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Occurrence of Natural Gas in Kansas

by

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KANSAS GEOLOGICAL SURVEY
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OCCURRENCE OF NATURAL GAS IN KANSAS[1]

by

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1/ Publication authorized by Director, Kansas Geological Survey
2/ Chief of Geologic Research
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ABSTRACT

Natural gas production in Kansas totals about 11.4 trillion c.f. since commercial discovery in 1873 in Allen County. The large Hugoton Gas Area, located in the southwestern part of the state, accounts for most of the production. Kansas gas reserves are estimated at about 17.4 trillion c.f.

Permian rocks have yielded about 74 percent of the cumulative production, Pennsylvanian rocks 15 percent, Mississippian rocks 9 percent, and the remaining 2 percent is from Lower Paleozoic rocks. A very minor amount of gas has been produced from Cretaceous rocks in northwestern Kansas.

Cumulative gas production reported from the major structural features of the state are the Hugoton Embayment, 76 percent; Cherokee Basin, 8 percent; Sedgwick Basin, 8 percent; Central Kansas Uplift, less than 3 percent; Pratt Anticline, less than 2 percent; and the Forest City Basin, Nemaha Anticline, and Salina Basin each less than 1 percent.

Helium, natural gas liquids, and carbon black are important byproducts from the natural gas. Transport of the gas is by more than 12,000 miles of pipeline. About half of the amount of the annual production is consumed within the state.

INTRODUCTION

Kansas is the fifth largest natural gas producer and fourth in reserves in the United States. This pre-eminent position is mainly because of production from the Hugoton Gas Area, one of the largest gas fields in the world. It is located in southwestern Kansas and extends into Oklahoma and Texas.

The year 1873 marks the discovery of the Iola Gas Field in Allen County in eastern Kansas, and the following year gas was piped to nearby Paola. However, abundant gas supply was not found until 1893 (Hambleton and others, 1962). The availability of cheap gas contributed to quick industrial growth and by 1903, over

15,000 domestic customers were served in eastern Kansas. In 1905, there were 20 glass works, 33 brick plants, and a number of zinc smelters using the cheap natural gas. Gas production leveled off after 1908 (when it reached 80 billion cu. ft./yr.) and did not reach that again until 1937, and only then because of increased production from the Hugoton Gas Area. The Hugoton discovery well was drilled in Seward County, Kansas in 1922, and by 1931 significant quantities of gas were being produced; gas production has increased in Kansas every year since this, until 1965. With the exception of the Lost Springs Field, Marion County, in the Salina Basin, large new gas fields discovered since 1946 are located in south-central and western Kansas.

About half the quantity of gas produced annually is consumed in Kansas, and over 12,000 miles of gas pipeline transport inter- and intra-state movement of larger quantities.

STRATIGRAPHY

The stratigraphic section in Kansas is relatively thin when compared to the deeper basinal areas such as the Denver or Anadarko Basins. The maximum thickness of sedimentary rocks is about 9,500 feet in the southwestern part of the state (Fig. 1). When viewed in perspective, the sedimentary strata constitute only a veneer covering the Precambrian basement complex. Also when compared to geosynclinal areas, the stratigraphy is seemingly simple and the succession of many thin beds of sediments has been compared to that of a layer cake (Merriam, 1963).

The Precambrian basement complex consists of igneous and metamorphic rocks and slightly altered sediments. The igneous rock most reported is granite; the most frequently reported metamorphics are quartzite and schist. The over-all distribution of rock type is known only vaguely despite more than 2,500 control points, because most of the control wells are located along the crests of the Nemaha Anticline and Central Kansas Uplift, and most identifications of rock type are generalized. A weathered

