Kansas Mineral Industry Report 1974

Mineral Resources Series 3

Kansas Geological Survey
The University of Kansas
Lawrence, Kansas 1975

Cover photograph of horizontal retort zinc smelter at Henryetta, Oklahoma similar to one which operated in Cherryvale, Kansas until the 1940's. Photo courtesy of Eagle-Picher Industries.

KANSAS MINERAL INDUSTRY REPORT, 1974

by

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MINERAL INDUSTRY PRODUCTION FOR KANSAS IN 1974

Pieter Berendsen

Introduction

The total estimated production value of Kansas minerals increased by 36% to $876,212,000. This large increase was primarily due to price increases resulting from increased production costs in every sector of the industry. Most of the increased production cost can be related directly to the increased cost of energy required to extract and process the minerals mined.

The amounts of minerals extracted showed a decrease in almost every category, the only exceptions being sand and gravel, salt, and natural gas liquids. (Table 1). The decrease in production ranged from 0.3 percent for natural gas to 92.0 percent for helium. The decrease in the production of helium is the direct result of Federal Government actions and is not related to a supply and demand picture as are the other commodities. The status of helium as a non-renewable but precious commodity is discussed in a separate article in this issue.

Because of the diminishing sources of energy available to our industries, the introductory paper on "The Politics of Energy" by the Director of the Kansas Geological Survey should be of great interest. The production of coal showed a decrease of nearly 50 percent. This was mainly due to the closing of a major mine in Cherokee County. Substantial reserves of coal

Table 1

MINERAL PRODUCTION AND VALUE IN KANSAS, 1973 AND 1974

Annual Preliminary

	Unit	1973		1974		% change		% of Total Value
		Quantity	Value	Quantity	Value	Quantity	Value	
Cement: Portland	1,000 short tons	2,036	42,390	1,985	50,221	- 2.5	+18.5	5.7
Masonry	1,000 short tons	70	1,983	65	1,820	- 7.1	- 8.2	.2
Clay, Shale & Products			11,337		11,873		+ 4.7	1.4
Coal (bituminous)	1,000 short tons	1,305*	8,390	680	4,302	-47.9	-48.7	0.5
Helium: Refined	1,000,000 cu.ft.	417	3,753	386	3,474	- 7.4	- 7.4	0.4
Crude	(14.7 p.s.i.; 70 F)	1,539	18,468	130	1,560	-91.6	-91.6	0.2
Natural Gas	1,000,000 cu.ft. (14.65 p.s.i., 70 F)	897,289	138,521	894,308	141,268	- 0.3	+ 2.0	16.1
Natural Gas Liquids	1,000-42 gal. bbl.	30,456	71,504	30,570	141,233	+ 0.4	+97.5	16.1
Petroleum (Crude Oil)	1,000-42 gal. bbl.	66,227	264,910	61,700	431,900	- 6.8	+63.0	49.3
Salt (Rock & Evaporated)	1,000 short tons	1,424	23,923	1,461	23,979	+ 2.6	+ 0.2	2.7
Sand & Gravel	1,000 short tons	13,261	12,663	14,500	14,645	+ 9.3	+15.7	1.7
Stone (crushed)	1,000 short tons	18,334	33,601	16,134	35,495	-12.0	+ 5.6	4.1
Miscellaneous: Gypsum (Raw & Calcined), Salt Brine, Carbon Black, Sulfur, Lime, Volcanic Ash (Raw & Expanded), Dimension Stone			12,797		14,442		+12.8	1.6
			644,240		876,212			

*Best estimate of Kansas Geological Survey. Department of Labor figures are lower because they do not include Linn County production (unwashed coal).

remain in southeastern Kansas. New mining techniques and well-administered environmental laws will undoubtedly help in developing this resource more fully in the future. An article dealing specifically with Kansas coal is also included in this issue.

The mineral industry is closely tied to the general state of the economy of Kansas as well as to that of the United States as a whole. A few words with respect to each commodity and how it generally fits into the economy should be of interest.

Petroleum, natural gas liquids, and natural gas are directly influenced by the economic and political trends of the United States. Coal in most large coal producing areas in the United States is affected much in the same way as petroleum products, however, Kansas coal production relies more upon local markets and is thus more influenced by the local economic picture. Helium is a common constituent of natural gas and resides in the gas stream derived from the gas fields. Practically all commercially extractable helium in the world occurs in the gas fields of Kansas, Oklahoma and Texas. Refined helium is used in small quantities all over the world. The demand will probably remain quite stable in the immediate future until forecast new uses expand the need for it. Because of the small demand and the relatively large supply, helium remains a cheap commodity in overabundance.

The Kansas Mineral Industry Report for 1974 again includes an informative paper dealing with the "Oil and Gas Industry Activity in Kansas in 1974." Also included is a paper on the "Energy Balance, 1974."

The remaining mineral commodities, notably the industrial minerals, except for some in the miscellaneous category, are dependent upon local markets and are thus more influenced by the Kansas economic picture. The slowdown in

the economy which started to be felt nationally in the second half of 1974, did not seem to affect the Kansas producers in the same way. Two reasons why the slowdown in these categories has not been felt as strongly by these industries are: (1) major dependence upon large construction projects which began before the 1974 slowdown and (2) the chance to build up inventories that in many cases were nearly depleted during the 1972-73 "boom."

During the latter part of the last century and the first decades of this century metal mining provided a major stimulus to the economy of Kansas. Due to the misfortunes of many United States mining companies in foreign countries, more emphasis is being placed on exploration and exploitation of domestic resources. A paper on the metal mining potential in Kansas explores this area.

Individual mineral commodities are discussed in alphabetical order, and a summary of data for both 1973 and 1974 is given in Table 1.

Cement

Based on Bureau of Mines figures, shipments of cement for the United States as a whole were 8.6% lower compared to the previous year, while for Kansas this figure amounted to 5.2%.

The production of Portland cement, which in 1973 climbed to slightly above two-million short tons, decreased by about 2.5%. This decrease was to be expected, due to the slowing of the economy. However, it was less for Kansas than for the nation as a whole. One of the reasons is that much of our cement production is tied to large-scale construction projects.

Masonry cement production decreased to 65,000 short tons from 70,000 short tons in 1973, a decrease of 7.1%. This compared to an overall decrease in shipments for the United States of around 12.3%. The approximate mill value of the product per ton is used to calculate the total dollar value of the commodity. Even though the total output for both types of cement decreased, the total dollar value increase amounted to 17.3%. Because of the short supply of natural gas, many plants in the United States have converted or are planning to convert their kilns to be able to use coal as the energy source. None of the Kansas plants has been converted as yet.

The two major forecasters for the construction industry, the Bureau of Domestic Commerce and Dodge/Sweet, anticipate an increase in construction for 1975. This can be translated into a rise in the production of materials supplying the industry, cement, sand and gravel, lightweight aggregate, etc. The 7.5 million expenditure by Monarch Cement Co. at Humboldt, Kansas, which includes modernization, a pollution control program, and expansion of their capacity by about 4%, will be completed in the coming year.

Clay, Shale & Products

In contrast to the Bureau of Mines figures which report only the clay mined, the Kansas Geological Survey includes in its figures the value of the major products derived from it. The Bureau of Mines preliminary figures indicate a total of 1,016,000 short tons of clay mined at an average value of $1.40 per ton for a total dollar value of $1,423,000.00. The total dollar value of clay, shale and products for the State of Kansas is placed at $11,873,000 which is up from 1973 by 4.7%.

The two largest consumers of clay are the brick and the cement industry. The cement industry uses about 400,000 short tons of clay per year. The

mill value of Masonry and Portland Cement already includes the value of the clay, so it is not accounted for under clay. Other than the brick industry, the following manufacturers use clay in decreasing order of demand: light weight aggregate, clay sewer pipe, and pottery.

The brick industry, which up to August, 1974 had shown an increased production over the same period in 1973, started a down trend in September, resulting in an overall production loss of less than 1% for the year. This slowdown is expected to continue well into 1975. However, the adverse effect on the manufacturers of brick will be somewhat dampened because most producers have low reserves and will be able to build up their stock supply. The other demand categories remained more or less stable during the past year.

The industry as a whole is heavily dependent upon natural gas as its energy source. The scarcity of fuel forced some manufacturers to cut back or even stop their operations for a limited time. Alternative ways to satisfy their fuel demands are actively sought by management. They include possible conversion to coal or securing their own energy source.

Coal

Coal production for the year totaled 680,000 short tons, down 47.9% from 1973. The total dollar value decreased by 48.7%. The reason the total dollar value decreased by a higher percentage than the amount of coal mined was due to the relative amounts of washed versus unwashed coal being sold. During 1974, unwashed coal valued at 35% less than washed coal represented a larger percentage of the total amount of coal mined.

The Pittsburg and Midway Coal Mining Co.'s Mine #19 in Cherokee County closed in May, 1974. The closing of this mine had a large effect on the

total production since it supplied 55% of the total amount of coal produced during the previous year.

The only other mine operating in Cherokee County is Wilkinson's Incorporated which supplied about 3,000 short tons in 1974. Clemens Coal Company, with two mines in Crawford County, has been producing steadily throughout the year. The Pittsburg Midway Coal Mining Co.'s Midway Mine in Linn County produced 249,000 short tons during the first three quarters of 1974, but most of their mining operations were moved into Bates County, Missouri, during the fourth quarter, resulting in an output in Kansas of only 25,000 short tons. All of the production of this Mine is unwashed coal which is directly delivered to the LaCygne Power Plant.

Besides the above mentioned developments affecting the production of coal, the four-week long miners' strike in November also reduced the output.

Even though there is a large demand for coal and a demand that will undoubtedly continue to grow over the next years, Kansas coal production probably will not show much, if any, growth during the next year. The nature of the coal reserves is such that they may be mined using new methods which are being developed and studied. One such study* dealing with new mining methods of shallow cover coal was recently completed at the University of Kansas - Kansas Geological Survey.

*James L. Reavis, 1974, Shallow-Cover Coal: New Mining Methods and the Environment. A report to the Ozarks Regional Commission by the Institute of Mineral Resource Research, The University of Kansas.

Lately, there has been renewed interest in starting up new coal strip-mining operations in both Labette and Osage Counties. Starting around 1870, reaching a peak towards the turn of the century, and steadily declining after that time with the last mine closing in the 1950's, strip-mining operations were active in both counties and deep coal mines were in operation in Osage County. Probable future mining in these counties should add to the total amount of coal produced in the state.

Helium

The combined production of crude and refined helium dropped again during 1974. The greatest decline, 91.6%, was in the production of crude helium. Although one could expect a slow general decline in the production of crude helium due to our dwindling natural gas resources, the reason for the drastic drop was the termination of helium contracts by the United States Government which was initiated in 1971. In last year's Kansas Mineral Industry Report the status of helium was discussed in a separate article. This year a follow-up on this subject is included. About 1.2 billion cubic feet of crude helium was extracted from natural gas during 1974 but about 95% of this precious commodity was either vented to the atmosphere or returned to the gas stream. In both cases the helium was lost. The production of refined helium fell 7.5%, but will probably remain relatively stable in the next few years. In past years the calculated dollar value of refined helium was arrived at by multiplying it by its value f.o.b. at the plant. This year the figure used for the dollar value of refined helium represents the differential between the price of refined and crude helium. This reflects more accurately the contribution of this commodity to the Kansas mineral industry.

