestone.	63	The amount of available limestone in Kansas is enormous. Much of it is nearly pure CaCO ₃ . A great amount is "impure" and hence useful for many purposes, for which purer calcium carbonate is undesirable. Quarries and quarry sites are numerous and widely scattered.	
Sulphide Ores.....	32	Zinc sulphide (sphalerite) and lead sulphide (galena) are the principal ore minerals of lead and zinc in the Tri-State mining district. Iron disulphides are associated with these minerals, and there are minor amounts of cadmium sulphide and copper iron sulphide in the area. Pyrite (FeS ₂) is produced as a by-product of the purification of coal in the south-eastern Kansas coal field.	
Brines.....	24	Enormous quantities of oil-field brines in all oil-producing areas.	Oklahoma, Texas, Louisiana.
Petroleum.	23	Petroleum is produced in 62 counties in Kansas. The production in 1942 was 97,845,000 barrels.	Oklahoma, Texas, Louisiana.
Natural gas	16	Annual production is nearly 100 billion cubic feet.	Large reserves in states to the south.

(Concluded on page 20)

*Frequency index number is the number of times the particular mineral is used as raw material in the production of 150 important industrial chemicals, as found by Keller and Quirke. (*Economic Geology*, Vol. 34, May 1939, pp. 287-296.)

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Basic Geologic Raw Materials for Industrial Chemicals; Availability in Kansas

(Concluded)

Materials	Fre- quency Index*	Availability	
		Kansas Sources	Sources in Region
Gypsum...	10	Kansas has a great amount of gypsum. It is produced in two areas; Barber County and Marshall County. The state normally holds eighth place among the states as a producer.	Oklahoma and Texas.
Lead ores..	9	Lead ore is produced with zinc in the Tri-State area.	
Sand.....	9	There is a virtually unlimited supply of sand in nearly all parts of Kansas. Moulding sand is being produced in several areas, especially in the Kansas City district.	
Aluminum minerals...	8	High alumina clays in central Kansas and locally in eastern Kansas.	Bauxite in Arkansas; high alumina clays in southern Oklahoma and Missouri.
Phosphate rock.....	6	Small supply of high grade nodules locally in eastern Kansas.	Northern Arkansas.
Magnesium minerals...	3	A potential supply of magnesium in oil field brines. A limited amount of dolomite, $\text{CaMg}(\text{CO}_3)_2$ in south central Kansas.	
Zinc ores..	3	Produced in the Tri-State area, (Missouri, Kansas and Oklahoma).	

*Frequency index number is the number of times the particular mineral is used as raw material in the production of 150 important industrial chemicals, as found by Keller and Quirke. (*Economic Geology*, Vol. 34, May 1939, pp. 287-296.)