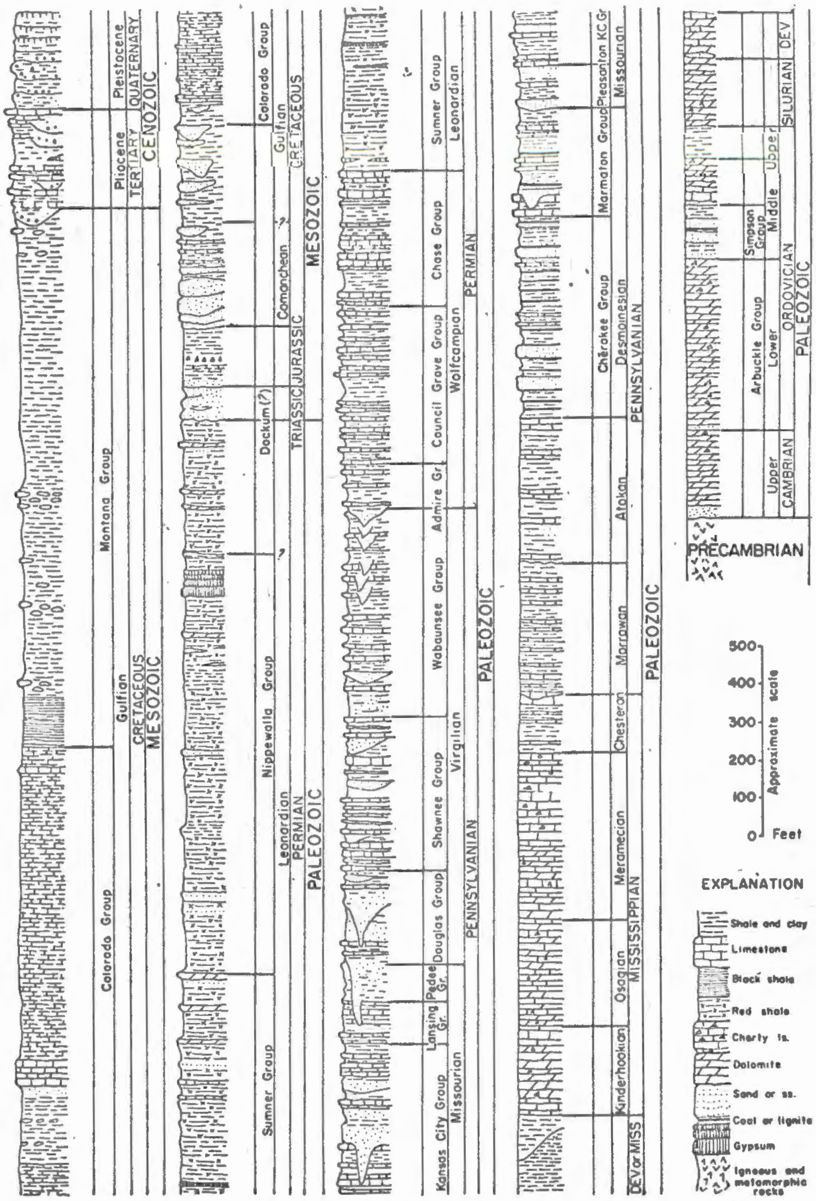

Figure 1.- Composite stratigraphic section of rocks present in Kansas. Beds older than Mississippian are known only in subsurface (modified from Moore and others, 1952).

or detrital material, known as "granite wash," covers large areas beneath Paleozoic sediments (Merriam, Cole, and Hambleton, 1961).

The pre-Pennsylvanian Paleozoic rocks consist mainly of marine sediments - limestone and dolomite and some shale and sandstone; chert is abundant in many of the units. Rocks of Cambrian, Ordovocian, Silurian, Devonian, and Mississippian age are present in various parts of the State. Siluro-Devonian sediments are not known to be extensively present west of the Central Kansas Uplift. The thickest sections of pre-Pennsylvanian rocks occur near the centers of the basins where they have been preserved from extensive erosion. Pre-Pennsylvanian rocks are missing from the crests of many of the uplifts, and unconformities are common and widespread in this part of the section. A major unconformity occurs between rocks of Mississippian and Pennsylvanian age.

Rocks of Pennsylvanian and Permian age occur almost statewide. Thin but persistent units, characterized by cyclic sediments of marine and nonmarine strata, can be traced over large areas of the Midcontinent region. Lateral facies changes occur between the shallow shelflike areas and the deeper basins. The numerous breaks in this part of the section are usually marked by channel sandstones that occur at the disconformities. The end of the Paleozoic is marked by a complete change in sedimentary and structural conditions.

Rocks of Mesozoic age are predominantly thick accumulations of marine shale, limestone and chalk, but nonmarine deposits of sandstone and shale are also widespread. Mesozoic rocks are present in about the western half of the State and increase in thickness west and northwest toward the Rocky Mountain region. The basal units of the Mesozoic overstep the older Paleozoic beds with pronounced unconformity. The upper limit of the Mesozoic beds is also an unconformity that indicates another complete change of geological conditions.

At the end of the Mesozoic, environment changed from marine to nonmarine. Tertiary rocks blanket the western one-third of the State, and because of the unconformity at the base of these sediments and the different structural conditions existing during the Tertiary, it is impossible to use surface structure as an indication of structure in the older beds.

Beds of Quaternary age, for the most part consisting of sand, gravel, silt, and clay, are confined to the present drainage systems and are relatively thin. The northeastern part of the State is covered by Pleistocene glacial deposits.

Igneous rocks crop out at seven localities in Kansas. Five of these are in Riley County and two in Woodson County. The rock type is a peridotite, with the exception of one granite outcrop in Woodson County. All of these intrusions are probably late Mesozoic or early Tertiary in age.

REGIONAL STRUCTURE AND GAS-PRODUCING PROVINCES

Parts of seven major structural units in the Midcontinent region are present in Kansas as well as two units that are contained entirely within the State's boundaries (Merriam and Goebel, 1956). Four of these major structures are uparched areas that separate downwarped basins and serve to delimit them (Fig. 2). The basinal areas are larger in areal extent than the uparched areas by a ratio of about 6:1 and likewise their volume of sediment is larger. The Hugoton Embayment, for example, extends over about one-fourth of the State. These structural elements were formed primarily in late Paleozoic time and have remained essentially unchanged.