Natural Gas

Natural gas production during 1974 amounted to 894,308 million cubic feet, a slight decrease over the previous year (0.3%). In figure (1) the production of natural gas since 1900 is shown. During the year no appreciable new production was added to the existing supply, however, this does not mean that no new wells were completed. Most natural gas was probably sold under old contracts, thus only slightly increasing the total dollar value of this commodity. Of the total amount of natural gas produced only about 16% is derived from oil wells.

Throughout this publication attention is focused on the increasingly short supplies of natural gas, on which most of the industry processing the mineral commodities mined in the State is dependent. Additional supplies will find ready customers who, at present, experience reduced or irregular deliveries.

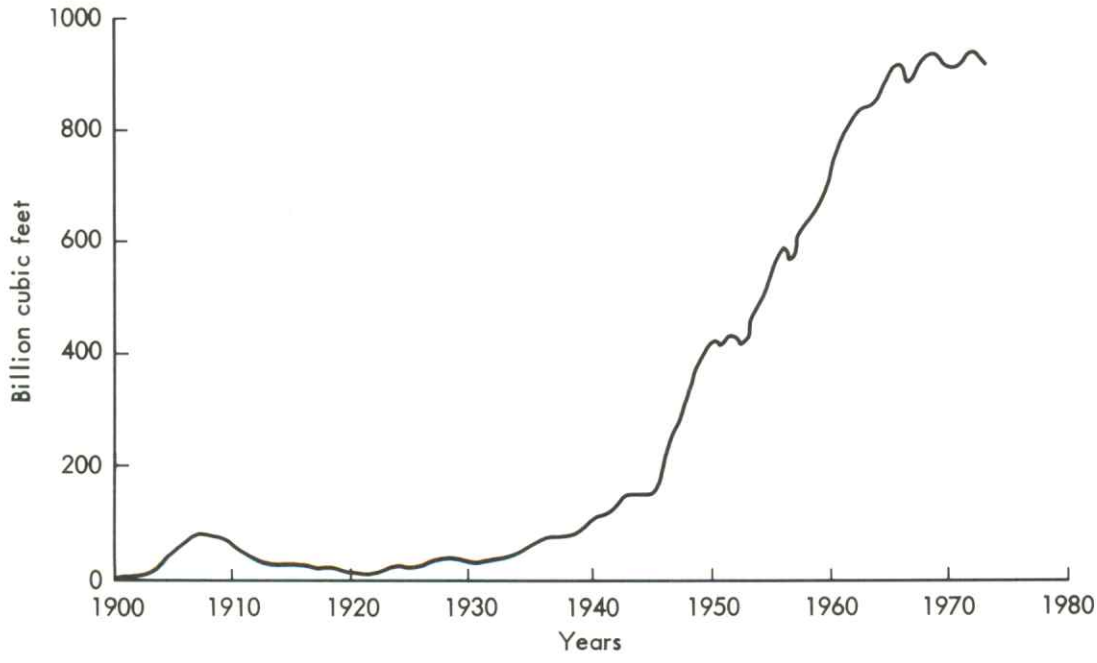

Figure 1. - Kansas annual natural gas production, 1900-1974.

It is anticipated that during the next few years production in Kansas will stabilize as new discoveries are exploited and as the producers are allowed to sell their product at higher prices. In some instances producing wells have been shut in and the pipe has been pulled to be sold elsewhere for use in new wells. Also, new discoveries of gas are not always tapped immediately due to the lack of an existing pipeline or as a result of present day pricing structures.

Natural Gas Liquids

The volume of combined natural gas liquids derived from natural gas has essentially been the same for the past three years. They are in descending order propane, LPG mix, natural gasoline, butane, ethane, and pentane.

Although a substantial amount of natural gas comes into Kansas via pipelines and by other means, the liquids reported here are from Kansas produced natural gas.

Even though production did not increase, the dollar value increased substantially and is 97.5% higher than in 1973. If the production during 1975 again stays the same, we may expect a 20-30% decrease in the dollar value, due to a price rollback ordered by the FEA effective January 1, 1975, on LPG and Natural Gas Liquids.

Petroleum (Crude Oil)

A total of 61.7 million barrels of petroleum was produced in 1974, a decrease of 6.8% from the previous year. The decrease in production for the year 1973 amounted to 10.2%, while for the years 1972 and 1971 it averaged 6.8%.

It is hoped that with increased exploration the rate of decrease in production may be slowed or even reversed for a limited time period. However, if the trend continues at the present rate of slowdown, the production of oil in Kansas would be down to a trickle in the second half of the 1980's.

The history of the Kansas crude oil production since 1900 is graphically shown in figure 2.

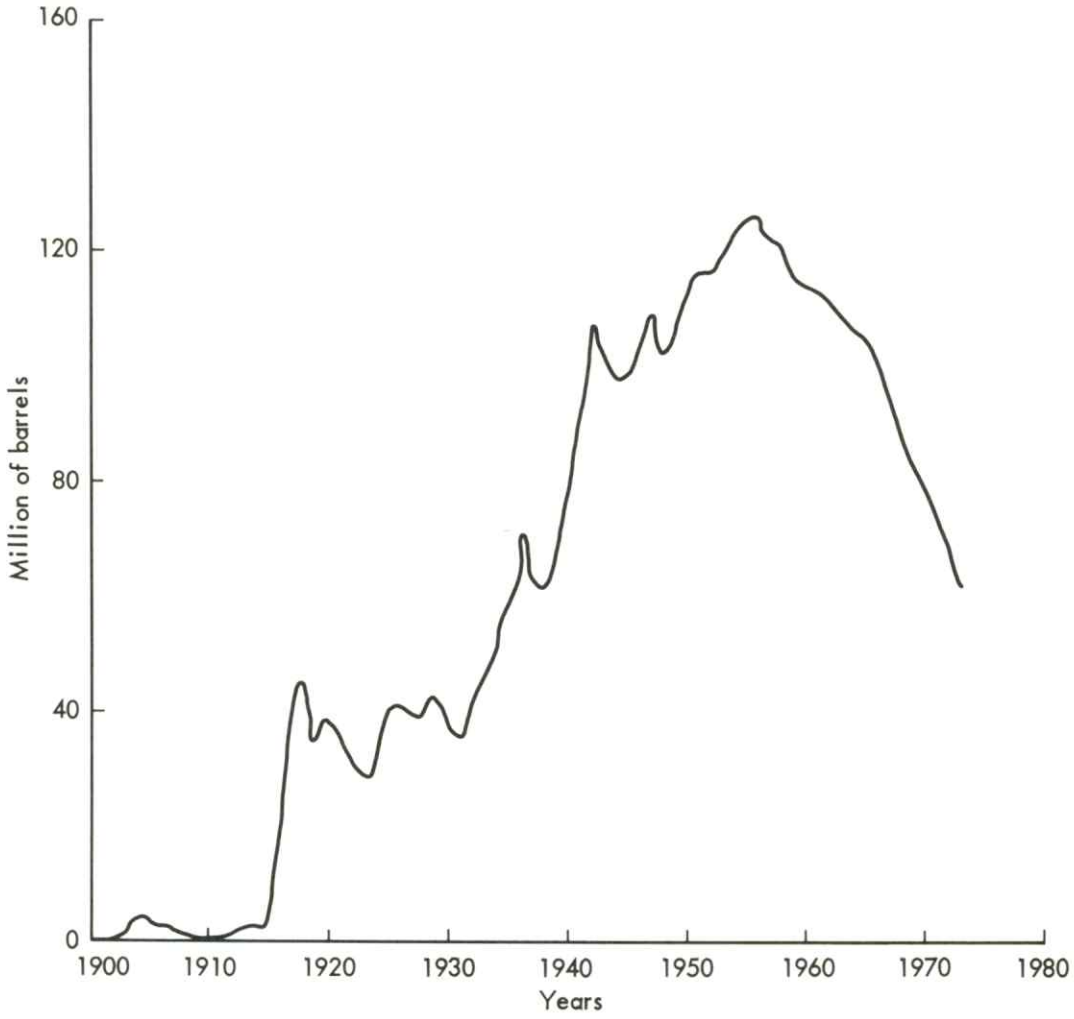

Figure 2. - Kansas annual crude oil production, 1900-1974

Salt

Salt production increased by 2.6%, however, the dollar value increased by less than one per cent.

The U.S. Bureau of Mines Preliminary Estimate shows that nationally the production increased by 5.3%, this in spite of the slowing of the economy. In Kansas, seven salt plants were in operation and several of these were in the process or had undergone expansion. The Carey Salt plant in Hutchinson is being expanded with final completion to be expected in 1976. Three of the plants operate underground mines, all other salt is being mined by solution techniques. At times solution mining of salt has created problems when too much salt was mined too close to the surface, causing the overlying rock to collapse. This past year a hole 250 feet in diameter and 30 feet deep formed just south of the town of Hutchinson when another one of these collapses occurred. A main east-west railway track was cut when this happened. Knowledge of subsurface conditions and proper planning could prevent such potentially dangerous occurrences. The production of salt in 1975 is expected to remain stable or even increase slightly.

Sand & Gravel

Contrary to the general trend of most mineral commodities, the amount of sand and gravel produced in the state went up by about 12 million short tons or 9.3%.

The cost per ton increased by about 6% which is less than the increased production costs caused by the inflationary trend of the past year. Much of the sand and gravel produced in Kansas was used in large scale construction projects, such as highway construction, building of dams, etc. Because these projects take several years to complete, the direct impact of the slowdown in the economy is not immediately reflected in the production figures. The outlook for 1975 is somewhat uncertain, however, it is believed that the construction industry will recover somewhat and probably hold its own.

Stone

Crushed stone is being produced from quarries as well as from underground mines. The quarries produce about 85% of the total amount. Underground production takes place mainly in the Kansas City area and utilizes Pennsylvanian limestones. Practically all crushed stone is derived from carbonate rocks and has a variety of uses in construction as well as agriculture. The underground mines in the Kansas City area are of the type that are mined by drifting horizontally into the rock bluffs which are prominent in the area. Apart from the crushed rock being used, the cavity thus created is found to be very useful for storage or even office or manufacturing space. One of the beneficial aspects of such cavities or mined-out areas is that the temperature does not fluctuate as much as on the surface. In the future it may be profitable to mine crushed stone in deep mines and use the mined-out areas for storage of some kind.

The stone production in Kansas declined by about 12% and probably would be worse if there had been no large-scale ongoing construction projects. It is anticipated that the production of crushed stone will improve in 1975. The U.S. Bureau of Mines feels that the lowering of the prime interest rate will act as a major stimulus by releasing new money for construction start-ups.

Miscellaneous

Included in this section are the following commodities in order of decreasing value: gypsum (raw and calcined), carbon black, salt brine, dimension stone, volcanic ash (raw and expanded), lime, and sulfur. The group as whole showed a 12.8% increase in total dollar value, which can be mainly attributed to increased production costs. The production of several of these commodities may show a decrease in 1975. The slowdown in the con-

struction industry, although this segment may recover soon, will affect the gypsum and dimension stone production, the slowdown in automobile manufacturing will affect the tire industry and as a result carbon black production. One might expect the lime production also to suffer, however, 47% of all lime is used in the steel industry and lime supplies have been tight. Most or all production in this category comes from a limited number of producers, and to preserve confidentiality of the data, only the total dollar value is given.

