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REPORT
1970**

**MINERAL RESOURCES
SECTION**

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University of Kansas June 1971
Lawrence, Kansas

In this issue: "The Disposal
of High-Level Radioactive Waste
in Salt: Why Kansas?"

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Kansas Mineral Industry Report

1970

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State Geological Survey of Kansas
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Introduction

All Kansas residents benefit from the Kansas mineral industries in one way or another. The State Geological Survey of Kansas is vitally concerned with our mineral resources and how they are used to further the welfare of the State. One response to the concern for optimum utilization of mineral resources was the organization, ten years ago, of what is presently known as the Mineral Resources Section.

In The Kansas Mineral Industry...1962, the purpose of this Section was outlined:

Guideposts of the Division's activities are the major role of mineral resources in the state's economy and the growing concern of Kansans regarding the state's economic future. One of our directives is the compiling of data on the state's existing and potential mineral resources, supported by the further objectives of preparing commodity reports, initiating or stimulating research where most needed, and keeping close liaison with Kansas mineral industries.

This annual report, a summary of the activities of the mineral industries during the preceding calendar year, provides information on production and reserves, fluctuations in demand, significant trends, and problems confronting industry. It outlines the present role of mineral resources in the economy of Kansas.

The Geological Survey's concern for the welfare of the State, its insistence on "maintenance of adequate mineral capability...effective application of technology in locating and extracting minerals...resolution of problems related to resource conflicts with the environment," reflects its primary responsibility to the State of Kansas and the people of Kansas. This responsibility has deeply involved the State Geological Survey in a project of extreme importance to Kansans--the proposed location of a demonstration site for the disposal of radioactive waste in salt deposits at Lyons, Kansas. Included in the Kansas Mineral Industry Report 1970 is an informative discussion, the title of which reflects the question of many Kansans--"The Disposal of High-Level Radioactive Waste in Salt: Why Kansas?"

Review of the Kansas Mineral Industry in 1970

Linda A. Flueckinger*

Kansas mineral production exceeded all previous records in 1970 with an estimated value of \$619 million (Table 1). This represents a 1.4 percent increase over the value of \$610 million in 1969 as compared to a 1.9 percent increase for 1969. Petroleum industry products (crude oil, natural gas and gasoline, and helium) accounted for 82.3 percent of the total with an estimated value of \$509 million. This gain of 2.4 percent over 1969 is attributed to more efficient exploration, inflated prices, and a certain degree of momentum from a previously stronger economy. A record output of natural gas and liquified natural gas products and strong market prices for both helped to compensate for a decline in crude oil production. Significant points about the Kansas petroleum industry will be reviewed by Margaret O. Oros later in this report. Gains in the estimated value of petroleum products, salt, and coal more than compensated for a loss of 3.3 percent in the value of metal and industrial mineral production from 1969 levels. This loss is attributed primarily to a continuing decline in Kansas construction contracts, a general economic slowdown, and the prolonged construction strike in the Kansas City metropolitan area.

Crude oil production and value continued to decline in 1970. Production decreased 4.4 percent to more than 84 million barrels while estimated value declined 3.5 percent to nearly \$280 million. In spite of a loss from 47.9 to 45.2 percent of the total mineral value over the past year, crude oil remains the most important Kansas mineral product. Unfortunately, the decline in production which began in 1957 is accompanied by a continuing decrease in proved reserves.

Natural gas production reached an all time high during the past year. Natural gas produced in 1970 amounted to over 909 billion cubic feet. This compares with 888 billion cubic feet produced in 1969, amounting to an increase of 21 billion

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TABLE 1. Mineral production and value in Kansas, 1969 and 1970.

COMMODITY	UNIT	1969		1970*		1970 % LOSS - GAIN FROM 1969	
		QUANTITY	VALUE \$1,000	QUANTITY	VALUE \$1,000	QUANTITY	VALUE
Cement: Portland	1,000 - 376 lb. bbl.	9,764	29,365	8,750	26,300	-10.4	-10.5
Masonry	1,000 - 280 lb. bbl.	348	1,022	310	910		
Clay and Shale [†]			13,424		12,568		- 6.4
Salt	1,000 short tons	1,270	17,090	1,280	18,075	+ 0.7	+ 5.8
Sand & Gravel	1,000 short tons	14,290	11,146	12,750	10,000	-10.8	-10.3
Stone	1,000 short tons	15,828	22,645	16,100	22,300	+ 1.7	- 1.5
Coal	1,000 short tons	1,313	7,108	1,621	9,712	+23.5	+36.6
Miscellaneous: Gypsum (raw and calcined), carbon black, salt brine, sulfur, lime, pumicite and volcanic ash, lead and zinc							
Crude Oil	1,000 - 42 gal. bbl.	88,716	290,102	84,812	279,879	- 4.4	- 3.5
Helium: Refined	1,000 CF (14.7 psia; 70°F)	312,000	8,279	300,000	8,190	+ 0.7	+ 3.4
Crude		2,665,700	32,548	2,700,000	34,020		
Natural Gas	1,000,000 CF (14.65 psia; 70°F)	888,038	115,445	909,413	130,046	+ 2.4	+12.6
Natural Gas Liquids (LPG)	1,000 - 42 gal. bbl.	27,150	51,042	27,186	57,180	+ 0.1	+12.0
TOTAL VALUE			610,708		619,002		+ 1.4

* The figures for 1970 are year-end estimates and should not be used as final figures. Final figures for 1970 will be available later in 1971.

† Clay and shale figures include value of clay and shale products.

cubic feet or 2.4 percent. Natural gas accounts for 20.8 percent of the total value of mineral production.

Estimated liquified natural gas production gained 0.1 percent in 1970. Production remains at more than 27 million barrels. However, estimated value has increased substantially from \$51 million in 1969 to \$57 million in 1970, a gain of 12.6 percent.

Helium production contributed to the overall gain in mineral value with an estimated production increase of 0.7 percent. Helium production is valued at \$42.2 million for 1970; production in 1969 was valued at \$40.8 million. This is a gain of \$1.4 million or 3.4 percent in the 1970 value of helium as compared with 1969. However, future production of helium is once again in doubt.

The non-petroleum sector accounted for 17.7 percent of the total mineral value, approximately \$109 million, a decrease of 3.3 percent over the final figures for 1969. In order of decreasing percentage of total mineral value, these include: (1) portland and masonry cement, 4.4 percent; (2) stone, 3.6 percent; (3) salt, 2.9 percent; (4) clay and shale products, 2.3 percent; (5) sand and gravel, 1.6 percent; (6) miscellaneous products whose values cannot be disclosed separately, 1.6 percent; and (7) coal, 1.5 percent. As most of the nonfuel minerals are used by the construction industry, their production has been depressed because of a continuing decline in total Kansas construction contracts from a high of \$639 million in 1967 to \$550 million in 1970. The decrease from 1969 is 4.5 percent. The prolonged work stoppage in the Kansas City metropolitan area was undoubtedly a major factor in accounting for the decrease in construction contracts in Kansas, as was the high cost of money. Industrial minerals used by the construction industry include sand and gravel, limestone, gypsum, clay, and shales. The nonbuilding sector shows a slight increase in construction contracts between 1969 and 1970. Other factors relating to production in 1970 will be discussed below.

Portland cement value of \$26.3 million and production were down more than twice (from the indicated national average of 5 percent). The portland cement industry as a whole is thought to be establishing the base for future growth and prosperity. At present, many plants are concerned with major problems of obsolescence (both from a cost and pollution point of view), low prices, and overcapacity.

The following plant changes occurred in Kansas during 1970. Permanent closing of the Lehigh Portland Cement Company plant in Iola was attributed by the company to age of the plant and the prohibitive cost of upgrading efficiency and environmental control to modern standards. The opening of this plant in 1900 inaugurated the portland cement industry in Kansas. At Bonner Springs, the Lone Star Cement Company has installed a single-chamber electrostatic precipitator on wet-process kiln 4 and is presently installing twin precipitators for three additional kilns. Existing facilities of the Monarch Cement Company at Humboldt are being improved by construction of a new packhouse with automatic pelletizing equipment, a package warehouse, and three additional drive-through silos.

The potential for the future appears great for portland cement and all construction materials because of a backlog in highway and airport construction, and housing demand. For 1971, F. W. Dodge¹ estimates that the construction it reports (75 percent of the total) will rise nearly 9 percent.

Estimated stone production in 1970 increased slightly over the previous year with a calculated value of over \$22 million. Kansas stone production consists of the following: (1) approximately 97 percent crushed limestone (of which 20 percent is used in the manufacture of cement and roughly 4 percent is used as agricultural limestone); (2) 1.4 percent crushed quartzite; (3) 1.0 percent crushed sandstone (of which 25 percent is used for cement); (4) 0.5 percent chat; and (5) 1.7 percent limestone and sandstone dimension stone. With construction slowdown and adverse weather conditions effecting declines in agricultural limestone, it is surprising that stone production increased slightly above that of the peak year, 1969. The increase may reflect continued high usage in highway construction. Improvement is expected for 1971; however, it will depend upon factors in the construction industry and climatic conditions. Opportunities for growth of the stone industry are present in water pollution control, sewage treatment, neutralization of acidic soil in mined land, and in use of limestone for the sorption of sulfur dioxide gases evolved during the burning of high-sulfur coals in power generation. The

¹Kostka, James G., Pit and Quarry, Jan. 1971, p. 72.

sulfur dioxide sorption method is presently being tested by the Kansas Power and Light Company in Lawrence, and is being considered for a proposed plant at La Cygne.