Forest City Basin.- Most of the Forest City Basin is located in the adjacent states of Iowa, Missouri, and Nebraska, and only the extreme southwestern corner lies in Kansas. This basin is bounded on the west by the Nemaha Anticline and on the south by the low indistinct Bourbon Arch. The axis of the basin trends slightly east of north and parallels and lies close to the axis of the Nemaha Anticline. The position of the basinal axis near the Nemaha gives the basin an asymmetrical profile with a steep west flank and a gentle east flank. Mississippian and older strata are upturned, truncated, and overstepped by Pennsylvanian sediments on the west side of the basin along the Nemaha Anticline. The present basin has been a depositional area since post-Arbuckle time, first as part of the older North Kansas Basin, then as a separate feature. It was not until after Mississippian time that the Forest City Basin came into being as known today. During early Pennsylvanian time the basin derived sediments from the low chain of hills of the Nemaha granite ridge. Lee and others (1946) have discussed the geology of the Forest City Basin.

The principal gas-producing beds are shallow Pennsylvanian sands. Many fields, now depleted, produced large quantities of gas, but the production was not adequately recorded. The McLouth gas field of Leavenworth and Jefferson Counties produced gas from basal Pennsylvanian sand and weathered Mississippian limestone (Lee and Payne, 1944), but is now used for gas storage (Merriam and Goebel, 1959b). Cumulative gas production from the basin accounts for less than 1 percent of the State's total (Table 1).

Bourbon Arch.—The Bourbon Arch is a low indistinct structural feature having a northwest-southeast trend (Jewett, 1951, p. 110). It separates the Forest City Basin on the north from the Cherokee Basin on the south. It has been shown as a unit with no width (Fig. 2) and is not considered a major structural feature in this paper.

Cherokee Basin.- The northwest part of the Cherokee Basin occupies extreme southeastern Kansas. It is a shallow basin, which in early Pennsylvanian time developed on top of the older Chautauqua Arch. It is probably more a depositional than a structural basin, although a certain amount of downwarping took place to accommodate sedimentation.

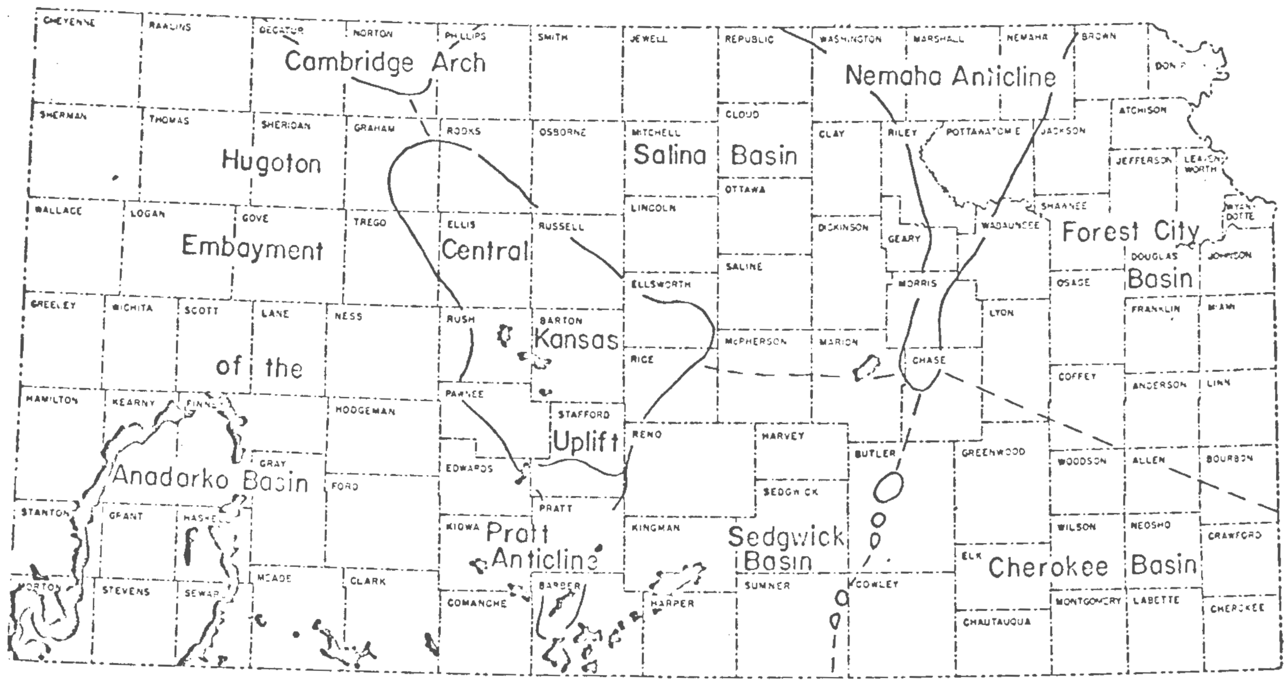

Figure 2.- Relation of gas fields in Kansas with cumulative production known to exceed 10,000 MM c.f. to major structural features (modified from Hilpman and others, 1964).

As in the Forest City Basin, the structural axis of the Cherokee Basin lies near and parallel to the Nemaha Anticline making the basin asymmetrical. On the west flank of the basin there is truncation of the early Paleozoic beds as in the Forest City Basin.

Gas production was first reported from the Cherokee Basin in 1873 from the area of the Iola field in Allen County. Most of the gas has been produced from Pennsylvanian sands. Conservative estimates of cumulative gas production are about 8 percent of the total (Table 1).