THE POLITICS OF ENERGY*

William W. Hambleton and Gary A. Waldron

Many observers have identified the political process as the source of many of our energy problems. Despite that, no one has suggested that the problems can be dealt with entirely outside the political arena. Although our political process is in disarray, and Congress seemingly is mired in confusion over energy policy, a few signs are developing that a convergence of viewpoints may be taking place, albeit very slowly. One of the more encouraging signs was to be found in an April 3, 1975 editorial in The Washington Post, a newspaper rarely regarded as nurturing the viewpoints of private enterprise. That editorial noted, with respect to pricing of natural gas, that "It is as though Congress were keeping down the price of red jellybeans, to protect the consumers - but not the prices of black and white jellybeans which, in the current inflation, are rising. In time you would find it increasingly difficult to get red jellybeans, although there would be plenty of others in the stores. In Congress, the defenders of the consumer would explain that the rapacious and monopolistic jellybean industry was willfully withholding red jellybeans from the public. That, of course, would be an outrage. Several Senators would promptly introduce bills establishing intricate rules for the dwindling national supply of red jellybeans - and maybe extending price controls to the black ones as well, since they are

*This is a revised and up-dated version of a paper presented April 21, 1975, Big 8 Cities Meeting, Lawrence, Kansas and A.I.M.E. Meeting, Wichita, Kansas, April 25, 1975.

getting increasingly popular.....We can afford to make mistakes in our national policy on jellybeans but not on basic fuels."

However, the politics of energy has been operating on an international scale. The era when world energy policy was set independently by the U.S. and the major international companies began to close in Libya in 1969, and as we all know, the Yom Kippur War in October 1973 punctuated its end with the embargo by the Arab countries.

A strong and united Organization of Petroleum Exporting Countries (OPEC) raised prices to approximately $11.00 per barrel for oil costing $.50 or less to produce, created a large imbalance in international monetary payments, contributed substantively to an international recession among industrialized countries, and changed to a remarkable degree the power structure of the world.

Facing the fuel shortages of the winter of 1973-74, we began to look for solutions to our energy problems. The enactment of the Emergency Petroleum Allocation Act, which will expire on August 31, 1975 unless extended, and creation of the Federal Energy Office, later the Federal Energy Administration, which has chewed up more administrators in its short history than any other agency of our Federal Government, were the initial responses.

The Emergency Petroleum Allocation Act of 1973 provided sweeping powers to the Federal Energy Administration to allocate petroleum fuels, especially through state allocation offices; control prices; equalize resources and costs to refineries through an entitlement program; and generally demanded accountability from the petroleum industry. Congress mandated Daylight Savings Time and reduced highway speeds. Interestingly, the Federal Government holds no inherent Constitutional powers to control energy; we will say

more about this later.

Under the stress of the embargo during the winter of 1973-74 and the accompanying economic recession, western Europe was able to reduce its fuel requirements by 8.9% during the period from January to June and 5.7% from July to December. During this same period, the United States reduced its petroleum fuel consumption by 5.2% from January to June, and 2.6% from July to December. The Bureau of Mines reported a small reduction of 2.2% for the year. Interestingly, the U.S. GNP dropped the same 2.2% for 1974. One should note that despite a 55 mile per hour speed limit, our gasoline consumption was reduced by only .8% during this same year. Kansans reduced their gasoline consumption from 1,456 million gallons in 1973 to 1,442 million gallons in 1974, less than 1.0%. Our conservation effort with respect to the automobile was not exactly a rousing success, and we seemingly did not take our energy problems as seriously as did our friends in Europe. An alternative conclusion is that their use of the market place was much more successful than our attempt to avoid higher prices through price controls and voluntary conservation.

Today, in 1975, we face the increasingly difficult problem of convincing our citizens of the need to conserve energy, knowing full well that a shortage will be of an artificial and political origin, during a time of great uncertainty and instability. The OPEC countries now possess excess production capacity, and predictions have been presented suggesting excess capacity of as much as 15 to 20 million barrels per day by 1980. Responding to this glut of oil on the world market, some countries have begun to cut back production. Saudi Arabia, which produced an average of 8.5 million barrels per day during 1974, and has a present production capacity of 11.5 million per day, cut back to 7.6 million barrels per day in January, 1975 and 6.5 million barrels per day during February. Some countries have cut

some prices - Libya by $.30 per barrel (Libya is producing 0.9 million barrels per day from a capacity of 3.0 million). We now possess a surplus of tankers in the 200,000 dwt category and larger, and new supertankers have been mothballed immediately upon completion. This situation will be exacerbated with the reopening of the Suez Canal, which President Sadat announced June 5. However, OPEC has displayed a convincing ability to manage both its production and the price of oil. The general agreement among the Western nations that they have no meaningful response to the predicted OPEC price increase of up to $2.00/barrel later this year indicates the success of the cartel.

The planning meeting in Paris for the World Energy Conference did not make much headway. Although OPEC sent no official representatives, the producing countries were represented by Venezuela, Iran, Saudia Arabia and Algeria. The United States, Japan and western European countries pushed for an agenda relating to oil. The OPEC countries, along with India, Brazil and Zaire representing the developing countries, wanted to expand the Conference to include all raw materials. Little progress was made as no compromise could be reached. The recent willingness of the U.S. to reopen the discussion is another demonstration of the power of oil.

On March 5, Kuwait announced the nationalization of the remaining 40% of Ku-wait Oil Company, owned by Gulf and British Petroleum. This change marks the beg-inning of an effort by producing countries to market their own crude. With a 2 million barrel per day production allowable, this change should drastically affect the international system.

Finally, the entire production of Canada's southwest Saskatchewan was shut down during the month of April because of the lack of a market for crude oil taxed at roughly $5.00 per barrel. Subsequently, the Canadians

have lowered the tax on oil while raising it on natural gas.

Interesting comparisons can be made for the week of April 14 as compared with the same week a year ago. In the United States, total demand for petroleum products decreased by 1.1%, but gasoline consumption was up 3.3%. The largest decrease was carried by residual fuel, down 7.1%, representing the mild winter with low demand for heating fuels. On the other hand, in the supply situation, crude domestic production was down 8.4% to 8.3 million barrels per day, whereas imported crude increased 41.5% to 3.64 million barrels per day. Product demand was down 29% to 1.97 million barrels per day. Stocks are at an all-time high. Domestic reserves dropped from 35.3 billion barrels to 34.25 billion barrels, a decrease of 3%, and productive capacity, the capacity which can be reached in 90 days, was down 800,000 barrels to 8.9 million barrels per day.

Natural gas consumption in the United States was down 2.1% during 1974, owing to a mild winter. However, industrial use increased 1.7%, reflecting the great price disparity between gas and other fuels. Production declined from 22.6 trillion cubic feet to 21.3 trillion cubic feet, and reserves declined 5% from 250 trillion cubic feet to 237 trillion cubic feet, despite reserve additions of 8.7 trillion cubic feet.

In Kansas, coal production decreased 47.9% to 608,000 short tons, crude oil decreased 6.8% to 61.7 million barrels, and natural gas decreased 0.3% to 0.894 trillion cubic feet. Crude oil reserves in Kansas on January 1 were 395,107,000 barrels as compared with 401,089,000 barrels a year ago, a decrease of 1.5%. Gas reserves declined from 11.722 trillion cubic feet to 11.704 trillion cubic feet.

To repeat, we see a situation of excess productive capacity in the Arab countries, large stocks above ground, excess tanker capacity and declining domestic production and reserves. Actions at the Federal level portend a period of intense energy regulation, with diminished consumption resulting from controls that will produce artificial supply shortages. Ironically, the Federal Government, which will mandate these controls, holds no explicit or inherent powers to control energy. These powers have been gathered through judicial interpretations of Constitutional powers to: a) regulate interstate commerce - considered relevent in minimum wages, rate setting, air and water pollution control, and gas regulation; b) provide for the national security - use of the original power to oversee foreign affairs and defense has resulted in the regulation of electric power, oil policy, Federal control of the OCS, and atomic energy; c) tax and spend - the Government can either support or withhold support; and d) control property - the Fifth Ammendment requires just compensation, to be decided in the last resort by Federal Courts.

At the state level, state regulation of energy derives from: A) police power - relating to health, safety and welfare and used in abatement, waste prevention, spacing of oil and gas wells; B) taxing and spending - state powers are used in gasoline taxes, excise taxes and the like for public purposes. State powers are limited in terms of taking private property without compensation, due process, and equal protection. The concept of parens patriae is used by the states to guard the people through ability to sue out-of-state corporations. The anti-trust suits which a number of state Attorney-Generals have filed against the major oil companies are based on this concept.

For the past several years, the call for a national energy policy has become increasingly intense. However, the Congress has responded with

legislation that reflects the strength of the new liberal Democratic majority and the New England caucus, along with the interest of the eastern coastal states and the northern tier of states of the mid-continent. In the main, this grouping has a strong consumer protection interest as the states have little or no energy resources.

Developing slowly are political power-blocks representing the interests of the producing states. The Interstate Oil Compact Commission, composed of 33 states, is one focus for this interest under the leadership of Governor Edwards of Louisiana who has taken an exceedingly vigorous role in presenting the views of the producing states to the Congress. Other power-blocks are forming as represented by the recent organization of the Western and Great Plains Governors' Association, a regional non-profit corporation to coordinate energy policy. This regional grouping includes Arizona, Colorado, Montana, Nevada, New Mexico, Utah, Wyoming, North and South Dakota, and Nebraska.

The Mid-West Governors Conference, comprised of 15 states, increasingly is making its views felt in energy policy. Finally, the Regional Commissions, modeled on Appalachia, are using the political power of their groupings to influence energy policy. Included are the Coastal Plains Regional Commission, comprised of North Carolina, South Carolina and Georgia; the Upper Great Lakes Regional Commission, comprised of Minnesota, Wisconsin and Michigan; and the Ozarks Regional Commission, comprised of Kansas, Missouri, Oklahoma, Arkansas, and Louisiana. All represent potential energy power-blocks.

Individual states have not forgotten their rights. In a recent act of the Texas Legislature, the Texas Railroad Commission was empowered to prohibit the sale of new intrastate gas produced on state lands to the interstate markets until all state needs have been satisfied. Louisiana has

enacted a sweeping energy bill that pushes the limits of state's rights to the point where some parts of the bill may be tested in the courts.

These power blocs have been formed because of the uncertainty which sur-rounds national energy policy. A comprehensive energy policy was proposed by President Ford on January 15, 1975. It incorporated a program of import fees beginning at $1.00 per barrel on February 1; an entitlements program to set up a system of rebates; removal of price controls from domestic crude oil on April 1, 1975; Presidential power to limit imports and add excise taxes; removal of Federal price controls from new interstate gas but placement of an excess tax of $.37 per thousand cubic feet on natural gas; allowing production from the Elk Hills Naval Petroleum Reserve; and numerous other conservation measures.

The have-not energy states with the liberal Democratic majority moved rapidly to oppose the President's program. After much debate, HR 2166 was passed by both houses and signed with great reluctance by the President. This bill eliminates the percentage depletion allowance for major companies and reduces U.S. tax credits on foreign-source tax payments. Depletion was retained for independents who do not own or control retail outlets, and refineries whose runs do not exceed 50,000 barrels on any day; also for those independent producers who produce no more than 2,000 barrels per day or 12 million cubic feet of gas per day at 22%. This limitation is reduced to 1,000 barrels per day or 6 million cubic feet of gas per day by 1980, and percentage depletion is reduced to 15% by 1984. Exempt are producers of regulated gas or gas produced under fixed contracts, and producers of secondary and tertiary recovery oil. Depletion is restricted to 65% of taxable income. The original wind-fall profits tax, without plowback fortunately was eliminated. It is estimated that the elimination of depletion allowance will drain nearly $2 billion dollars a year from exploration, and

already there is some evidence of slow-down and cancellation of drilling contracts.