Salt production during 1970, 1.28 million short tons, showed increases of as much as 1.5 percent, and averaged an estimated 0.7 percent higher than in 1969. Estimated dollar value is up 5.8 percent to slightly over \$18 million. These changes are attributed to increased demand for evaporated salt and fine rock salt for feedlot consumption. A \$1 million development program has been reported for Morton Salt Company mine facilities located at Hutchinson.

Clay and shale products decreased an estimated 6.4 percent in value from \$13.4 million in 1969 to \$12.6 million in 1970. Value of bricks produced, approximately one-third of the total value of clay and shale products, decreased approximately 15 percent while sewer tile and light-weight aggregate declined slightly. The declines are again attributed to the prolonged Kansas City work stoppage and the slowdown in construction during 1970. Clay and shale products comprise approximately 2.3 percent of the total 1970 mineral value compared with 2.2 percent for 1969.

A trend toward increasing sand and gravel production since 1965 was halted during 1970. Estimated production decreased 10.8 percent from 1969 to 12.7 million short tons, while estimated value declined 10.5 percent to \$10 million. This figure is considerably larger than the 1 percent estimated nationwide decline for the industry. The decline is apparently due to the local construction strike as well as to the overall economic slowdown. Recovery is expected for 1971 with a possible increase of as much as 4 percent.

Miscellaneous products decreased 14.5 percent in estimated value during 1970 from \$11.5 to \$9.8 million. Miscellaneous Kansas mineral products listed in order of decreasing contribution to the total value include gypsum (raw and calcined), carbon black, salt brine, sulfur, lime, pumicite and volcanic ash, and lead and zinc. Values are not listed separately to prevent disclosure of confidential information. The decline in estimated value of these materials since 1969 is attributed mainly to termination of natural cement production and continued decline of lead and zinc mining. The Fort Scott Hydraulic Cement Company ceased operation early in 1970 after 102 years of production. The company's assets have reportedly

been purchased by Cullor Limestone Company, Inc., Fort Scott. Eagle-Picher Industries, Inc. closed its new Swalley Mine and Central Mill in October, 1970. The Swalley incline mine and pollution control facilities completed in 1969 were closed because of the high cost of pollution control and lower zinc prices. In addition, production of crude gypsum and calcined gypsum is reported down approximately 3 percent and 8 percent, respectively. On the positive side, Pearl-lite, Inc., of Mankato, began production of door panels in January 1971, after successful development of molding techniques for combinations of volcanic ash and urethane resins. Large growth potential is expected for building materials of this type. Interpace Corporation is reported to be negotiating sale of its expanded volcanic ash, filter-aid plant at Mankato.

Coal production has increased continuously from a 54-year-low of 666,800 tons in 1961 to 1,621,093 tons in 1970 with an estimated value of \$9.7 million. Production increased 23.5 percent between 1969 and 1970, and growth is expected to continue. The demand for coal will be strengthened by the consumption of approximately 4,000 tons per day by a plant at La Cygne being built jointly by Kansas City Power and Light Company and Kansas Gas and Electric Company. The Kansas Power and Light Company plant at Lawrence consumes 5,000 tons of coal per day. Successful restoration of land strip-mined for coal since January 1, 1969, has been demonstrated in 1969 and 1970 in compliance with the standards set by the State Mined-Land Conservation and Reclamation Board under the Kansas mined-land law.

The Kansas Geological Survey continued work on development and improvement of the Kansas mineral industry during 1970. Research continues in exploration and development of Kansas clay and volcanic ash resources. Absorbent granules were made from mixtures of bentonite and volcanic ash. Tests are presently being made on bentonite materials in connection with their possible exploitation. The Materials Development Division is researching development of rapid-fired ceramics and mineral fillers, primarily for plastics.

Colored ceramic chips for planters or patios have also been developed and are currently being evaluated. In 1970, a procedure for slip casting and decoration of ceramic art objects was set up for patients at the Norton State Hospital.

A review of Kansas mineral reserves, particularly coal, bentonite, and

volcanic ash will be made during 1971.

In a cooperative program with the U.S. Bureau of Mines, local power companies, and Kansas State University, the feasibility of using fly ash on coal strip-mined spoil banks is being investigated. The use of fly ash may provide a source of nutrients and/or alkaline material for correction of acid soil conditions, and may also provide a method of solid waste disposal, particularly for mine-mouth power plants. Results of tests in West Virginia give impetus to the use of fly ash for soil conditioning. The U.S. Bureau of Mines has granted the Survey \$3,000 to support student research on this program.

Studies of means and procedures for redeveloping mined land in southeast Kansas are continuing for the second year.

It seems appropriate here to emphasize the importance of the mineral industry to state and regional areas as well as to local communities. The Kansas Geological Survey is working to satisfy increased mineral resource demands; to resolve increasing resource conflicts related to surface disturbance, air and water pollution, and waste disposal in the mineral industries; and to determine the best use of land in order to protect nonrenewable mineral resources.

Review of the Petroleum Industry in Kansas

Margaret O. Oros*

INTRODUCTION

This short review covers some significant points about the Kansas petroleum industry. The State presently ranks seventh in production of crude oil, fifth in natural gas production, and about fourth in the nation in drilling. Discussed in this review are the Oil and Gas Division's current scouting and reporting program, changes that have occurred during the 11 years of 1960 through 1970, some local happenings of significance, a perennial problem of the oil producers and a suggested solution, and a current world problem and its possible effects on the Kansas industry. A suggested research program for recovering low-gravity oils is also mentioned.

WELL SCOUTING AND REPORTING

Since 1966, the Oil and Gas Division of the Kansas Geological Survey has been participating with the American Association of Petroleum Geologists and the American Petroleum Institute in a national well-reporting program. The chairmanship of the six-state North Mid-Continent District (Iowa, Kansas, Minnesota, Missouri, Nebraska, and Wisconsin)^{1/} for all 5 years has been maintained at the Kansas Survey. A geologist in each state reports wells drilled in his state. The Oil and Gas Division acts as a liaison for state reporters and CSD (Committee on Statistics of Drilling) headquarters.

The reporting program was started by the AAPG because there was such a difference in well totals reported for the individual states by various organizations. The API is now sharing the responsibility of the work. Well statistics reported by the group are used as official figures by the Federal government (Dix, 1970; Porter, 1970).

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^{1/} Only the eastern portion of Nebraska was included in CSD District 12 before 1970.

In order to report wells drilled in Kansas, it was first necessary to secure well data for all completions. Two commercial reporting companies are excellent sources for data on western Kansas drilling, but very little information about the many holes that were drilled in southeastern Kansas was received. Therefore, in 1966, the Oil and Gas Division began scouting that area by mailed questionnaires. Operators, in increasing numbers, have been cooperating by returning the completed questionnaires to us. Some also send copies of driller's logs, electric logs, and other types of information. All material received is placed on open file for use by the public.

Data on some of the unreported completions are obtained from the monthly list of holes plugged, which is prepared by the Oil and Gas Conservation Division of the State Corporation Commission of Kansas. We also visit company offices occasionally to obtain data from company records, as some of the Kansas operators prefer to have us do this. In one day, from one company, we obtained completion data on about a hundred shallow wells, and some information on nearly a hundred more.

Figure 1 shows the counties scouted. It also shows the drop in number of Intents-to-Drill filed from 1964 to 1970; 4,806 intents were filed for the State in 1964, and only 2,763 in 1970. Our success in reporting wells in the 20 counties is indicated by the change in wells reported in 1965 (40) and in 1966 (398).

The Survey's annual Oil and Gas Development Report, through the year 1966 (Oros and Beene, 1967, Table 3), included a built-in estimate of holes drilled for which reports had not been received. We are now receiving information on most of the holes drilled in the area scouted.

PRODUCTION AND REFINING

Crude oil production for 1960 through 1970 dropped from 113 million barrels, produced in 1960, to 85 million barrels in 1970 (Fig. 2). Crude oil produced by secondary recovery methods has held at a steady rate of about 20 million barrels per year (Figs. 2 and 3).

Natural gas production has increased from 633 billion cubic feet in 1960 to 909 billion cubic feet produced in 1970.

Natural gasoline and LPG (liquid petroleum gas) products increased from about 5 million barrels in 1960, to 27 million barrels in 1970 (Fig. 3). Until late in