Nemaha Anticline.- The Nemaha Anticline trends northeast-southwest across Kansas, continuing north into Nebraska and south into Oklahoma. The narrow anticline separates the Forest City and Cherokee Basins on the east from the Salina and Sedgwick Basins on the west. The Precambrian granite core of the anticline comes within about 600 feet of land surface near the Kansas-Nebraska line, but plunges south, so that on the Oklahoma-Kansas line it is about 4,000 feet below the surface. On both sides of the uparched area, pre-Pennsylvanian strata have been upturned, truncated, and overstepped. Farther south along the ridge, near the Kansas-Oklahoma border, however, the deformation is of less magnitude and sharpness, and the Paleozoic beds are folded over the crest. The anticline is faulted along the east side in several areas. The Nemaha Anticline was uplifted periodically in the late Paleozoic, at which time it divided the North Kansas Basin, and formed the western limit of the Forest City Basin and the eastern side of the Salina Basin.

Gas production from the province, although not significant, is from shallow sands of Pennsylvanian and Permian age. Much of the gas produced has been used in field operations. Less than 1 percent of the cumulative production has been recorded from fields along the Nemaha Anticline (Table 1).

Table 1. Cumulative gas production from Kansas structural features.

Structural unit	Percentage
Forest City Basin	* < 1%
Cherokee Basin	* 8%
Nemaha Anticline	* < 1%
Salina Basin	< 1%
Sedgwick Basin	8%
Cambridge Arch	none
Central Kansas Uplift	< 3%
Pratt Anticline	< 2%
Hugoton Embayment	76%

*Based partly on estimates

Salina Basin.- Only the southern tip of the Salina Basin extends into Kansas. By far the greater part of this structural unit lies in central Nebraska. The east edge of the basin is bounded by the Nemaha Anticline, the west side by the Cambridge Arch, and the southwest flank by the Central Kansas Uplift. Boundaries at the southern end are designated arbitrarily. This is the second largest basinal feature in Kansas. The axis of the basin trends northwest-southeast and plunges north toward the deeper part of the basin in central Nebraska. Pre-Pennsylvanian strata locally are upturned, truncated, and overstepped around parts of the perimeter of the basin, and sediments increase in thickness toward the center. Lee (1956) described in some detail the stratigraphy and structural development of the basin.

Most of the gas production in the Salina Basin comes from rocks of Mississippian age. With exception of one or two fields, production has been relatively unimportant. Most of the production, less than 1 percent of the State's total, comes from the Lost Springs field in Marion County (Table 1).

Sedgwick Basin.- The Sedgwick Basin, located in south-central Kansas, is a northern shelflike extension of the Anadarko Basin into Kansas. This basin or embayment is roughly symmetrical and plunges southward. It is bounded on the east by the Nemaha Anticline and on the west by the Central Kansas Uplift and Pratt Anticline. The strata in the basin are characterized by facies change and increased thickness southward from the shelf area into the deeper part of the Anadarko Basin proper (Kelly and Merriam, 1964).

Cumulative gas production from the Sedgwick Basin amounts to slightly more than 8 percent of cumulative production (Table 1). Gas in large amounts is found only in the uppermost part of Mississippian rocks, and Mississippian gas production has been found in most of the counties in the basin. Peaks of production occurred during the early 40's and in the late 50's.

Central Kansas Uplift.- The Central Kansas Uplift is the dominant structural feature of central Kansas. The uplift separates the Salina Basin on the east from the Hugoton Embayment on the west. Before the formation of the Cherokee Basin, this uplifted area continued to the southeast and connected with the axis of the old Chautauqua Arch. Along the crest and flanks of the uplift are several minor structures, which differ in trend from the uplift itself. Precambrian rocks are overlain by Pennsylvanian sediments, and on the flanks pre-Pennsylvanian sediments are upturned, truncated, and overstepped by Pennsylvanian beds. A good description of buried Precambrian hills on the uplift is given by Walters (1946). The structural history of the uplift is described by Lee (1953) and Walters (1958).

Gas production has been mainly from beds of Pennsylvanian age. Uniquely, gas is produced from fractured rocks of Precambrian age in the Orth field of Rice County and from "granite wash" in the Otis field (Stephenson and Moore, 1941). Production from the Central Kansas Uplift has amounted to about 3 percent of the State total (Table 1).

Cambridge Arch.- The Cambridge Arch is a large anticlinal feature located in Nebraska and Kansas. It is elongated in a northwest-southeast direction on the same trend as the Central Kansas Uplift and Chadron Arch of Nebraska. The trend forms an arcuate chain of uparched features convex to the southwest. A low structural saddle separates the Cambridge Arch from the Central Kansas Uplift. On the crest of the structure, Precambrian rocks are overlain by strata of Pennsylvanian age; older Paleozoic rocks are upturned, truncated, and overstepped on the flanks. The arch is flanked by several smaller paralleling anticlinal and synclinal structures (Merriam and Atkinson, 1955).

No significant gas production has been reported from the Cambridge Arch.

Pratt Anticline.- This feature is a large, broad, southward-plunging nose, separating the Sedgwick Basin on the east from Hugoton Embayment on the west. Farther south in Oklahoma the structure dies out and there is no distinction between the Sedgwick Basin and the Hugoton Embayment on the northeastern flank of the Anadarko Basin. On the crest of the anticline are several areas where Mississippian rocks are absent.