Although the depletion allowance debate has received the preponderance of attention in congressional energy activities this session, an incredible number of other pieces of energy-related legislation have been introduced. Among the bills are ones concerned with the continuation or elimination of price controls on crude oil, regulation of natural gas, creation of a strategic petroleum reserve, standby Presidential powers for energy emergencies, Outer Continental Shelf (OCS) issues, the creation of a National Energy Board or a Federal Oil and Gas Company (FOGCO), a gasoline tax, strip-mining regulation, and allowable import levels for oil and natural gas. Naturally, this list could be extended.

There are four major devices which Congress is attempting to combine to shape our energy policy. Interestingly, each of these tends to correspond to one of the four avenues of power through which the Federal Government has gained its authority in energy matters: (i) regulation of interstate (and foreign) commerce - the price mechanism; (ii) provide for the national security - security measures and some regulation; (iii) tax and spending - tax measures and withholding of federal funds; and (iv) control of property - entitlements programs and mined-land measures.

A strong argument is being made for the return to a free market for fuels; the primary concerns are the regulation of natural gas and decontrol of the price of crude oil. Economically, the most sensible price for the various fossil fuels would be one that was equivalent for each according to its ability to provide energy (Btu content) with provisions for the environmentally premium nature of natural gas over coal. Unfortunately, Federal Power Commission regulation has resulted in just the opposite occurring.

Senators Hollings and Magnuson introduced Senate Bill 692 which would have perpetuated and extended this situation. The bill effectively would have placed intrastate gas under the Federal Power Commission price control through the device of identifying all new gas produced on public lands as interstate gas. All pipelines carrying such gas, and all other gas entering such a pipeline, automatically would become interstate and thus, subject to FPC control. A price ceiling of $.50 to $.75 (compared to a Btu equivalency price of about $2.00) per thousand cubic feet would have been placed on this gas, and end-use allocation would have been with us. Interestingly, this attempt at an apparent invasion of state's rights with respect to public lands resulted in a coalition involving the western states that effectively blocked the consuming states. Also, a substitute for S.692 has been introduced by Senators Pearson of Kansas and Bentsen of Texas with ten co-sponsors. In it, all onshore gas will be deregulated and offshore gas will undergo phased deregulation to be completed by 1981. The gas deregulation bill does not include a excess profits tax as all tax legislation must originate in the House of Representatives.

A bill involving both the regulatory and national security aspects of the powers of the federal government, is S.622, the Standby Energy Authority. The bill, which has been passed by the Senate, authorizes the President to ration gasoline, restrict imports, extend the Emergency Petroleum Allocation Act to March 1, 1976, prohibits increases in the price of old oil, requires the President to set the price of new oil at the price prevailing January 31, 1975, and sets a price of $7.50 for tertiary and secondary recovery oil. Unfortunately, this last provision creates a 3-tier pricing system involving old oil at $5.25 per barrel, secondary and tertiary oil at $7.50 a barrel, and other oil at roughly market price. (We won't even have Btu price equivalency for the same product.) The entitlement program would be a nightmare. The bill further provides the President with authority to mandate increased

production above maximum efficient rates (MER), mandates state conservation programs, and provides for a 4% reduction in consumption.

At one time, it appeared that the Federal Government would become the sole importer of crude oil and products. Additionally, the government has been unwilling to lift price controls; the Senate voted three times to reject decontrol of price of crude oil. However, recent indications are that the administrative complexity of some of the price-control measures is resulting in gross inequities. Many Congressmen are adopting the President's position that pricing and distribution would be more efficiently handled by the free market as long as the monopoly nature of current crude oil prices is recognized and measures are taken to ensure the proper distribution of the resultant profits.

This philosophy is most completely embodied in HR 7014, the congressional version of President Ford's omnibus energy package designed to increase domestic energy supplies while reducing the rate of increase in domestic energy consumption. The major points of the Energy Conservation and Oil Policy Act are the gradual removal of price controls with an excess profits tax and a plowback provision, creation of a strategic petroleum reserve, rationing subject to a congressional veto, production rates in excess of MER for 90 days, and provision for international agreements among oil companies with immunity from any anti-trust suits. The bill also provides for a review of pricing and allocation in the FEA, a 2% reduction in consumption of gasoline over 1972 with minimal inconvenience to motorists, provision for prohibition of minimum price setting by the President, control of refinery operations, and prohibition of natural gas use as a boiler fuel. Other portions of the energy package such as opening the Naval Petroleum Reserves for commercial development and a guarantee of the purchase of 1 million barrels per day of synthetic oil at $15.00 per barrel were spun-off as

separate pieces of legislation because they involve issues outside of the basic energy picture (national security and government subsidies) which have yet to be resolved.

The Democratic counterpart to the President's proposals is HR 6860, Ways and Means Committee Chairman Al Ullman's Energy Conservation Tax bill. This bill was originally planned to be a portion of the Democrats' legislative package on energy, but the rest of the package has failed to materialize. Instead, Ullman is working with Representative John D. Dingell, chairman of the Interstate and Foreign Commerce Subcommittee on Energy and Power to make HR 7014 and 6860 compatible. The Ways and Means bill was originally designed to be based on a gasoline tax of $.37. The unruly majority in the committee has scuttled those plans and is aiming in the direction of mandated quotas, with a maximum gasoline tax of $.23. They want no more than 6 million barrels per day of imported crude oil and products by 1975 and a 25% cut by 1985. A 2% duty on imported crude and 5% duty on products are important to the program, as are import licensing which requires sealed bids to the Government, restrictions on imports from other than friendly countries, tax credits for solar heating, and taxes on inefficient automobiles. Representative of the power-block politics is the amendment introduced (and passed) by Representative Cotter of Connecticut who would allow 2 million barrels a day of distillates to be imported, regardless of other restrictions, in order that the New England states would have plenty of heating oil. When the bill reaches the floor of the House the Democratic majority will attempt to increase the penalties which fall on the oil companies and lessen those to be assumed by the consumer. (Note: This has come to pass with the complete removal of the gasoline tax and most other measures which used the price mechanism. Allocation instead of conservation seems to be the preference of the House.)

The Federal Government controls the development of the OCS through its monopoly over foreign affairs, a situation which was recently reaffirmed by a Supreme Court decision. In Congress, Outer Continental Shelf discussions center around S 521 (Jackson), S. 426 (Hollings) and S. 740. These bills would expand the Federal role in exploration, delay development in terms of state's responsibilities, and provide for revenue sharing among the coastal states. S. 740 provides for a National Energy Production Board. With the Supreme Court decision retaining the mineral rights to the Federal Government, the way is open for leasing 10 million acres of the OCS annually as the Administration has proposed.

Tied up with Outer Continental Shelf exploration and development is the great problem of reserves, a subject which still seems to confuse Congress. However, Congress can hardly be blamed for its confusion as the U.S.G.S. has steadily reduced its reserve and resource estimates over the past five years. Until this spring, the U.S.G.S. was pegging our undiscovered reserves of oil at 200 to 400 billion barrels and 1,000 to 2,000 million cubic feet of gas while many others were estimating about one-half of that, 113 billion barrels of crude oil and 530 trillion cubic feet of gas. In May 1975, the U.S.G.S. again revised its estimates downward to the point where they nearly agree with those of their critics. All forecasters show very little room for new discoveries onshore in the United States, with the great majority of the remaining resources to be found in Alaska and on the OCS. While these figures indicate how limited our resource is, the monetary value represented is still enormous. Congress wants to make sure that a National Energy Production Board does the exploration so that no one is cheated, a move which the U.S.G.S. opposes.

The Federal power of the purse and control of public lands have supplied the basis for the Strip Mining Act (HR 25, S. 7) which has been passed by

Congress, but vetoed by the President. The initial confidence of its supporters that they would override the veto was destroyed by the prediction of large negative economic impacts which its enactment could cause. The bill is tough and requires extensive submission of reports concerning environmental protection, prohibits mining on steep slopes and in alluvial valleys, and prohibits increased siltation of streams. Estimates indicate that 48 to 141 million tons of production will be lost, which is the equivalent of 1.7 million barrels per day of crude oil. Small producers will be hit hardest, especially in the East and losses of 52 million tons of spot production of surge coal are predicted.

The FEA has increased its activity, requiring a market shares questionnaire to be filled out each month by all sellers of distillate and residual fuel oil to ultimate customers. It is anticipated that the proposed monthly questionnaires will be mailed in May 1975 to approximately 1,500 respondents, whose time required to fill out the forms is estimated at an average of 40 man hours. The FEA has also held hearings to exempt production from stripper wells from price control, even though production exceeds 10 barrels per day. Under the Energy Supply and Environmental Coordination Act of 1974 (Pub. L. 93-319) the FEA has ordered 25 (of an ultimate target of 79) power plants in Kansas, Iowa, Nebraska, and Missouri to cease burning petroleum products and natural gas as a primary energy source. Power plants in the early planning process must be designed and constructed so as to be capable of using coal as their primary energy source.

The implications of this order and of natural gas curtailments within the State have made natural gas policy the number one concern of the State Legislative interim session. State SB 564, which provided for price regulation of intrastate gas by the Kansas Corporation Commission, was referred to the committee which will deal with natural gas. SB 557, which extended the

participation of Kansas in the Interstate Compact, was signed by the Governor as was SB 13 which established a Kansas Energy Office. This office replaces the Kansas Fuels Allocation Office. Its duties include those of the old office but have been appreciably expanded in recognition of the need of the State for a central focus for energy matters.

Returning briefly to the Federal energy policy situation, the review of the bills presented here indicates both the complex nature of the energy problem and the appallingly piecemeal approach that is being taken. There is one consistent feature of all of the current legislation however, it is all focused on the extreme short-term, at most the next five years. The only long-term policy we have is expanding energy research and development and encouraging the use of atomic energy. This is hardly a complete or realistic approach when the planning and construction of any major refinery, synthetic fuel plant, pipeline or other energy facility takes a minimum of five years. Those who would develop these facilities must know the specifics of our energy policy, not simply that we are aiming for "energy independence" by 1980 or 1985 or 2000. Hopefully, Congress and the Administration will recognize this soon and will refocus their attention once the basic legislation they are now working on is passed.

Predictions

1. The availability of natural gas will continue to decline, perhaps as much as 30% during the next three or so years, affecting the use of natural gas in Kansas and elsewhere rather dramatically. Industry will be severely affected. End-use allocation of gas will be with us, and we will see a large increase in coal use.

2. Within a relatively short time, the price of gas, crude oil, and coal will begin to equalize through a process of political accommodation in the Congress (Btu equivalency). Even the Washington Post editorial referred to earlier noted that "the way to deal with the gas shortage is to deregulate the price. In present circumstances it ought to be done in stages, over several years, to cushion the impact. No one can say exactly where fuel prices will be several years from now. But they will not return to the level of two years ago. The basic reason for the great upswing in fuel costs is not the producers' cartel, but a world-wide surge of demand for cheap fuel. Higher prices are a signal that supplies are not unlimited and that we have to begin conserving. Price controls merely suppress the warning signal."