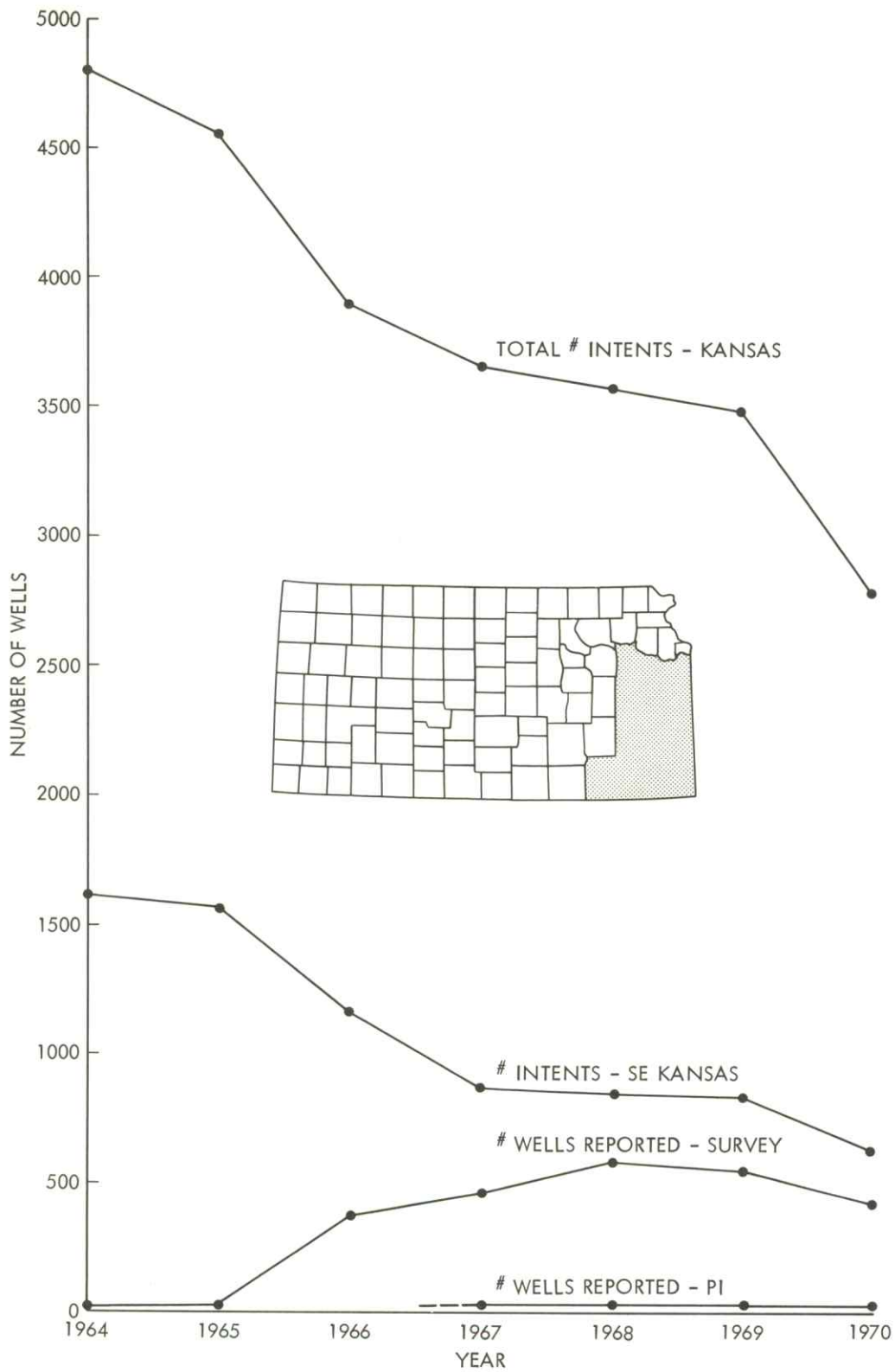


Figure 1.--Comparison of wells reported in 20 southeast Kansas counties by Survey's Oil and Gas Division and Petroleum Information, Inc., 1964-1970.

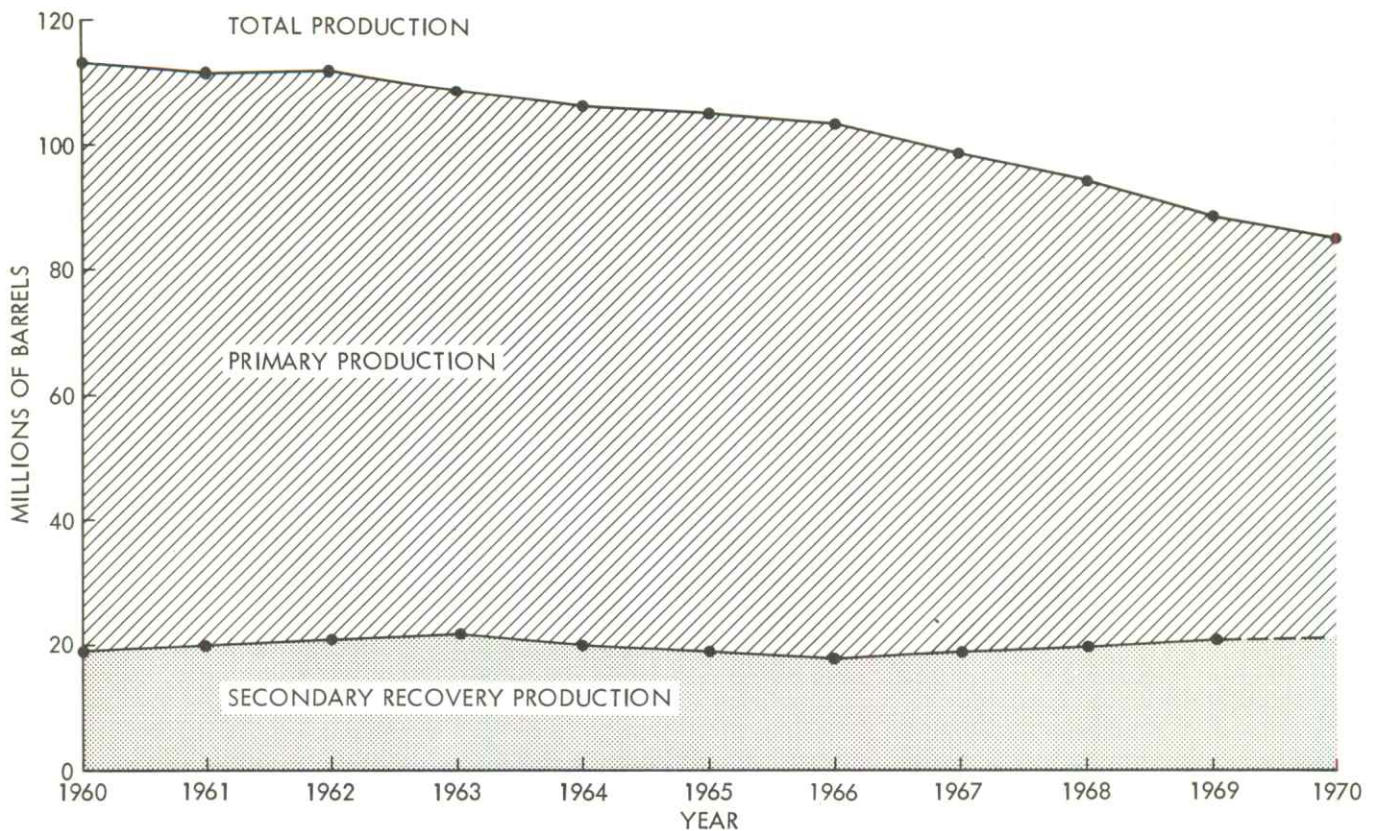


Figure 2.--Kansas crude oil production, 1960-1970. (Graph shows amount produced by secondary recovery methods.)

the 1960's, natural gasoline and LPG production figures, because production was low, were listed by the gallon instead of by the 42-gallon barrel. This method of measurement is still used by journalists in listing oil spills. Their figures, divided by 42, would not seem so dramatic.

The great increase in LPG production results from the construction of large helium extraction plants, and an increase in natural gas production. Prior to the construction of these plants, most of the natural gasoline in the State was obtained from "wet" or casing-head gas produced with oil from many oil wells, or from gas wells producing from the same oil-containing strata.

The LPG products (propane, butane, etc.) are removed from natural gas as its temperature is being reduced in the cryogenics process required to extract helium. Helium is the last element recovered. It becomes a liquid at virtually absolute zero (-273.16°C). Much of the natural gas processed by helium extraction plants

in Kansas is produced in Oklahoma and Texas. The helium is sent by pipeline to Amarillo, Texas, for storage in the underground Cliffside storage area. This conserves the helium, which is produced in quantities too large for immediate use and which would otherwise be lost forever.

Kansas has a number of extraction plants and underground storage areas (Fig. 4). Newer plants include Kathol Gas Company's Rattlesnake Creek Natural Gasoline Plant in Stafford County, and Cities Service Helex Company's Cryogenics Plant, near Scott City in Scott County.

LPG is stored in salt beds in south-central Kansas and in Grant County in western Kansas. Excess natural gas is stored in depleted gas fields during periods of low use to provide gas for use during peak winter and summer seasons.

Three refineries have recently been closed--the Neodesha refinery, Wilson County, which was owned by American Oil Company; the refinery at Shallow Water, in