Slightly less than 2 percent of the State's total of gas has been produced from the province, peak production coming before 1940 and again in the early 60's. Considerable production has come from Viola, Simpson, and Mississippian rocks.

Hugoton Embayment.- The Hugoton Embayment, a northern shelflike extension of the larger Anadarko Basin of Oklahoma (Merriam, 1955) extends over parts of Kansas, Colorado, Texas, and Oklahoma. The eastern edge of the structure is formed by the Pratt Anticline, Central Kansas Uplift, and Cambridge Arch; the western limit is formed by the Las Animas Arch. It plunges south and the sediments generally thicken both toward the axis of the embayment and south into the Anadarko Basin. The embayment is reflected in Paleozoic rocks and is not expressed in Mesozoic and Teritary beds.

The big production in the province has been the gas from its namesake, Hugoton Gas Area, of which more than 50 percent lies within Kansas. By definition, the gas production from the Hugoton Gas Area, which was discovered in 1922, is entirely from the Chase Group of Permian age. The reported production from the field during 1939 was more than 32,000,000 M. c.f., in 1954 the production exceeded 346,000,000 M.c.f. and exceeded 567,000,000 M.c.f. in 1964, which is about 70 percent of the State's total production (Table 2). Cumulative production from the Kansas portion of the embayment amounts to more than 76 percent of Kansas' total. Rocks of the Chase Group are found in the Hugoton Gas Area at depths of about 2,600 to 2,950 feet below the surface.

Table 2. - Percentage of the Kansas State total production from the Hugoton Gas Area

1964	70%	1955	85%
1963	72%	1954	85%
1962	71%	1953	92%
1961	69%	1952	90%
1960	71%	1951	90%
1959	68%	1950	88%
1958	65%	1949	85%
1957	68%	1948	77%
1956	73%	1947	75%

Pressure is anomously low for the depth; in 1963, shut-in pressure from selected wells veraged 350 psia. The reservoir of the Hugoton Gas Area is a stratigraphic trap that is due to the irregular distribution of porosity in dolomitic limestones along their strike. A westward limit of production seems to be the zone of marine and nonmarine interfingering (Moore and Jewett, 1942).

Additional gas reserves have been discovered within the province in recent years; some are geographical within and stratigraphically below the Hugoton Gas Area. The Pomona Gas Area is restricted by definition to gas production from the Council Grove Group, Permian. Of special significance in the area is the Greenwood Gas Area which by definition includes only production from Lansing-Kansas City and younger Pennsylvanian rocks. Morrowan gas production from Boehm, Richfield, Adams Ranch, Liberal-Light, Liberal Southeast, and Thirty-One fields contributes an important quantity of the cumulative figure (Kansas Geol. Soc., 1959). Mississippian gas production is important in the Hugoton Embayment. The large McKinney field in Clark and Meade Counties is perhaps the best example, and its discovery led to the development of other new Mississippian gas fields in Kiowa and Edwards Counties.

Small quantities of shallow-occurring gas have been produced from the basal part of the Pierre Shale and upper part of the Niobrara Formation (Cretaceous) in northwestern Kansas (Merriam, 1958).

NATURAL GAS PRODUCTION AND RESERVES

Cumulative natural-gas production of Kansas surpassed the 11,000,000 M.M.c.f. mark in 1964 (Fig. 3). This is a fantastic volume considering it is more than triple the total production of Kansas prior to 1949 and almost quintuple the amount prior to 1939. Since 1954, annual production has exceeded 500,000 M.M.c.f., and since 1943 has been more than 100,000 M.M.c.f. annually (Fig. 4). The 1965 estimated production, (worth an estimated 88.2 million dollars), is 800,082 M.M.c.f. from 8,356 gas wells, the second highest of all-time for the Sunflower State.