3. Enhanced recovery will loom increasingly important in adding to our reserves and production.

4. Kansas production of oil and gas is not likely to increase significantly, nor will reserves. We look only for a possible flattening of our decline curve in Kansas and in the U. S. generally, unless offshore production comes soon and at a greater rate than expected.

5. We will see accommodation with the Arab states and other foreign producers, as interests of both consuming and producing states become more evidently coincident.

6. The states, including Kansas, will begin to take an active interest in conservation measures, either on a voluntary basis or through Federal mandate. Requirements will be promulgated that new state buildings be designed in a conservative mode with respect to insulation, fenistration, orientation, and reclamation of heat. Our legislators are beginning to

KANSAS ENERGY BALANCE 1974 - PRELIMINARY

Carol Zarley

The following "energy balance" is a graphical description of the aggregate energy flows in Kansas for the year 1974. For each energy source - natural gas, crude oil and petroleum products, natural gas liquids, coal and electricity - we have given the appropriate (preliminary) data for production, imports (exports), and consumption by user.

Natural gas production fell slightly from peak 1973 output of 897.3 billion cubic feet down to 894.3 billion cubic feet in 1974.* Kansas retained its position as a net exporter of natural gas, although the 236 billion cubic feet exported (including changes in underground storage) is less than the 244 billion cubic feet exported in 1973. The 609.8 billion cubic feet classified as consumption for 1974 accounted for 63% of the State's energy requirements.

Wellhead natural gas was processed at twenty-four plants in Kansas which extracted 30.8 million barrels of hydrocarbon liquids, commonly referred to as LPG. Refinery input demand, which has been credited to Kansas production, was 12.2 million barrels and net exports were 12.0 million barrels. Final consumption of 6.6 million barrels plus the 0.7 million of refinery-produced LPG accounted for 4% of 1974 energy requirements in Kansas.

Crude oil production continued on a downward trend that began in 1957. The 61.7 million barrels of crude oil produced in 1974 was a decrease of 4.5 million barrels from 1973 output.

*All natural gas data is given in cubic feet at 14.73 psi and 70°F.

Based on volume of crude inputs, Kansas ranked 10th in production of petroleum products. The ten active refineries in Kansas produced 152.1 million barrels of refined products such as motor gasoline, distillates, jet fuel, LPG, residual oil, and asphalt. Motor gasoline accounted for 54% of the refined output and distillates, 24%.

State consumption of refined products in 1974 rose from 1973 levels. This was due to 25% and 16% increases in distillate and residual oil consumption, respectively. Gasoline, jet fuel, and LPG consumption remained about the same. Altogether, petroleum products supplied about 29% of 1974 energy needs.

Coal production in 1974 was 0.7 million tons, a drop of almost 50% from 1973. This was due primarily to the closing of a major mine in Cherokee County and the movement to the Missouri side of a border mine near LaCygne, Kansas. Increased coal use by power plants contributed to the tentative rise in consumption of nearly 0.8 million tons and the change from a net exporting position to a net importing one. Coal accounted for 4% of total energy requirements in 1974.

The overall picture of flows in the electric power sector appears to be relatively stable from 1973, with a slight increase in demand being met by increased production. The primary fuel input requirements can be found from the center insert in the diagram which shows the major flows of energy among the energy producing industries. Approximately 1.8 million tons of coal, 2.1 million barrels of fuel oil and 158.3 billion cubic feet of natural gas were used in 1974 by Kansas power plants to generate 19 billion KWH of electricity.

KANSAS COAL: A REVIEW AND OUTLOOK

Lawrence L. Brady

Introduction

Coal in Kansas has followed an irregular rise and fall in production since the start of coal mining in the early 1860's. Production of coal rose from this early start to peak production years during 1917 and 1918 with annual production of approximately 7.5 million tons. The lowest production since about 1880 occurred during 1974 with .68 million tons of coal.

What is the reason for this low Kansas production at a time when "King Coal" is again coming into the energy picture with a big push from Federal Government?

In recent years, Mine #19 of the Pittsburg and Midway Coal Mining Company in Cherokee County has supplied from one-half to two-thirds of the coal produced in the state. In May 1974, Mine #19 closed, apparently for economic reasons. Coal stripping ratios (cubic yards of overburden to tons of marketable coal) at the mine were approximately 36:1. This stripping ratio was probably the highest in the U.S. for a utility coal.

The closing of Mine #19 could indicate the demise of coal mining in Kansas. However, other factors such as demand, changes in markets, new pollution control equipment, or new mining equipment or mining techniques could result in a reversal of the present production trend and lead to an increase in the amount produced.

Characteristics and distribution

Two outstanding characteristics about Kansas coal must be considered for anyone interested in mining or using Kansas coal:

1) All coal reserves in Kansas are believed to be medium to high sulfur coal (more than 1% sulfur). Commonly there is 3 to 5 percent sulfur in most commercial Kansas coals.
2) Most of the coal reserves in Kansas that can be strip-mined are thin-bedded coals (less than 28"). A few areas, however, especially in the Mulberry coal, are of intermediate thickness (28"-42"). Most of the deep-mine coal reserves are of intermediate thickness.

Coal reserves are concentrated mainly in the southeastern portion of Kansas; however, significant reserves also exist in Osage County. Estimates of the total reserves of coal for the various Kansas counties are shown in figure 1 (Brady and Dutcher, 1974, p. 14). Reserves of coal for the various counties shown in the figure were derived from earlier studies by Abernathy et al. (1947), Schoewe (1958), and Stroup and Falvey (1969). At the present time the Kansas Geological Survey is conducting a coal reserve study and a more accurate figure, especially of strippable reserves, should be completed in late 1975.

With a coal reserve of approximately 900 million tons, there is a total coal resource in Kansas of 18.7 billion tons of coal (Averett, 1969). A coal resource is considered to be the total coal deposits in the state where economic extraction is currently feasible, or may become feasible in the future.

Most of the reserves of Kansas coal are associated with the Cherokee Group of Middle Pennsylvanian age in Kansas (Fig. 2). The largest reserves of strippable coal are associated with the Mulberry coal of the Marmaton Group, and Bevier and Mineral coals of the Cherokee Group. Substantial reserves of coal also exist in the Nodaway coal of the Wabaunsee Group of

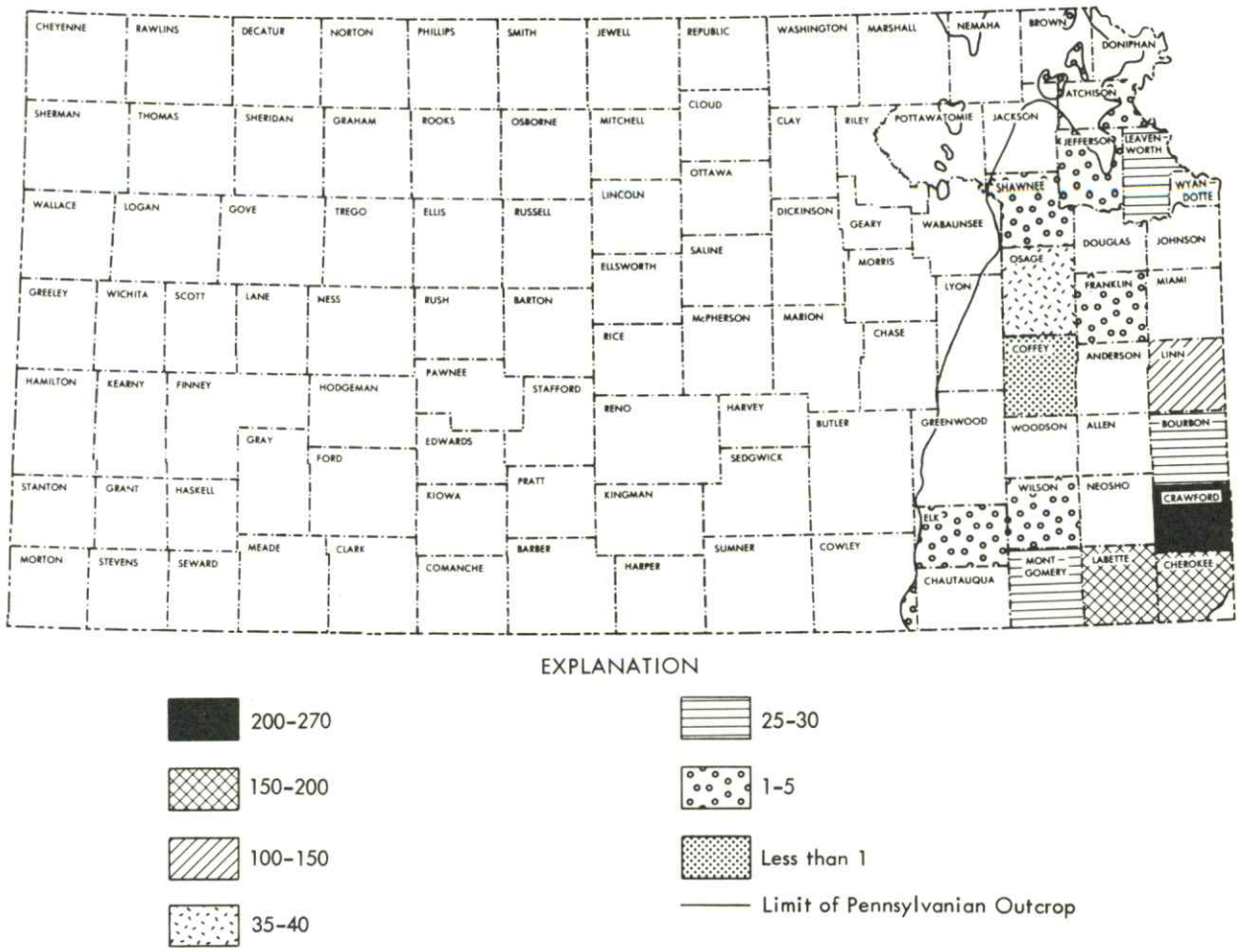

Figure 1. - Estimated recoverable bituminous coal reserves.

Upper Pennsylvanian age in the Osage County area. Most of the underground reserves are in unmined areas of the Weir-Pittsburg coal bed in southeastern Kansas.