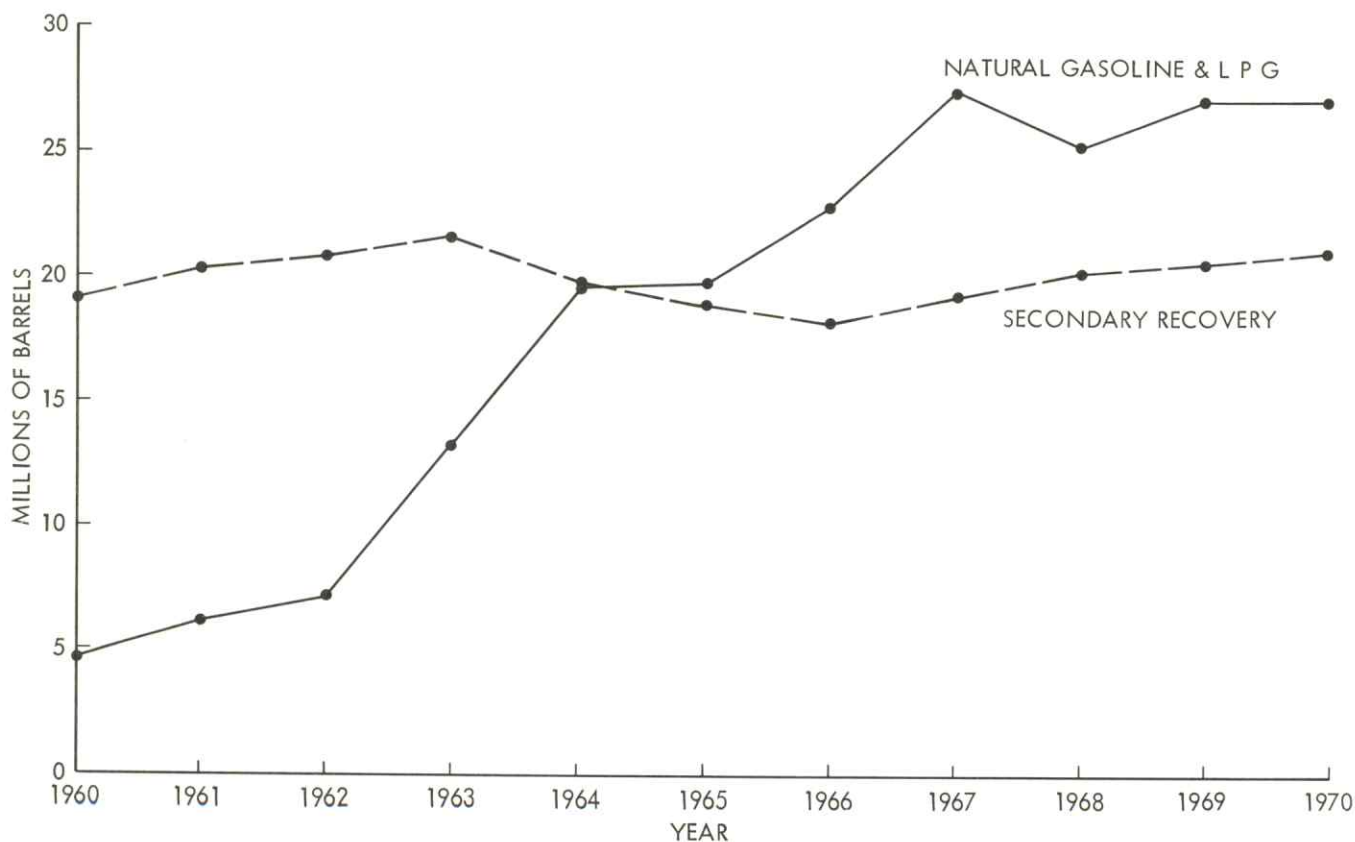


Figure 3.--Natural gasoline and LPG processed, and crude oil produced by secondary recovery methods, 1960-1970.

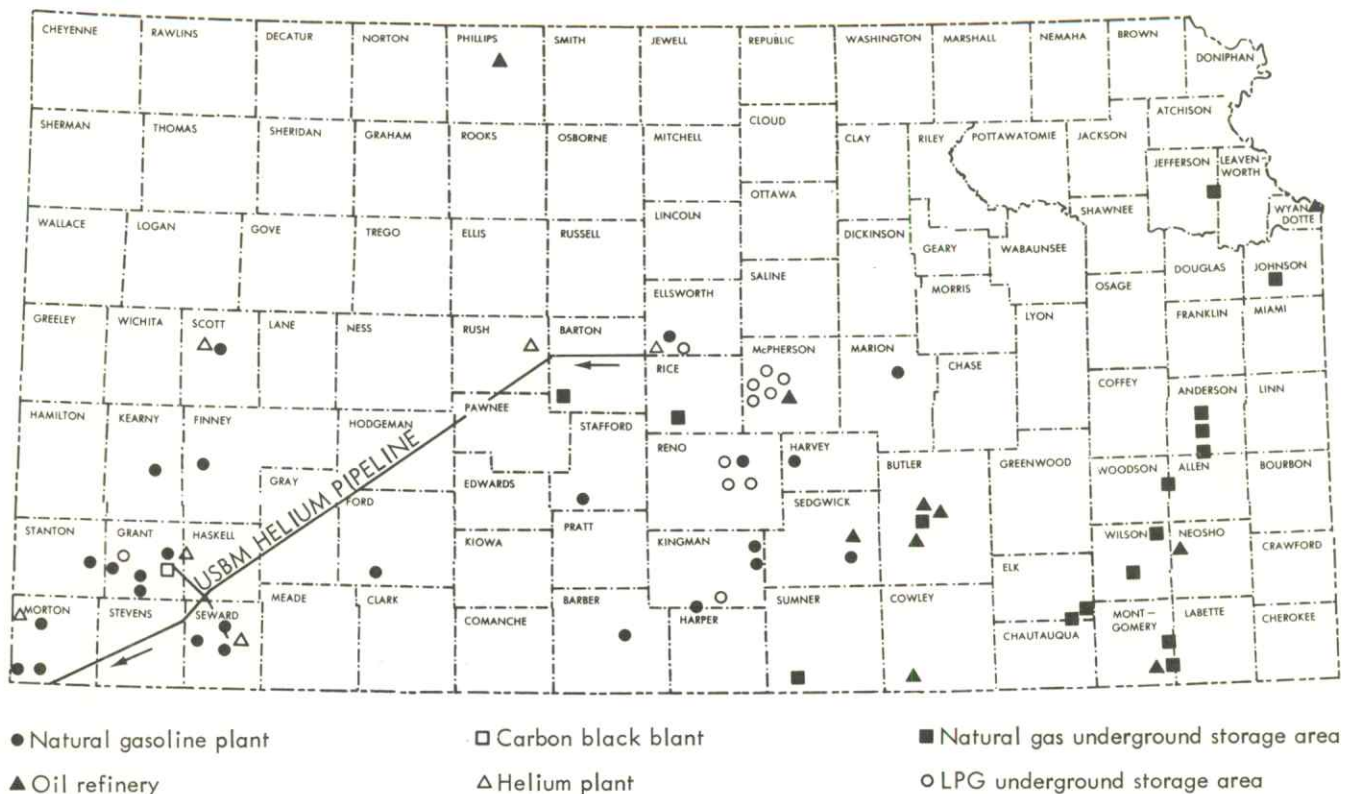


Figure 4.--Processing plants and underground storage areas in Kansas.

Scott County, operated by Century Refining Company; and the Vickers Refining Company plant at Potwin, Butler County. Vickers still has a petrochemical plant at Potwin, although it is not in operation at the present time.

Several helium extraction plants are now selling helium directly to private customers. The United States, however, is about to lose the largest part of its annual helium production. The U.S. Bureau of Mines has shut down three of its older plants, including one at Otis, Kansas. It is also closing its research center near Amarillo, Texas.

On January 26, 1971, the U.S. Department of the Interior advised the operators of the three helium extraction plants in Kansas that have government helium-purchasing contracts that such contracts are to be terminated effective March 26, 1971. The 22-year contracts for the purchase of helium were negotiated

in 1961. The companies involved plan to contest this action. Wilfred Bush, on behalf of the Kansas House of Representatives, in House Resolution 1038, asked Honorable Rogers C. B. Morton, Secretary of the Interior, to reconsider the action of Fred J. Russell, Undersecretary of the Interior, who had issued the cancellation orders.

Until the government's conservation program for extracting helium began, most helium produced with natural gas was lost. With the stoppage of the program in 1971, this again will be the fate for most of the helium (Oil and Gas Journal, v. 68, no. 23, June 1970). Helium has physical properties that make it invaluable. Once the natural gas containing helium has been produced and used, this element will no longer be available. Few areas in the world are known to have helium as a part of their natural gas composition.

The 11-year change in production and refining, and in imports and exports of Kansas crude oil, is shown in Figure 5. The daily through-put capacity of the