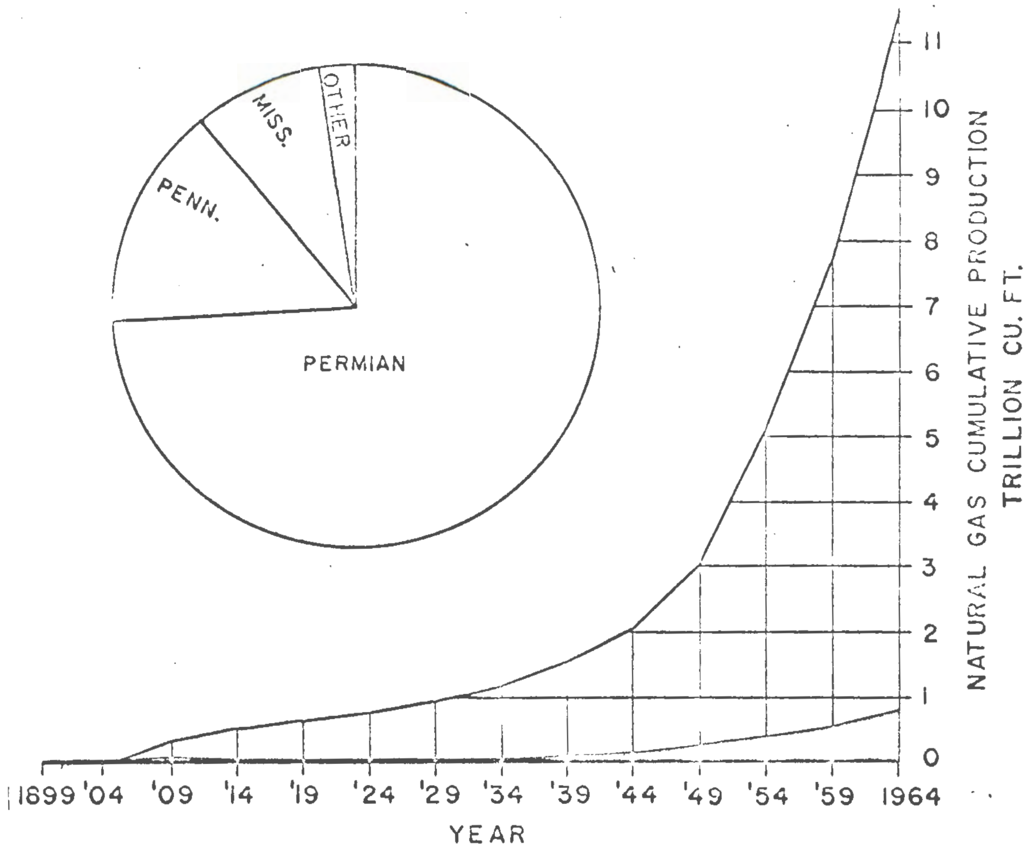

Figure 3.- Kansas cumulative natural-gas production rose above 11 trillion cubic feet in 1964. Permian rocks, mainly in Hugoton Gas Area of western Kansas, have yielded about 74 percent of total gas production, Pennsylvanian rocks are second, Mississippian rocks third, and remaining is from Lower Paleozoic rocks (in part from Merriam and Goebel, 1960).

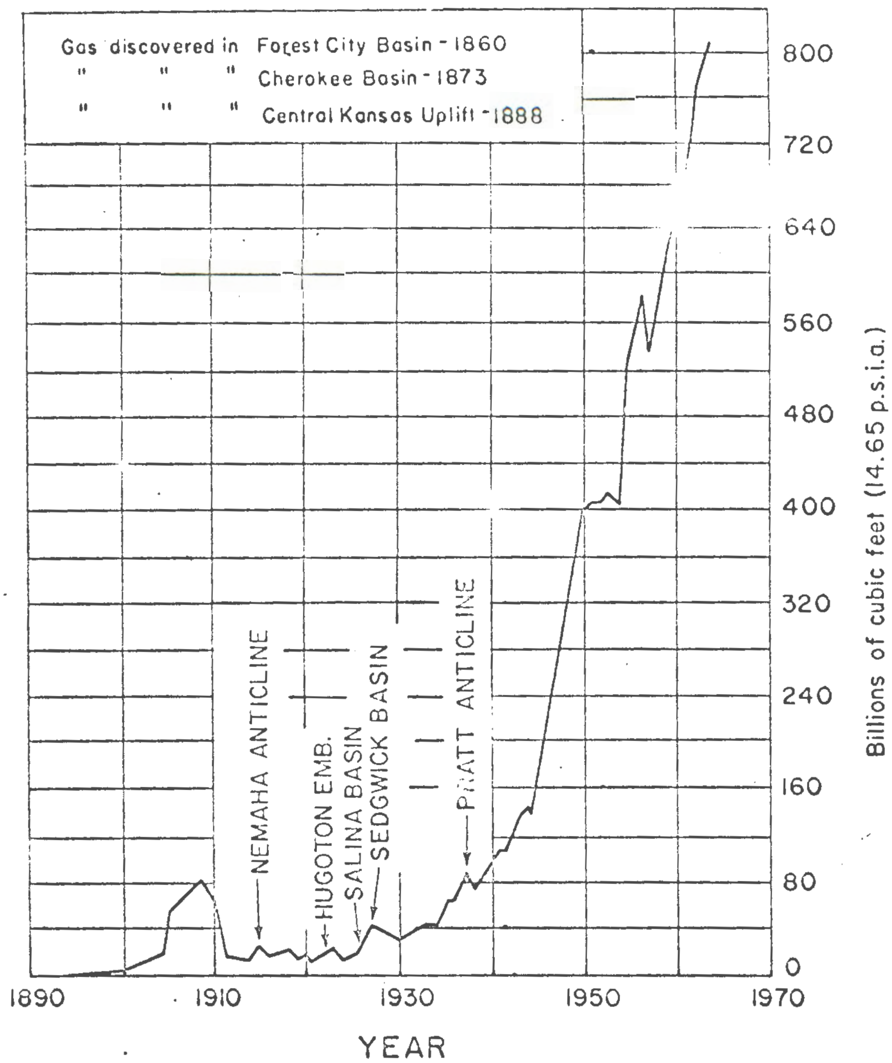

Figure 4.- Total gas production by year in Kansas from 1890 to 1964. Also shown is year of discovery from each of structural features (in part from Merriam and Goebel, 1956).