There is considerable variation in the quality of the different coal beds, but the commercial coal beds generally show the following range:

Moisture	5-10%
Ash	17-30%
Sulfur	2-5%
BTU/lb.	9,600-12,000 (as received)
BTU/lb.	13,700-15,000 (ash free)

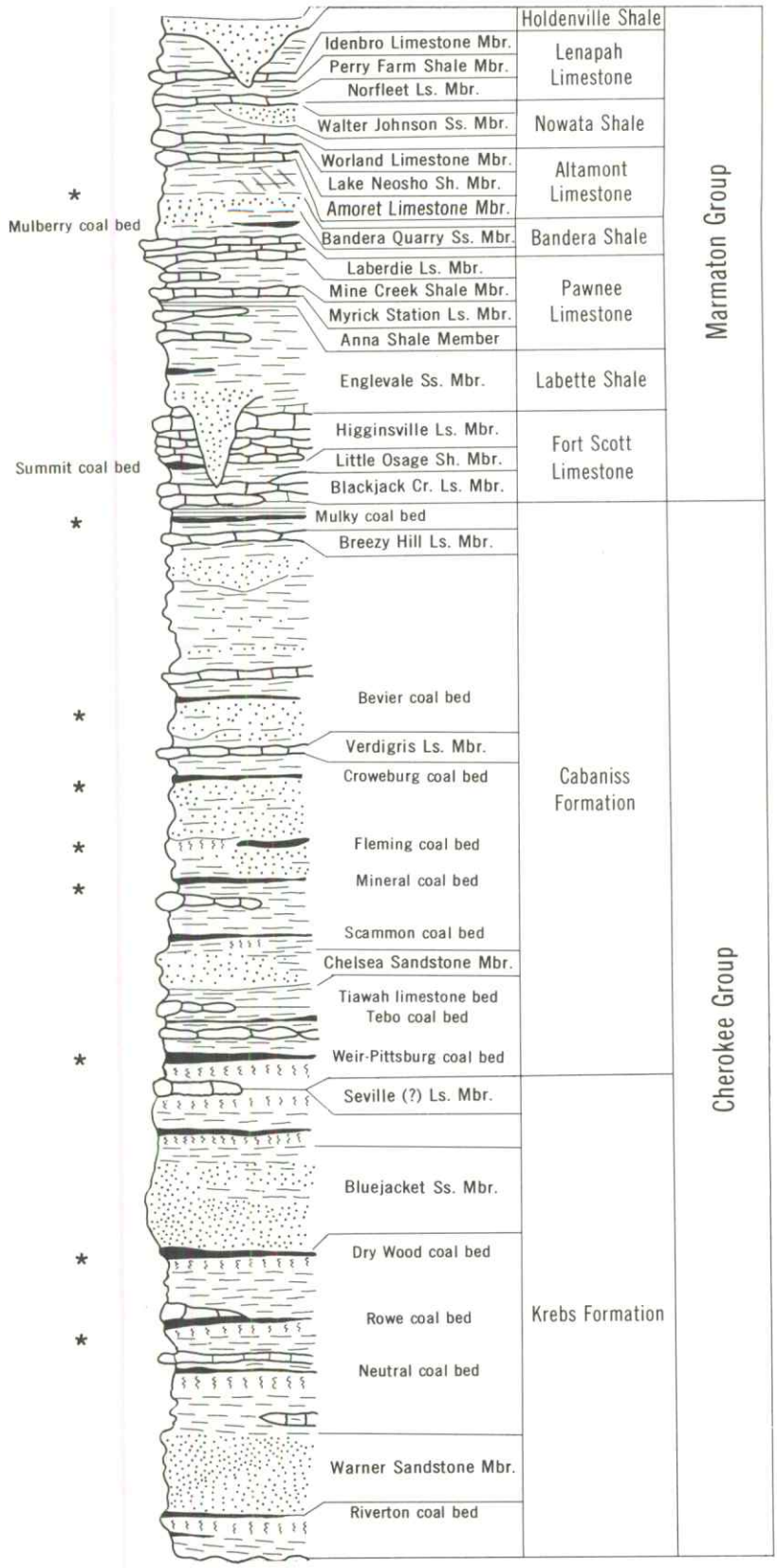

Figure 2. - Coals of economic importance in the southeastern Kansas Coalfield.

Mining Methods

Since 1964, all coal mining in the state has been by strip-mining techniques (locations of operating mines in early 1975 are shown in figure 3). Recent operators of mines have used large draglines, shovels, or combinations of these to remove the soil and rock overlying the coal. Some small amounts of coal have been uncovered by earth-moving scrapers or bulldozers. In most cases, the rock has been fractured by explosives prior to excavation.

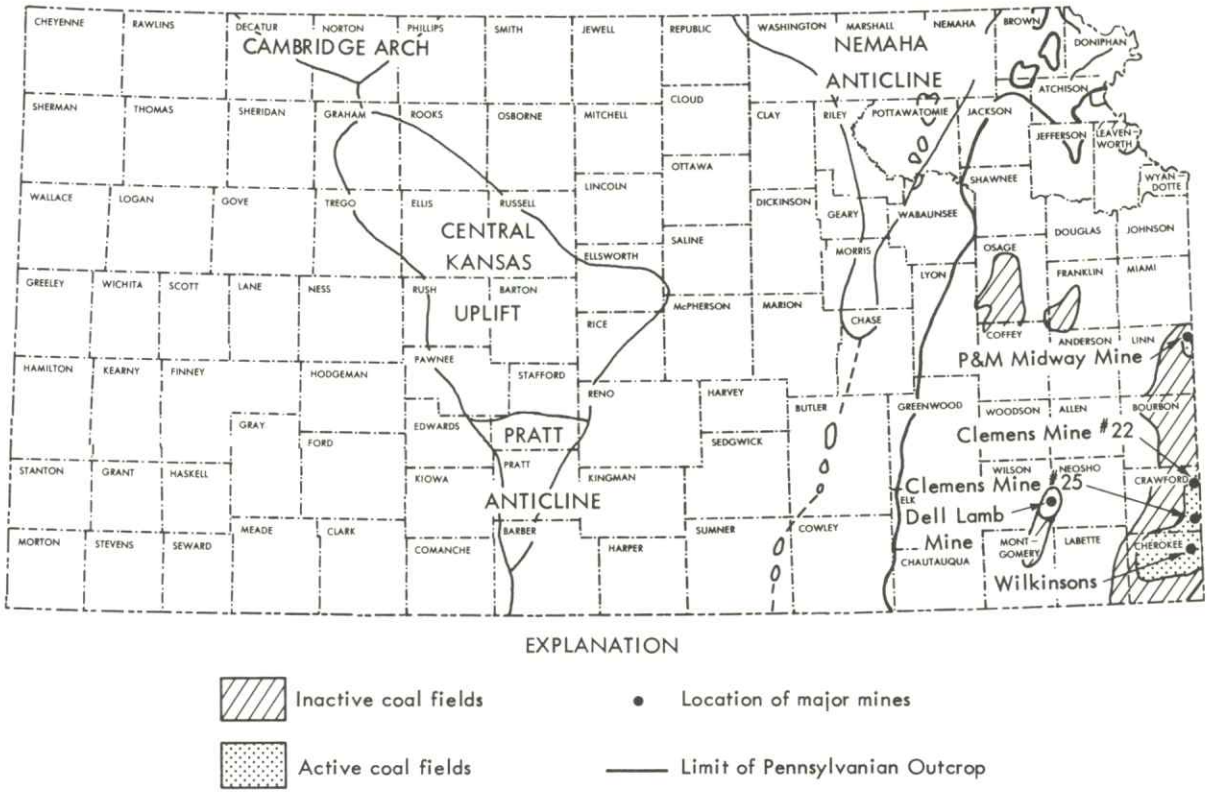

Figure 3. - Location of Kansas mines and coalfields.

The largest pieces of equipment used in Kansas for removing overburden have been "Brutus" a 90 cubic yard shovel at Pittsburg and Midway Coal Company's Mine #19 in Cherokee County, and P & M's 110 cubic yard dragline "Midway Queen" at the Midway Mine in Linn County. These machines are used in the area strip-mining method. Briefly, this method involves the removal

of the overburden down to the coal by the large machines, making a large trench the length of the mining area. The coal is stripped and loaded into large trucks that traverse a portion of the trench. Material excavated by the large shovel or dragline as it returns adjacent to the previous trench is then piled in this earlier excavated trench. A series of linear spoil piles are formed that are then leveled and the area shaped to a flat to rolling terrain by large bulldozers.

The disadvantage of this type of mining is the complete disturbance of the area mined. Strip mining, however, has proved to be the most economical method of mining coal and has a definite safety advantage for the miners. Any method that would attempt to replace strip mining for coal under less than 150 feet of cover must offset these advantages.

Reclamation in Kansas for recent large stripping operations costs between 500 and 1300 dollars per acre. Reclamation costs will be considerably higher if topsoil replacement is required, as was recently voted by the Kansas Mined-Land Conservation and Reclamation Board to be enacted during 1975.

A recent study by the Kansas Geological Survey and the School of Engineering at Kansas University (Reavis, 1974) was made in an attempt to find alternate mining methods to the area strip-mining techniques. The objective of the study was to determine the feasibility of new mining methods that will allow for the mining of shallow-cover coal without the harmful effects to the environment that are associated with present mining activities.

From the evaluation of numerous techniques, two concepts evolved that show promise for future surface mining: 1) an application of auger mining, and 2) an adaption of longwall mining - a present underground mining method. Both of these methods utilize large draglines to open the initial trench (boxcut) in a manner similar to area strip mining. These box cuts are made at intervals of 500 to 1,000 feet across the area of mining interest.

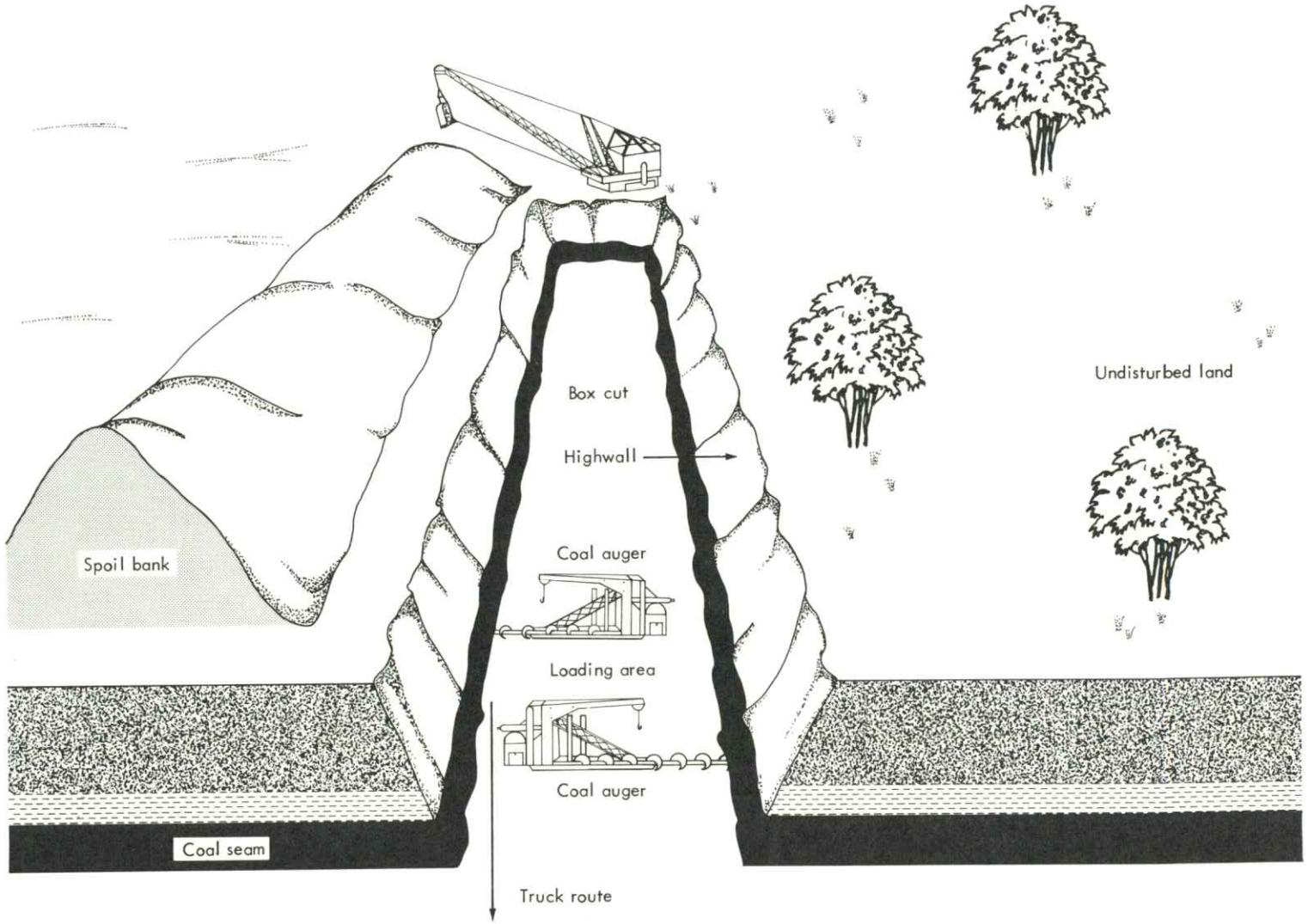

Figure 4. - Auger Strip Mining

In the auger-mining method, the auger is used as a principal machine for coal mining. The auger machine, using a three or four head auger, would be used to mine coal back to a distance of 200 to 300 feet on each side of the box cut (Fig. 4). Coal augers are presently used in many areas to obtain coal in the last cut of a coal mine, especially in the hilly areas where contour strip mining is used. This method has cost advantages similar to those of area strip mining and less land will be distrubed by the mining method. There are several disadvantages to this method.