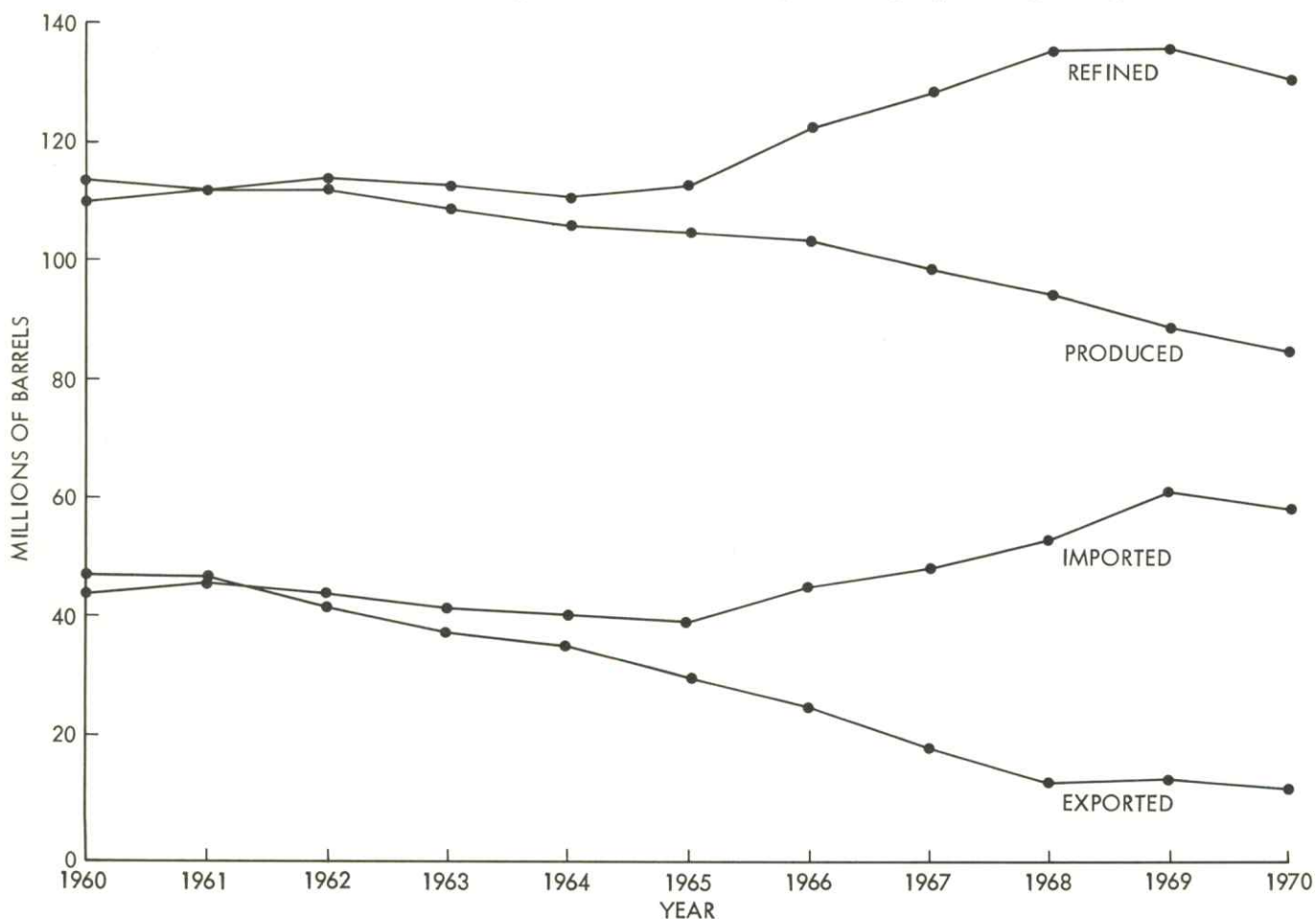


Figure 5.--Comparison of refinery runs and imports of oil, and Kansas production and exports, 1960-1970.

State's refineries has been increased, and runs of crude oil through the refineries has risen from 110 million barrels in 1960 to 131 million barrels in 1970.

Production of crude oil in the State, however, has dropped from 113 million barrels in 1960 to 85 million barrels in 1970.

There was a close balance between imports and exports of crude oil in 1960. Exports (crude oil moved out of Kansas) dropped from 47 million barrels to 12 million barrels in 1970. Imports, mainly from Oklahoma, have risen from 44 million barrels to 59 million barrels per year.

EXPLORATION AND DISCOVERY

The major subsurface structural features in Kansas had been developed by the end of Mississippian time (Figs. 6 and 7). Later sediments cover these underground structures, and leave the surface of Kansas as we see it now, rising in stair-step fashion westward from Missouri to Colorado. Mississippian age rocks are on the surface only in the southeastern part of Cherokee County. In a westerly direction the rocks on the surface are progressively younger in age. Glacial and Recent deposits, which are youngest in age, are present in many areas of the State (Kan.

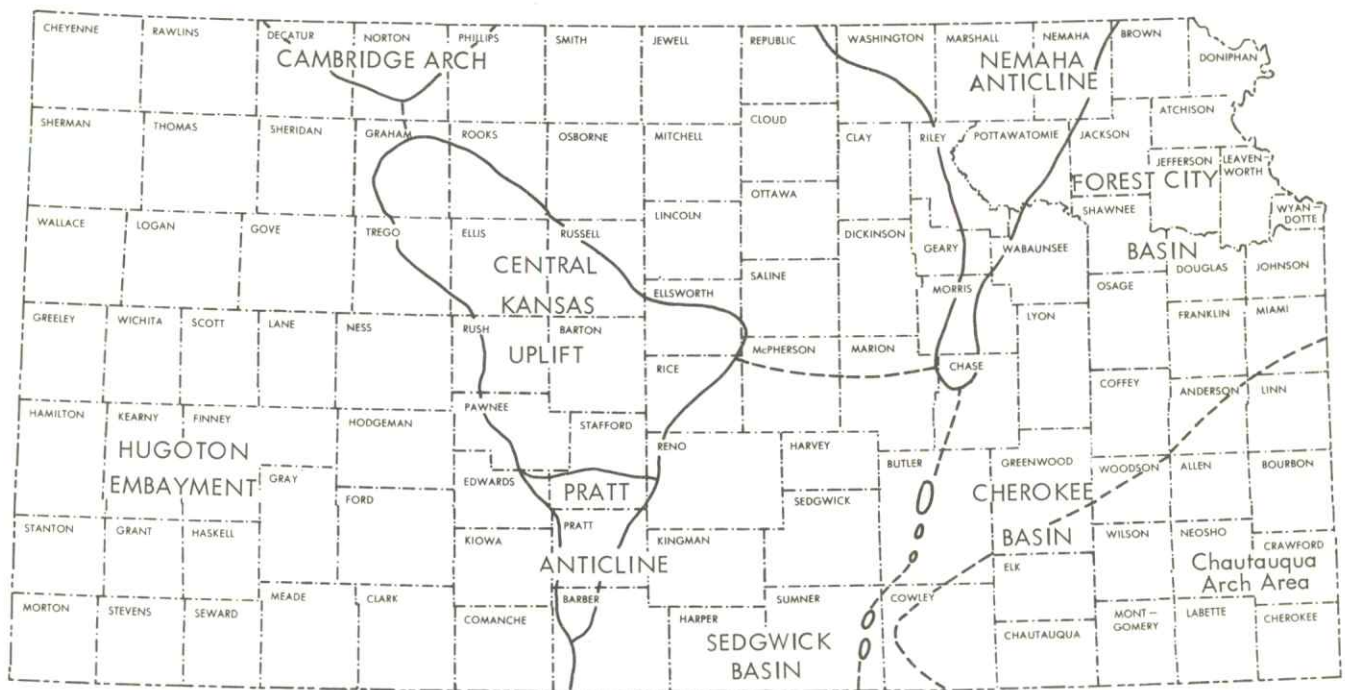


Figure 6.--Major subsurface structural features in Kansas. (Chattanooga shale [Kinderhookian] overlies rocks of Arbuckle Group in Chautauqua Arch area.)

Twelve counties have no recorded production. They lie mainly in the Salina and Forest City basins. Cherokee County, which is on the flanks of the Ozark Uplift in the southeastern corner of the State, also has had no oil or gas production to date (Fig. 8).

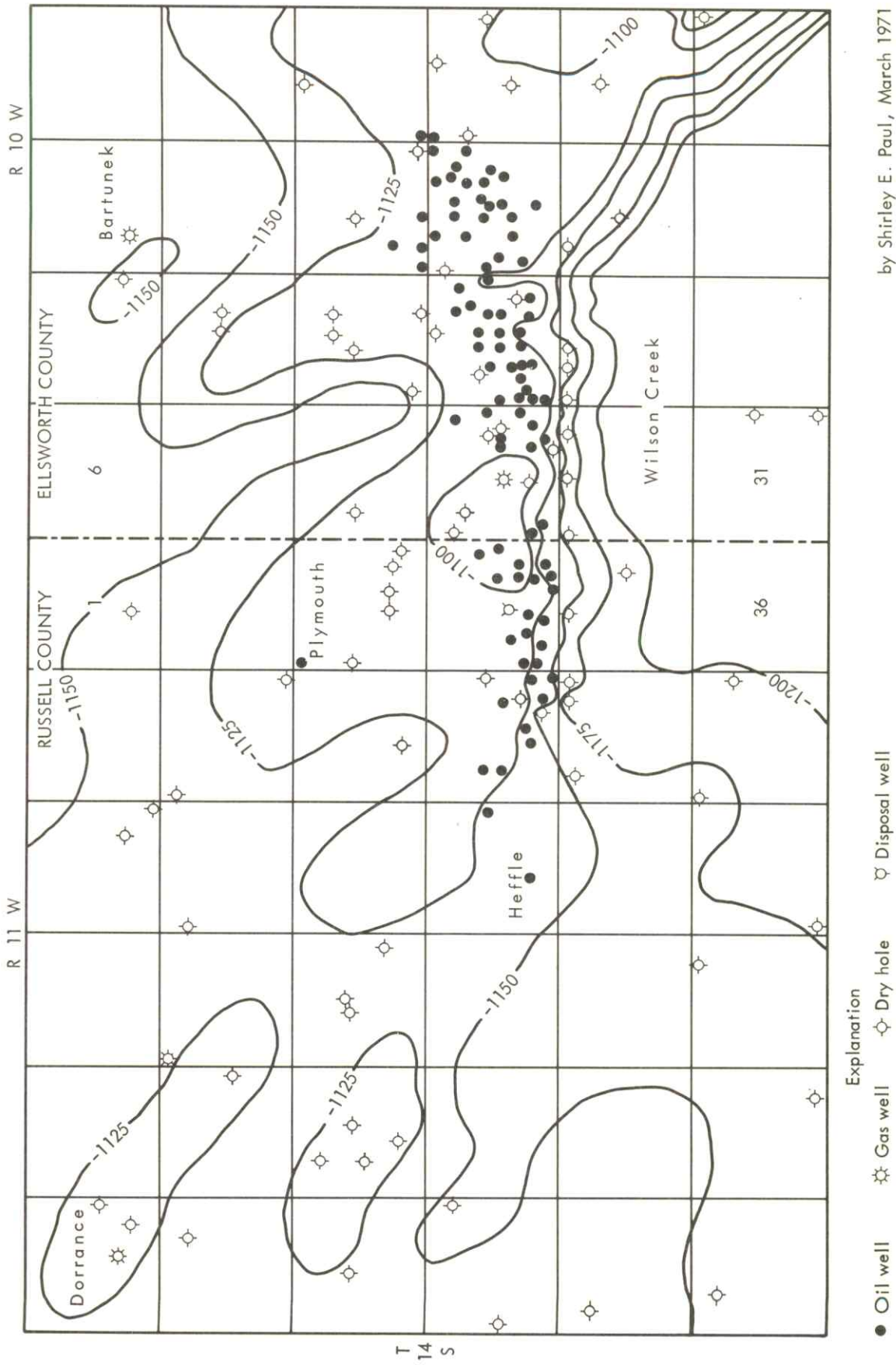
Some counties shown as having had production, in fact, have produced little more than a token amount of oil or gas.