Gas from most Kansas fields is dry relative to other gas fields in southwestern United States. Heating value of gas from the Hugoton Gas Area ranges from 750 to more than 1,000 BTU per cubic foot and yields about 0.5 gallons of natural gasoline condensate per thousand cubic feet.

By far the greatest amount of gas has been produced from the prolific Hugoton Gas Area (by definition, Chase Group, Permian; Fig. 5). In recent years gas production from outside and stratigraphically beneath the Hugoton has been gaining in importance. Permian rocks yielded 74 percent of the cumulative total of the State through 1964. Pennsylvanian beds have supplied the second-largest amount of gas, yielding about 15 percent of the total (Fig. 3). Lesser amounts have been obtained from beds of Mississippian age (9 percent) and Lower Paleozoic rocks (2 percent). There is a notable absence of gas production from Silurian and Devonian rocks in Kansas. A very minor amount of gas, produced from Cretaceous reservoirs in northwestern Kansas, has been used locally.

Leading gas-producing fields in Kansas are listed in Table 3. The information is based on recorded and estimated production to the end of 1964. Many of these fields have received detailed study and are so noted. Location of fields with cumulative production of more than 10,000 M.M.c.f. are shown in Figure 2.

Helium, natural gas liquids, and carbon black are important byproducts of the gas producing and extraction industry in Kansas. Development of these has assumed an increasingly important role in the Kansas gas industry. Helium, uniquely, is present in a number of Kansas gas fields. Helium was discovered as a component of natural gas in Kansas by Cady and McFarland in 1908. The helium conservation program, supported by the federal government, has resulted in the location of several extraction plants in western

Table 3. - Gas fields in Kansas with cumulative production know to exceed 10,000 M M c.f. (in part from Oros and Beene, 1965).

Pool or field name and year of discovery=	County	Gas Prod. M cu. ft. (at base of 14.65 psia.) To end of 1964	Production zones
#Hugoton Gas Area ('22)	Finney, Grant, Hamilton, Haskell, Kearny, Morton, Seward, Stanton, Stevens	7,576,268,461	Chase Group
#Greenwood Gas Area ('51)	Morton	422,254,129	Wabaunsee, Shawnee, Lans.-K.C.
*Medicine Lodge-Boggs ('27)	Barber	280,935,863	"Douglas sand," Marmaton, "Penn conglomerate," Mississippian, Simpson.
*Spivey-Grabs-Basil ('49)	Harper, Kingman	186,581,115	Mississippian, Lans.-K.C.
Otis-Albert ('30)	Barton, Rush	152,311,000 est.	Neva, Reagan
*Rhodes ('54)	Barber	81,291,117	"Douglas sand", Mississippian
*Hardtner ('54)	Barber	79,730,402	Cherokee, Mississippian
#McKinney ('50)	Clark, Meade	65,859,654	Mississippian
+Glick ('57)	Comanche, Kiowa	51,639,265	Mississippian
Boggs SW ('55)	Barber	46,826,276	Mississippian
#Sparks ('54)	Morton, Stanton	46,303,873	Wabaunsee, "Keyes", Morrowan
Aetna Gas Area ('35)	Barber	40,152,681	Mississippian, Viola
#Richfield ('48)	Morton	32,193,340	Atokan, Morrowan
#Taloga ('55)	Morton	31,774,858	Morrowan, Cherokee
#Liberal-Light ('51)	Seward	30,205,910	Morrowan
Skinner ('43)	Barber	29,351,196	"Douglas sand", Lans.-K.C., Marmaton, Viola, Simpson
*Harper Ranch ('53)	Clark	27,858,525	Morrowan, Mississippian

#Liberal SE ('47)	Seward	26,941,085	"Penn sand", Chester
Lost Springs ('26)	Marion	24,501,906	Mississippian
*Nichols ('55)	Kiowa	19,674,410	Mississippian, Lans.-K.C.
Sharon NW ('56)	Barber	19,246,954	Mississippian
#Stevens ('52)	Meade	16,937,371	Morrowan, Mississippian
*Rhodes NE ('56)	Barber	15,017,268	Mississippian
Unruh ('45)	Barton	14,730,606	Arbuckle
Reichel ('53)	Rush	12,142,014	Topeka, Lans.-K.C., Granite wash
Borchers ('59)	Meade	12,123,208	Morrowan
#Eubank ('58)	Haskell	11,278,638	Toronto, Lans.-K.C., Marmaton, Cherokee, Morrowan, Mississippian
Boehm ('51)	Morton	10,932,296	Morrowan
Belpre ('42)	Edwards	10,323,107	Lans.-K.C., Mississippian
*Embry ('55)	Edwards	10,307,559	Mississippian, "Kinderhook"
Chitwood ('43)	Pratt	10,095,142	Viola

=Excellent individual gas field studies including data on geologic conditions and nature of trap, quality of gas, and production history are available in Kansas Geological Society I through IV. Roman numerals identify volume number of Kansas Geol. Soc. report containing field study.