1. Coal recovery would be limited to approximately 60% of the coal bed. In the thin coal beds in Kansas, Oklahoma, or Missouri, the area mined would be considerably greater than by the strip-mining method even though total mining cost per ton of coal would be similar.
2. Only a few coal beds are uniform enough in thickness and lacking hard concretions (large spherical or disc-like forms of carbonate or pyrite in the coal bed) to allow extensive mining by this method.
3. If depth of the boxcut extends more than about 50 feet, then due to the size of the boxcut, the surface area disturbed approaches the area disturbed by area strip-mining for a similar output.
4. For best development of this mining method, some refinement and improvement of existing auger machines is necessary.

In longwall strip mining the basic components would be (1) a surface mining operation to prepare large coal panels and (2) an underground longwall system to mine the coal (Fig. 5). The method, as described by Reavis (1974), is 3-part:

(a) by preplanning, parallel box cuts would be constructed up to 1000 feet apart. The coal on the bottom of the box cuts would be removed to expose the coal seams in the highwalls.

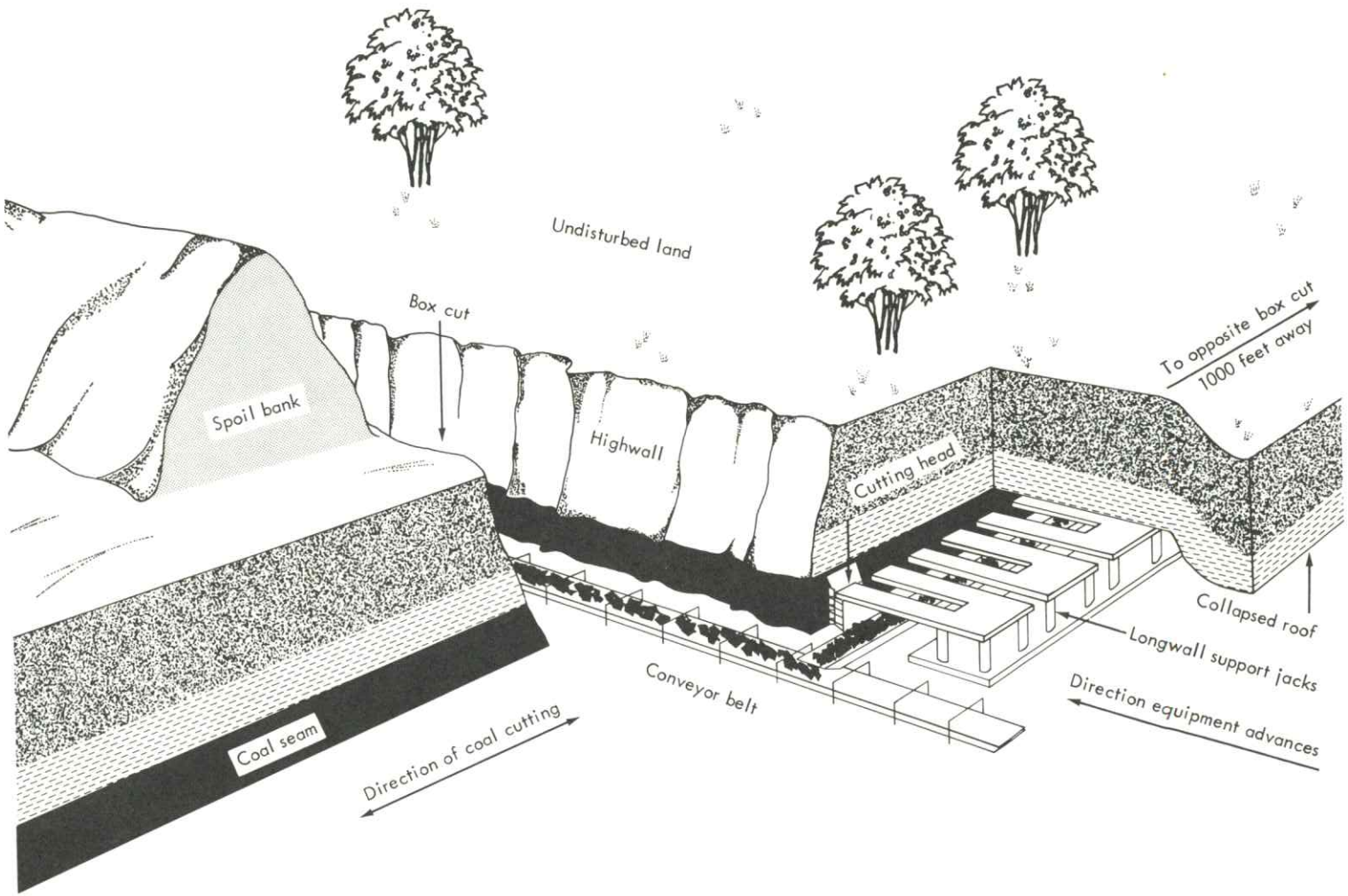

Figure 5. - Longwall Strip Mining

(b) Then the longwall system would be installed between the box cuts by digging a narrow trench between the box cuts.

(c) Finally, coal between the box cuts would be mined by the longwall system with remote operation from the box cuts.

A similar type of mining technique is presently being tested in West Virginia in a cooperative agreement of the U.S. Environmental Protection Agency and the West Virginia Surface Mining and Reclamation Associations. This study is in a thicker coal bed and uses some conventional longwall techniques.

For this method of longwall strip mining to be adaptable to mining in southeastern Kansas, certain equipment developments would be necessary. These necessary adaptations would include:

1. Development of the longwall system to be fully automated, with self-advancing roof supports to be operated by miners in the boxcut areas outside the underground mining area;
2. Refinement of the longwall system to work in the thin seams of this area;
3. Use of a plow or shearer cutter with a guidance system to be operated from the boxcuts.

The system as proposed is untested and the economics of using this mining method are unknown. In the cost study by Reavis (1974) he indicates that lower costs per ton of coal can be expected by the longwall stripping method than with conventional strip mining. The advantage comes mainly in lower capital costs and savings in reclamation costs. As with the auger method, only a few of the coal beds in Kansas and surrounding states have reasonably uniform characteristics which would be adaptable to this mining method. However, the potential for equivalent safety and economics, with minimum surface disruption, makes these methods possible alternates for some areas that presently are mined by area strip-mining methods.

Problems in Marketing Kansas Coal

In addition to the physical and chemical limitations of Kansas coal, several outside factors play an important role in the mining and marketing of Kansas coal. Foremost among these outside factors is the availability of low-sulfur western coals, especially those of eastern and central Wyoming. Also, on a local basis, there is direct competition from coal in Missouri and Oklahoma. These coals are of similar chemical composition and are extracted by similar technology to the Kansas coals.

Outside the coal community is the competition for the energy dollar from oil and natural gas. Although there is a rapid depletion of oil and gas reserves, these commodities still dominate the main utility markets from which the coal producers are trying to cut a larger percentage of the necessary fossil fuel input.

Western coal beds can be characterized as occurring in thick coal beds and having large reserves of low-sulfur (less than 1% S) coal. Coal beds presently mined in Wyoming range up to 118 feet in thickness with the average of 32 feet for a surface-mined coal bed (Glass 1973, p. 196). About half of the strippable Wyoming coal reserve is less than 0.7% sulfur and 99% of the coal is less than 1%.

Kansas Power and Light Company is presently using Wyoming coal to power its Lawrence power station. This coal is replacing Kansas coal previously obtained from Mine #19 of the Pittsburg and Midway Coal Company. In addition, KP&L has recently announced the purchase of 200 million tons of Wyoming coal over the next 40 years to fuel its planned 2.8 million kilowatt power plant in Pottawatomie County. At the LaCygne Power Plant in Linn County, a second unit is to be built by the Kansas Gas and Electric Company and the Kansas City Power and Light Company to supplement the existing power unit. Plans are to fire this new unit with approximately 32 million tons of Wyoming coal over a 20-year period. The use of Wyoming

coal in the second unit is in strong contrast to the use of Mulberry coal from Kansas and Missouri in a mine-mouth operation for the first LaCygne unit.

Transportation of coal from these western coal fields will be mainly by unit trains in order to limit transportation costs. The concept of the unit train is to obtain a load of coal at one location, travel non-stop to the unloading facility at the consumer location, then return empty to the original loading point for the next load. Coal cars for the train are usually owned by the power company using the coal; the locomotive and use of rails are through a lease arrangement with the railroads.

With a reasonably low transportation rate due to unit trains, and low product cost due to the abundance of thick coal beds and a low mining cost per ton, the Wyoming coals can compete with Kansas coals on a cost per ton basis. The Wyoming coals forming the large strippable beds have a lower BTU/lb. than Kansas coals; this is due mainly to high moisture content in the seams. Numerous coal beds in Wyoming have heating values that are equivalent to the Kansas coals. These coals are usually in the thinner coal beds or are mined by underground methods. A good summary of Wyoming coals, their thickness, location, and analyses is given by Glass (1973).

The low-sulfur content of the western coals is their distinct advantage over the coal from Kansas, Missouri, and most of Oklahoma. New SO_2 standards by the U.S. Environmental Protection Agency (Clean Air Act of 1970) would require coal with a sulfur content of approximately 0.7% or less to be used by power plants. New power plants utilizing coal will have to meet the E.P.A. standards of 1.2 pounds of SO_2 per million BTU. This can be met either by using low sulfur coal or by control procedures to remove sulfur emissions from the stack gases. Existing power plants, or power plants converted from fuel oil or natural gas, have less restrictive air quality requirements which vary according to their location.

Two large power generating stations in Kansas, the Lawrence station of Kansas Power and Light Company and the LaCygne power station of Kansas Gas and Electric and Kansas City Power and Light Companies, use large limestone scrubbing units to control the SO_2 emissions. The KP&L power unit used coal from Cherokee County and was able to control the SO_2 produced from Kansas coal by a system that injects limestone ground to a fine powder into the boiler along with, but separate from, the finely ground coal. The gases and particulate material (fly ash) are directed from the boiler area through a scrubber assembly that is designed to remove the fly ash and sulfur gases derived from the coal. The KP&L facility is changing to Wyoming coal following the close-down of Mine #19 and will have less demand on its limestone scrubbing unit.