Pottawatomie County, one of the barren twelve, may soon have oil wells. A major exploration program was under way in Marshall, Nemaha, and Pottawatomie counties in 1970 (McCaslin, 1970) in a joint venture by McCulloch Oil Corporation of California, Venus Drilling Company of Texas, and Alex McCoy Company of Oklahoma. The group leased around 850,500 acres, in about 3,000 separate tracts, before starting their drilling program. Additional acreage has been obtained since completion of the first phase of exploration. This is probably the largest acreage ever leased in Kansas by one organization. It is of interest that all three companies in the group are from outside of Kansas. Thirty-four wildcat tests were drilled during 1970 by this group, and most were drilled to Precambrian rocks. Very little information on results obtained by the drilling has been released to date.

Not mentioned in McCaslin's article about the Nemaha Anticline exploration, but nevertheless a possibility, is that iron, copper, and other metals may be present in this area in the oldest (Precambrian) rocks. These rocks occur at depths of less than a thousand feet at places in northern Kansas.

Recent aeromagnetic studies in Iowa conducted by the U.S. Geological Survey (Henderson et al., unpublished manuscript; Henderson and Vargo, 1965) indicate that metals may be present in Iowa in a large anomaly (magnetic difference) that extends southwest from Lake Superior, across Iowa, and into Kansas. The strongest part of the anomaly is in Iowa. Some metallic minerals have been found associated with kimberlite pipe-like bodies in Riley County (Brookins, 1970).

One of the better recent Kansas oil discoveries is the Wilson Creek Field in Ellsworth and Russell counties (Fig. 9). This Lansing-pay field is located on the northeast flanks of the Central Kansas Uplift, and on the southwest side of the Salina Basin. Production is limited by prorationing, but since its discovery in



by Shirley E. Paul, March 1971

Figure 9.--Structure map on top of Lansing Group, Wilson Creek Field.

January 1967, the field has produced about a million barrels of oil. The discovery well was drilled about a quarter of a mile from a small Tarkio gas well that had been shut in since its completion in 1962. That well had first been drilled in 1946, and plugged. It was then re-opened in 1962.

The field is now 6 miles long and has nearly 70 wells. The productive limits have not been defined, except on the south side. Oil production from the Lansing Group is found in small closed structures on a broad east-west trending structure. These subsurface structures have steep dip to the south and gentle dip to the north. Rocks older than those from which production is obtained may be faulted, with the rocks on the north side of the fault now higher than the rocks of the same age on the south side of the fault. Wells that have been drilled to date have not provided evidence of faulting.

Scattered wells in the field produce from the Tarkio Limestone Member (Wabaunsee Group), and Topeka Limestone (Shawnee Group). Some of the wells have several possible productive zones.

RESERVES

Estimates of total proved recoverable reserves of crude oil, natural gas liquids, and natural gas are presently down, compared with reserves in 1960. This is largely due to the slowdown in drilling in recent years. Crude-oil reserves dropped from an estimated 884 million barrels in 1960 to 566 million barrels at the end of 1969. At present rates, this represents 6 1/2 years of production, if no new reserves were found. Some new reserves are added every year, of course.

Total liquid hydrocarbon reserves are estimated at 835 million barrels. This includes the crude oil reserves plus about 269 million barrels of natural gas liquids reserves.

With the imminent closing of the major helium extraction plants, much of the potential gas liquids will not be recovered from the natural gas.

Natural gas reserves have also dropped from about 20 trillion cubic feet to 14 trillion cubic feet.

A comparison of the rate of production of Kansas oil wells and those in Saudi Arabia is interesting: 423 wells in Saudi Arabia produce 3,400,000 barrels of oil per day (8,037 bbls/day/well); in Kansas, about 43,500 wells produce about 250,000

barrels of oil per day (5.7 bbls/day/well).

Of the Kansas wells, nearly 40,000 are "strippers," producing about 4 barrels per day (Interstate Oil Compact Commission and National Stripper Well Association, 1971). The remainder are under prorationing orders which limit production. Basic proration orders for pools allocate production between wells. They are, in reality, conservation orders. They provide for well location and well spacing, so that the reservoirs are drained efficiently at the lowest development and production cost.

The stripper wells cannot be kept in production when operating costs become higher than income from the wells. A rise in the price of crude oil may make the difference between keeping many of these wells in production, or plugging them. In other words, the economic life of a well lengthens as the price of crude oil goes up. The quantity of oil produced yearly by these wells is quite important to overall Kansas production.

Is the 4 cents-per-degree gravity differential necessary? Oil of 25° API gravity is discounted 40 cents per barrel from the price paid for 35° API gravity oil^{2/}. Many eastern Kansas producers believe that because petrochemicals are now produced by the refineries, and lower gravity oils are used for these new products, there is no present justification for the difference in price. As of February 1971, the formerly unwanted residual oils are also commanding a premium at the eastern markets which financially benefits the refineries. Producers are not yet benefiting from the "resid" crisis.

Marketing methods in the United States may change before long. Producers now must accept the prices that are offered, a practice carried over from the early production days. A new approach was suggested by Nesbitt (1970) which would give the producers an opportunity to bargain with the purchasers for long-term purchase contracts.

PRESENT CRISIS

The present crisis in the Near East has affected residual oils more than other

^{2/} API gravity is the standard American Petroleum Institute method for specifying the density of crude petroleum. The density in degrees API is equal to $\frac{141.5}{P} - 131.5$, where P is the specific gravity of the oil measured at 60°F. For a rough comparison of the specific gravities of crude oil of different gravities with water (sp. gr. = 1): 35° gravity oil has a sp. gr. of about .850, and 25° gravity oil has a sp. gr. of about .900.

crude-oil products. Residual oil has been called the "Cinderella" product, because it was once a "problem child" with very little market value but is now in great demand. The fuel oil that is called Mid-Continent (Group 3) was priced at \$1.75 to \$2.00 per barrel last year (1970); it increased to \$1.95 - \$2.10 on May 18, to \$2.50 - \$2.90 per barrel on May 25, and is now (February 1971) \$3.25 to \$3.50 per barrel (Oil and Gas Journal articles). No figure was quoted for Chicago deliveries in the spring of 1970, but quotations for that city in February 1971 were \$4.52 to \$4.62 per barrel for residuals with a maximum of 1 percent sulfur. The New York price is now \$4.60 per barrel (February 1971), up a dollar per barrel since September 1970. Low-sulfur residuals are used primarily for fueling electric generators. The recent "brown outs" on the east coast may forecast more severe shortages in available power as well as increased generation costs (Oil and Gas Journal, v. 68, no. 39, Sept. 1970, p. 50-51).

The crisis in residual fuels will carry over to the market price of crude oil. Refining companies have been asked to leave more residual oil in their refining processes, cutting down on gasoline and various petrochemicals (Oil and Gas Journal, v. 68, no. 40, Oct. 1970, p. 66-67). They are happy to do this when they can receive such a good price for the residuals.

In an article in the Oil and Gas Journal on September 21, 1970 (v. 68, no. 38, p. 68) Morrell stated that it costs more to lay down the cheap foreign crude oil in New York City than it does to deliver Texas crude at the same terminals. The closing of the Suez Canal several years ago, the cutting of the Trans-Arabian Pipeline Company's pipeline (Tapline) in Syria, and Libya's action in holding some oil exports down, has changed the foreign oil situation greatly in recent months. OPEC (The Organization of Petroleum Exporting Countries) is now in a position to bargain effectively for better prices for their crude oil and more tax revenues (Heller, 1970). A contract negotiated in February 1971 between the oil-producing states and the companies will soon bring price increases (Gardner, 1971). The price of crude oil in Libya, before considering transportation costs, was \$2.53 per barrel in the fall of 1970.

EXPLORATION AND RESEARCH

According to Dr. Edwin D. Goebel, Senior Geologist, Kansas Geological Survey

(personal communication), some rocks in southeastern Kansas on the Chautauqua Arch (Fig. 6) that have until now been considered Arbuckle (Cambro-Ordovician) in age may actually be younger. Just a year or two ago it became general knowledge that some Devonian, Viola, and Simpson rocks in southwestern Kansas were improperly assigned to the Arbuckle Group (Fig. 6).

Unconformities are usually good hunting places for oil and gas. Where these eroded surfaces have not been cemented, and source rocks for oil or gas are present with a tight rock layer overlying them, a good trap may be found. Since Devonian rocks are now recognized in areas where they were formerly not thought to be present, Silurian and Upper Ordovician rocks having boundary unconformities may also be present there. These unconformities may have productive possibilities. A good subsurface study of the area is essential. Although thousands of holes have been drilled in southeastern Kansas, few have reached Mississippian rocks, and even fewer have been drilled into older rocks.