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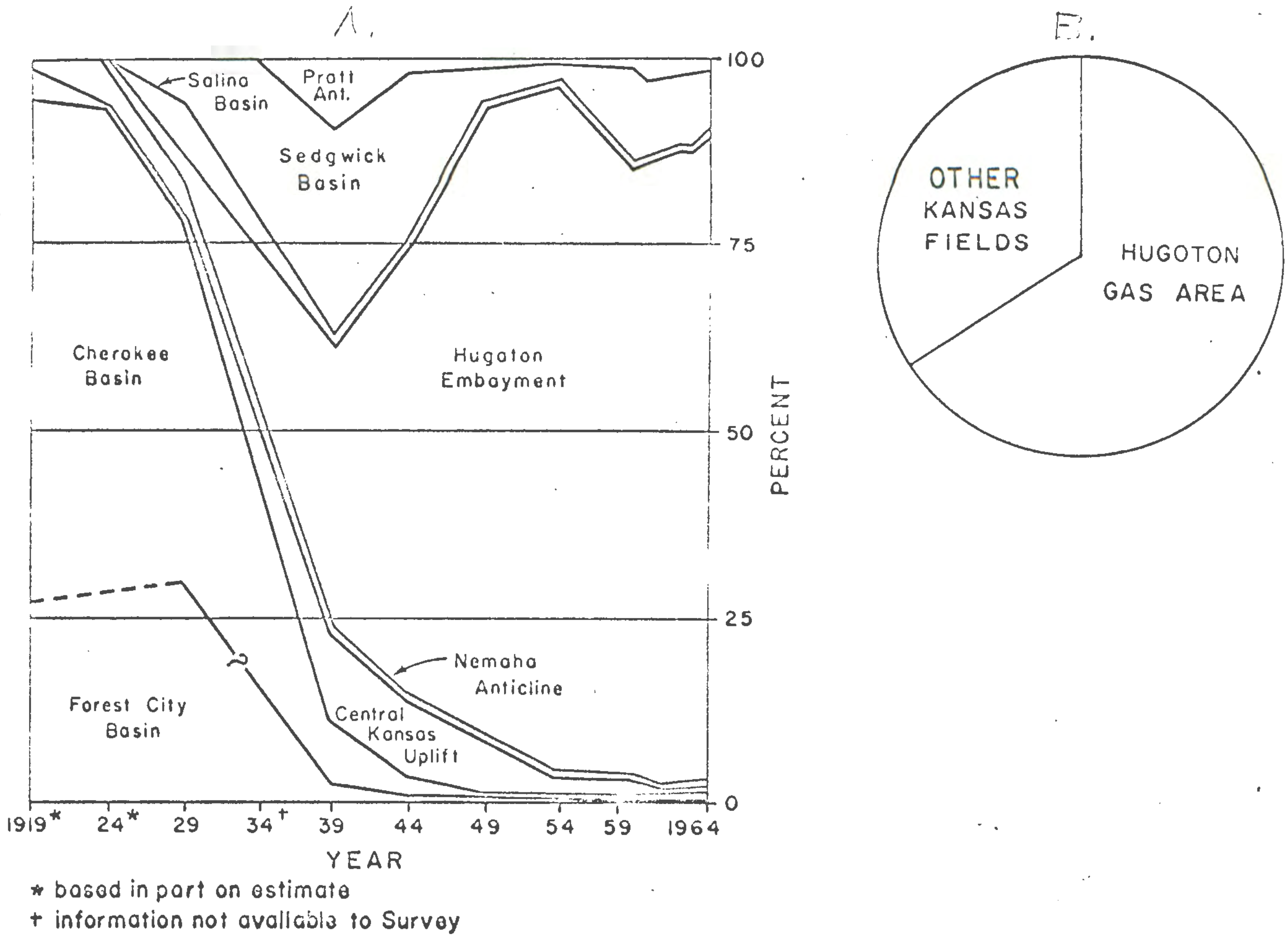

Figure 5. A.-Percent of gas production of the Kansas total by major structural feature is shown. B.-Relation of cumulative gas production from Hugoton Gas Area to rest of Kansas also shown.

Kansas, either in gas fields or along major transmission lines. Although the helium content of gas fields in southwestern United States is generally less than 0.5 percent, annual yields of helium are substantially high because of high withdrawal rate of gas.

Like crude oil, gas production since 1935 in Kansas is regulated according to market demand by the Conservation Division of the State Corporation Commission. Reserves of gas in many Kansas fields have been dedicated or in a sense encumbered to certain interstate pipelines by the Federal Power Commission in the interest of assuring marketing areas a long time supply. Through developmental drilling in established gas fields and the opening of many new gas fields, reserves of Kansas gas increased to a high of more than 20 trillion cubic feet in 1958 (Table 4). Since then the production rate has exceeded the finding rate of new reserves and a steady decline to 17.4 trillion cubic feet in 1964 has occurred.

ACKNOWLEDGMENTS

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Table 4 .- Natural gas reserves*, 1946-64 in Kansas (in part from Merriam and Goebel, 1959a)

Year	Natural gas (trillion c.f.)	Year	Natural gas (trillion c.f.)	Year	Natural gas (trillion c.f.)
1964	17.4	1957	19.3	1950	13.8
1963	18.1	1956	17.6	1949	14.5
1962	18.7	1955	16.3	1948	14.4
1961	19.2	1954	15.8	1947	14.6
1960	19.6	1953	15.8	1946	13.7
1959	20.0	1952	14.2		
1958	20.2	1951	13.5		

*Based on AGA figures: 14.65 psia.

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