EXPERIMENTAL RESEARCH IN SOUTHEASTERN KANSAS

Southeastern Kansas has huge quantities of low-gravity crude oil that presently are all but unrecoverable. For this reason, this oil is not included in our normal reserves estimates. If an economical recovery method is found, this area will add billions of barrels to our estimated proved reserves. Although the term "asphaltic" is commonly applied to the low-gravity oil, this is probably a descriptive term only. Wells and Anderson (1968, p. 1720) say, "Although commonly referred to as tar, pitch, bitumin, asphalt, heavy oil, or bituminous sandstone, this material is a true oil of low asphalt content."

The apparent large quantities of crude oil present at shallow depths and nearness to market make southeastern Kansas an attractive area for research. Although various companies have invested much effort and money in this area, the key to the treasure box has not yet been found. Considering the present "low" in U. S. crude oil reserves, the rise in cost of foreign crudes, and lack of pipelines to bring crude oil from the Prudhoe Bay area in northern Alaska, there are reasons for seriously looking at the area.

Kansas is strategically located in the central portion of the "lower 48," near areas of large consumption of oil products. This gives the area an immediate

advantage over oil from northern Alaska.

Experimental methods tried in an attempt to unlock this great reservoir of oil have included steam, fire-flood, miscible floods, CO₂, and conventional waterflooding methods. Recovery of crude oil by injection of water is normally referred to as "secondary recovery." The term "tertiary recovery" is often used for the other methods listed.

A company operating in Linn County is now giving a good test to the "huff and puff" method of tertiary recovery, in which an inert gas is injected into a hole for several days, after which the injection of gas is stopped and the oil flows from the same hole because of the built-up pressure. The company has had difficulty with many old, unplugged holes, and with some poorly completed wells. It will be some time before this project can be evaluated thoroughly. The producing sand is 300 feet or less in depth, which makes this an attractive area for experimentation. The same method of recovery is being used in a field in Vernon County, Missouri, east of Fort Scott, Kansas, and is reported to have increased production in that field (Independent Petroleum Monthly, 1970, p. 29).

Southeastern Kansas was an important industrial area in the early 1900's. Natural gas produced in that area was the fuel used by the glass plants, brick plants, zinc smelters, and other industries (Clark, in press).

Natural gas is also very much in demand now and the price of natural gas has increased in recent years. An area for exploration could well be the old gas area just mentioned. Many holes with good shows of gas (some reportedly as much as one-half million cubic feet per day) that were drilled in the heyday of gas production in southeastern Kansas were plugged because they were too far from pipelines, and wells nearer the market areas were regularly being completed with much greater potentials. Driller's logs give the reported gas shows. A study of these logs together with a careful selection of new drilling sites, and the application of modern completion methods, could result in gas production large enough for commercial use.

OIL AND GAS DIVISION WELL RECORDS AND SERVICES

The success of exploration for oil and gas, as well as the success of secondary and tertiary recovery methods, requires that all facts regarding the oil- or gas-

carrying beds be available to the operator, whether these facts were accumulated years ago or just recently. Many of the well records of the Oil and Gas Division are for holes drilled before the year 1900. Drilling in Kansas, the first exploration for oil west of the Mississippi River, began in Miami County in 1860 following Colonel Drake's discovery of oil in Pennsylvania in 1859 in a well drilled specifically for that purpose.

A wealth of information about the wells drilled in Kansas is on open file at the Kansas Geological Survey in Lawrence. In addition to data obtained on well drilling in southeastern Kansas that is scouted by members of the Oil and Gas Division, we receive all the usual commercial well records for holes drilled in the remainder of the State--driller's logs, electric logs, top cards, and sample studies. Current drilling is at a rate of about 2,500 holes per year, so a great deal of material must be taken care of. An estimated 4,489 wells were drilled during 1960.

Unfortunately, many well records have never been received. The Survey welcomes donations of privately owned logs and will arrange for transportation or duplication of any that are available. We recently received a donation of about 10,000 driller's logs and 3,700 plotted strip logs from the estate of W. L. Stryker, a long-time geologist and oil producer of Fredonia who had for many years served on the Survey's advisory board, known as the Mineral Industries Council.

All records received are compared with those already in the files to avoid duplication, and top cards are made for cross-reference purposes.

Many requests for information are received, from visitors, and by telephone and letter. Most inquiries require a search for published information or interpretation of data, as well as use of the records. A Stanford University graduate student, who is from Argentina, spent 6 weeks in our office in the fall of 1970 obtaining material for a thesis. People in search of water or industrial minerals also find our records useful. Our pipeline and industry map (Oros, 1963) is used by many outside the petroleum industry.

SELECTED REFERENCES

- Aalund, Leo R., 1970, High prices send refiners scratching for more resid: Oil and Gas Journal, v. 68, no. 38, Sept. 21, p. 47-50.
- Brookins, Douglas G., 1970, Factors governing emplacement of Riley County kimberlites: Kansas Geol. Survey Bull. 199, pt. 4, 17 p.
- Bush, Representative Wilfred (121 District, Liberal, Kansas), 1971, A resolution memorializing the United States Secretary of the Interior to reconsider action in canceling contracts for helium: Kansas House of Representatives House Resolution No. 1038.
- Clark, John G., (in press), Towns and minerals in southeastern Kansas, a study in regional industrialization, 1890-1930: Kansas Geol. Survey Spec. Dist. Pub. 52.
- Dix, Fred A., Jr., 1970, North American drilling activity in 1969: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 6, p. 889-921.
- Gardner, Frank J., 1971, Persian Gulf now has taken oil reins: Oil and Gas Journal, v. 69, no. 8, Feb. 22, p. 36-39.
- Heller, Charles A., 1970, Ten years of OPEC: World Petroleum, v. 41, no. 11, p. 46-54.
- Henderson, John R., and Vargo, Joseph L., 1965, Aeromagnetic map of central Iowa: U.S. Geol. Survey Geophysical Investigations Map GP-476: Scale 1:316,800.
- _____, Zietz, Isidore, White, Walter, No Date, Preliminary interpretation of an aeromagnetic survey in central and southwestern Iowa: U.S. Geol. Survey (prepared in cooperation with the Iowa Geol. Survey), unpublished manuscript, p. 30.
- Independent Petroleum Monthly, 1970, Shallow oil reservoir in Kansas [sic] responds favorably to inert gas injection: v. XL, no. 11, March, p. 29.
- Interstate Oil Compact Commission and National Stripper Well Association, 1971, National Stripper Well Survey (for the year 1969): Jan. 1, 1971.
- Kansas Geological Survey, 1964, Geologic map of Kansas: M-1, Scale 1:500,000.
- McCaslin, John C., 1970, A new look at an old play takes shape: Oil and Gas Journal, v. 68, no. 39, Sept. 29, p. 133.
- Morrell, Gene, 1970, It's official: Foreign oil costs more: Oil and Gas Journal, v. 68, no. 38, Sept. 21, p. 68.
- Nesbitt, Charles R., 1970, A new approach to the problem of oil imports: Interstate Oil Compact Comm., Comm. Bull., v. XII, no. 2, Dec., p. 19-23.
- Oil and Gas Journal, 1969, Refined products prices: v. 67, no. 39, Sept. 29, p. 141.
- _____, 1970, Refined products prices: v. 68, no. 20, May 18, p. 174.
- _____, 1970, Refined products prices: v. 68, no. 21, May 25, p. 122.
- _____, 1970, U. S. helium may be gone in 30 years: v. 68, no. 23, June 8, p. 62-63.
- _____, 1970, Refined products prices: v. 68, no. 38, Sept. 21, p. 193.
- _____, 1970, East's winter-resid picture worsens: v. 68, no. 39, Sept. 28, p. 50-51.

- _____, 1970, Industry asked to fill fuel-oil demand: v. 68, no. 40, Oct. 5, p. 66-67.
- _____, 1971, Refined products prices: v. 69, no. 1, Jan. 4, p. 117.
- Oros, Margaret O., 1963, Oil and gas pipelines and industries in Kansas: Kansas Geol. Survey Map M-2, Scale 1:500,000.
- _____, and Beene, Douglas L., 1967, Oil and gas developments in Kansas during 1966: Kansas Geol. Survey Bull. 190, 191 p.
- Porter, Jim, 1970, Developments in north Mid-Continent in 1969: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 6, p. 985-989.
- Wells, J. S., and Anderson, K. H., 1968, Heavy oil in western Missouri: Am. Assoc. Petroleum Geologists Bull., v. 52, no. 9, p. 1720-1731.
- Zeller, Doris E., (Ed.), 1968, The stratigraphic succession in Kansas: Kansas Geol. Survey Bull. 189, 81 p.

The Disposal of High-Level Radioactive Waste in Salt: Why Kansas?

Ernest E. Angino*

As most Kansans know, a site at Lyons, Kansas, has been proposed by the Atomic Energy Commission to be the first national repository demonstration site for the storage of nonrecoverable, high-level, radioactive wastes in salt. What may not be so commonly known is why central Kansas was chosen for the first demonstration site and, in particular, why salt is the desired storage material.

Under Kansas Statute 48-1601, the State Geological Survey of Kansas is charged with studying and preparing a report on the geologic effects of storing radioactive materials in subterranean areas. Presently underway are detailed studies of the subsurface and surface geology, hydrology, geophysics (thermal effects), and radiation effects on the salt. These investigations are supported by both Federal and State funds. At the present time the State Geological Survey of Kansas neither endorses nor opposes the storing of radioactive material at the Lyons site. Our position is a neutral one. We feel that much work remains to be completed before one can, in fact, say whether it is or is not a wise decision to store high-level radioactive wastes at the Lyons site.

What are the advantages or disadvantages, especially the advantages, of storing radioactive wastes in salt formations? The advantages are:

- (1) wide distribution and abundance of salt deposits,
- (2) high structural strength of salt approximating that of concrete in terms of compressibility,
- (3) good thermal conductivity of salt,
- (4) location of most salt deposits in areas of low earthquake probability,
- (5) essential impermeability of salt deposits, and
- (6) relatively low cost of developing the space.

Possible disadvantages of storing radioactive waste material in salt are:

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- (1) corrosive effects of the salt on the storage cylinder,
- (2) change in physical properties of the salt with increasing temperature,
- (3) high solubility of the salt if surface and ground water were to reach the salt beds, and
- (4) change in physical properties of salt with increasing radiation damage.

All of these problems are under study at present by personnel of Oak Ridge National Laboratory, U.S. Geological Survey, and State Geological Survey of Kansas.

Potential dangers now and in the future must be investigated before any radioactive material is stored in the State. The State Geological Survey insists that the safety and integrity of the site be assured before a final decision to proceed with storage is reached.

Some of the principal alternatives to salt formations for permanent disposal of high-level wastes are: (1) perpetual storage as liquids in above-ground tanks, (2) storage as liquids in bedrock caverns, (3) storage as solids in concrete vaults, (4) storage as liquids or solids in granite caverns, and (5) disposal in outer space. While all of these methods are possible, none is really as satisfactory as disposal by storage of the wastes in salt. Storage as liquids is not considered a proper means for long-term disposal because as long as the wastes remain in a liquid phase, they are mobile. Storage as solids in concrete vaults is not recommended at any depth where leakage may have access to groundwater supplies. Storage as solids and/or liquids in granite caverns is presently under consideration at the Savannah River, South Carolina, plant of the A.E.C.

Transmutation of the radioactive material to nonradioactive species is being investigated but it is not considered a practical solution for other than a few selected species. While disposal in outer space is in a theoretical sense the best solution, it cannot be considered practical because of the cost involved. More importantly, one cannot guarantee the success of every rocket launching, nor can one guarantee that the vehicle will not abort and fall back to earth. These wastes are of such a nature that we do not want them to return in any form.

Prior to selection of a site for the initial United States high-level, solid-waste repository, specific geological criteria were established which were consistent with the requirements of long-term isolation. These same requirements would

not necessarily be applicable to any selection of a future repository site. The basic criteria used in selecting the site are as follows:

- (1) The salt formation should be of the bedded type, approximately horizontal, and relatively undisturbed structurally.
- (2) The formation should have considerable horizontal extent, extending for several hundred square miles in all directions, in order to provide adequate isolation of the disposal area.
- (3) The formation should not be less than 500 nor more than 2,000 feet deep and should be at least 200 feet thick in order to provide for adequate heat dissipation, as well as to provide a reasonable margin of safety for isolation above and below the plane of disposal.
- (4) The formation used for storing the waste should not be associated with nor be in any immediate proximity to useful or potentially useful reserves of any mineral resource.
- (5) The site should be situated in a zone of tectonic stability.

In considering the United States as a whole, three general areas met these criteria. One was a large area of central Kansas, the second was a smaller area in west-central New York, and the third, an area in southeastern Michigan near the city of Detroit.

Consideration of all the factors involved and evaluation of the geologic aspects of each of the three sites led to the conclusion that the one in Kansas was the most favorable. The advantages that can be attributed to the central Kansas site are that the depth of the salt is generally less than that of the other areas, the thickness and extent of the deposits are greater than at the other areas, and the Kansas site is in a low Seismic Risk Zone (a zone of minimum expected earthquake damage). In addition, on the basis of information developed by prior studies, detailed information regarding the nature and properties of the salt in this general area was already available.

The proposed demonstration repository at Lyons is considered to have sufficient space for the storage of anticipated wastes to be generated by the nuclear power industry in the United States up to the year 2000. In conjunction with the high-level waste facility at Lyons, it is presently the plan of the A.E.C. to build an

alpha-waste facility for storing what are sometimes referred to as "low-level" radioactive wastes. By "low-level," it is meant that radiation levels are sufficiently low that personnel can be protected from irradiation by storing the alpha-wastes in steel drums or concrete casks. Up to the present time, high-level wastes have been stored as liquids or solids in tanks. Low-level alpha wastes have been stored in containers in shallow burial grounds.

These storage operations are, of course, only temporary, and it is recognized that a permanent solution to the problem is required. The A.E.C., in consultation with the National Academy of Sciences and appropriate study committees, has sponsored research over the last 15 years to examine the suitability of storing radioactive wastes in various geologic formations. On the basis of these studies, the salt formations have been recommended. As noted earlier, studies are being conducted on all phases of the problem by Oak Ridge National Laboratory, U.S. Geological Survey, and State Geological Survey of Kansas. In November, the State Geological Survey submitted to the A.E.C. a preliminary report entitled, "Report on the Geology and Hydrology of the Lyons, Kansas, Radioactive Waste Repository Site." A final report is due April 1, 1971.

The State Geological Survey is presently preparing a planning proposal for studies which we feel should be made to assure that the storage of high-level radioactive wastes in salt is indeed safe.

It is hoped that this brief review will answer some of the questions which have undoubtedly occurred to the people of Kansas regarding the A.E.C. selection of the Lyons, Kansas, area as the site of a proposed radioactive waste repository. I want to emphasize that the State Geological Survey's primary responsibility is to the State of Kansas and to the people of Kansas. It must be clearly demonstrated that it is indeed safe to store high-level radioactive wastes in salt before we give our endorsement to the concept of storing this material in Kansas.

remapping strat. trap fields - extension of fields & trends

geophys. survey of basement config. & local anomalies

boundary problems - age units

land situation changes as indication of ind. activ.

Correl. w/ drilling & discovery

Elemental analysis ^{and mapping} of subsurf. materials as indic.

of areas favorable for mineralogy studies

drilled depths of wells by rock unit (max display) (coded)

subsurface trend of Penn. reefs - facies study

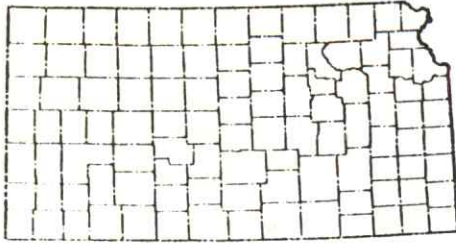
Corrections to Merriam's subsurface structure maps showing changes in strat. age of some units

Consult w/ Ed Goebel & Margaret Osos

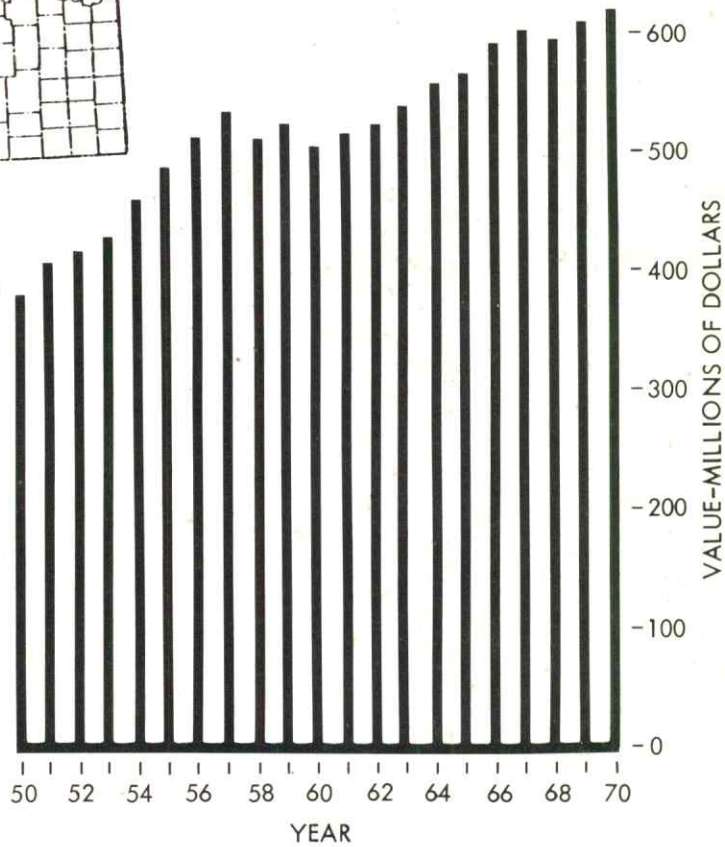
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DAPG summaries - drilling activ. / Kansas

Mineral Production in Kansas1970



Total \$619,002,000
Estimated 1970 Value



COMMODITY	1970 ESTIMATED VALUES	1970 PERCENT OF TOTAL VALUE	1970 PERCENT LOSS OR GAIN FROM 1969	
			PRODUCTION	VALUE
Crude Oil	\$279,879,000	45.2	- 4.4	- 3.5
Natural Gas	130,046,000	20.8	+ 2.4	+12.6
Liquid Petroleum Gases	57,180,000	9.2	+ 0.1	+12.0
Helium	42,210,000	6.8	+ 0.7	+ 3.4
Cement	27,210,000	4.4	-10.4	-10.5
Stone	22,300,000	3.6	+1.7	- 1.5
Salt	18,075,000	2.9	+ 0.7	+ 5.8
Clay and Shale	12,568,000	2.3	--	- 6.4
Sand and Gravel	10,000,000	1.6	-10.8	-10.3
Miscellaneous Minerals (Combined)	9,822,000	1.6	--	-14.5
Coal	<u>9,712,000</u>	<u>1.5</u>	<u>+23.5</u>	<u>+36.6</u>
TOTAL 1970	\$619,002,000	99.9	--	+ 1.4
1969	\$610,708,000			