A scrubber system of slightly different design is used at LaCygne. The LaCygne plant (utilizing local Mulberry coal) injects finely ground limestone as a slurry outside the boiler into a scrubber unit that will also remove fly ash and sulfur gases. Cost of the limestone scrubber unit at LaCygne is approximately 34 million dollars; it will use approximately 600 thousand tons of limestone a year.

The choice facing future major users of coal is using a low-sulfur, lower BTU coal with reasonably high transportation costs, or using a local coal and removing the sulfur emissions by existing technology. However, even those new units being planned for western coals will have sulfur gas removal systems built with the plant. Initial capital costs for the scrubber units are, therefore, not a savings to the company for using western coal.

Coal production in Missouri totaled 4.6 million tons during 1974, while Oklahoma produced 2.4 million tons. During this period Kansas produced 0.7 million tons of coal. These bordering states are obvious competitors to the Kansas coal market. Oklahoma coal producers shipped 1.5 million tons of coal into the Kansas City area during 1973 (Friedman, 1974,

p. 51). In addition to the utility coal, Oklahoma produces some coals that are used for coke manufacture and metallurgical use.

Mining in Oklahoma and Missouri is mainly of thin and medium thickness coal beds, and with the exception of the few high quality coals in Oklahoma, the quality of the coals are comparable. The best summary of Oklahoma coals is found in an article by Friedman (1974). Summary of Missouri coal and coal reserves is covered in recent articles by Robertson (1972, 1973).

Coal produced in states surrounding Kansas does not provide nearly the competition for Kansas coal as other, locally derived energy products. Based on a recent Federal Power Commission (1975) summary of fuel purchased for electric utilities for a twelve month period ending December 1, 1974, coal fueled less than 18% of the electricity generation in Kansas. Natural gas was used for 78% of the electric generation and approximately 5% was generated by fuel oil or other petroleum products. Electric power generation accounted for 93% of the total coal consumed in Kansas for 1973 (Zarley, 1974).

With a decrease in natural gas reserves in Kansas and the U.S., more reliance will be placed on coal for power generation. Recent emphasis by Presidents Nixon and Ford on development of Project Independence depends on coal to a large extent to carry the increased power generation needs of the future. In 1974, U.S. coal production totaled 601 million tons, but studies by the Interagency Task Force on Coal (1974) predict production of coal by 1980 to be between approximately 900 and 1,400 million tons. By 1990 the Task Force estimates that between 1,300 and 2,800 million tons of coal will be mined. The difference between the figures depends on a "Business as Usual" approach and an "Accelerated Development" approach. Production for "Accelerated Development" assumed some relaxation of pollution control standards including variances on the controls, public land leasing practices as needed, and no serious adverse limitations on surface mining.

Plans for future coal-fired power plants are already underway at KP&L's Pottawatomie County Unit #1 and the LaCygne Power Station #2. In the future, when some smaller power plants in the state have difficulty in obtaining natural gas, or new Federal Energy Administration of or Federal Power Commission regulation requires it, conversion to coal or synthetic natural gas derived from coal will become a necessary move.

Future of Kansas Coal

Thin coal beds and medium to high sulfur coal will be the limiting factors on the future of Kansas coal. The thin beds limit production to shallow strip mining or some future modification of strip mining. Any underground mining by conventional methods will probably be limited to the Weir-Pittsburg coal or possibly small areas of the Mulberry coal. The medium to high sulfur content will limit the desirability of the coal unless better pollution control devices are developed or significant relaxation of the clean air standards occurs in the future.

New strip-mining reclamation requirements under consideration in Congress should have little effect on Kansas mining. New topsoil requirements proposed by the Kansas Mined-Land Conservation and Reclamation Board should be similar to the new federal standards. One major change in Kansas coal mining practice will be the filling of the final pits. Kansas reclamation law allows the final pit to remain open to fill with water. These pits provide the well-known strip-pit bass fishing areas of southeast Kansas. If no variance is allowed in the proposed federal requirements of returning the land to its original contour, then this final cut will have to be filled.

It is anticipated that mining of the western coals will become much more expensive because of the proposed federal reclamation requirements. Restoration of the land to its original contour would be difficult where thick seams with thin overburden are mined. Acceptable vegetation estab-

lishment in the arid climates of the west is also expensive. In general, the cost of western coal relative to Kansas coal should increase significantly because of the new reclamation requirements.

Missouri and Oklahoma coal will still compete favorably with Kansas coal. The important situation that will develop, if and when the federal reclamation requirements go into effect, will be uniform reclamation in the three states. At the present time, Kansas producers feel that the required reclamation in Kansas is more expensive than surrounding states, especially when the proposed Kansas topsoil requirement goes into effect.

With Pittsburg and Midway Coal Mining Company shifting mining operations of their Midway Mine to Missouri, and the closing of their Mine #19, Kansas coal production dropped from 1.3 to 0.7 million tons in 1974. The loss of production from these two mines will reduce 1975 production to approximately 0.4 million tons. A period of readjustment is expected in the next five years in the Kansas coal picture. During this period several new coal mines are expected to open in Kansas. In early 1975, the Lamb Coal Company opened its mine in Wilson County. Bill's Coal Company of Welch, Oklahoma will open a mine of Osage County, probably in 1976. Bill's Coal Company is also expected to mine coal in eastern Bourbon County within the next few years. With the possibility of other small mines, production could reach one million tons from small and medium-size mines by 1980. In the '70's Pittsburg and Midway could resume mining operations in Kansas at their Midway Mine that could result in an additional 1 to 2 million ton increase in coal production.

Large power plants in Kansas will probably utilize western coal because of the large amount of coal required over a long period of time. However, a number of small power plants in Kansas and neighboring states will probably convert to coal-fired units, and they could find Kansas coal the most economical to use.

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KANSAS PETROLEUM INDUSTRY REPORT

Margaret O. Oros

Crude-oil production in Kansas, at 61,690,731 bbl, decreased 6.8% during 1974, from 66,227,391 bbl produced in 1973. Refinery runs to stills of 133,632,586 bbl, were down 2,445,357 bbl from 1973; the 71,941,855 bbl of imported oil supplied to the State's 11 refineries came principally from Oklahoma, Wyoming, and Canada. Production of natural gas decreased 1% to 894,307,867 Mcf. Kansas processing plants recovered 30,845,505 bbl of natural gasoline and LPG products, down 532,963 bbl from 1973. Helium production in 1974 was 573,462 Mcf, which was 73% less than the 2,100,898 Mcf produced in 1973. Almost all of the year's production was refined (high purity) helium. This drastic production curtailment resulted from cancellation of helium purchasing contracts by the Federal Government.

All aspects of petroleum exploration work showed increasing activity, stimulated by higher prices being paid for crude oil and natural gas, but production continued to decline. Seismic work increased from 62 crew months in 1973 to 89.5 in 1974, and there was a backlog of 3 to 4 months work at year's end. In excess of one million acres of land has been leased in the Anadarko Basin east of the Hugoton Gas Area, where Permian to Mississippian gas zones are the target for most of the exploration. In the common corners of Kansas, Missouri, and Nebraska, in the Forest City Basin, several million acres are under lease. Exploratory holes completed there during 1974 were drilled to relatively shallow depths, although into pre-Pennsylvanian rocks.

In Kansas, company plans for well drilling are revealed by "Intents-to-Drill" filed with the Conservation Division of the State Corporation Commission of Kansas. During 1974, that Division listed 3,833 "intents" filed for oil and gas tests, service wells, and work-overs. This was a 53% increase over the 2,504 filed during 1973. Many wells have not been completed due to lack of casing, and a drilling-rig shortage has delayed the spudding of many planned holes. About 85 rigs were working in Kansas in late 1974.

New holes drilled showed a 25% increase, to 2,825 completed in 1974 (Table 1). In addition, about a hundred holes were worked over. Total footage drilled was up 15%, from 6,876,242 ft in 1973 to 8,105,937 ft in 1974, and averaged 2,869 ft per well.

Of the 2,690 new holes drilled for oil or gas, 1,378 (51%) were successful. Of 1,853 field development holes, 1,247 (67.3%) were completed as producing wells. There were 847 exploratory tests drilled; 131 (15.4%) found oil or gas. Twenty-three (8.1%) of the 285 holes drilled more than 2 miles from production found oil or gas; 38 (10.3%) of the 370 new-pool wildcats, 70 (37.6%) of the 186 outpost extensions, and 1 of the 7 holes that searched for deeper producing zones in fields were productive. Thirty-seven stratigraphic or core tests, and 98 service wells were also drilled. Several important exploratory failures are shown on Figure 1, and listed in Table 2; 6 of the field discovery wells are listed in Table 3.

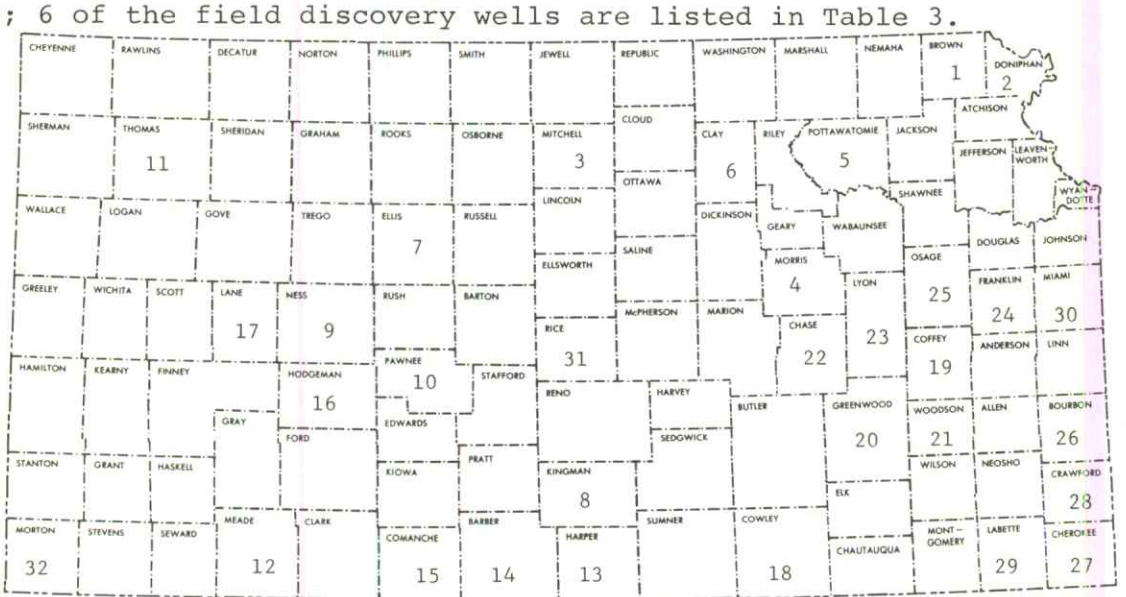

Figure 1. - Index map showing areas of interest in 1974.

Table 2. Important Exploratory Failures, Kansas, 1974

Map No.	Operator, Well No., and Lease	County and Location	TD (Ft)	Formation at TD	Remarks
KANSAS					
7	BMB Oil Company 1 Torkelson	Brown 33-3S-16E	2,866	Hunton	Forest City Basin
8	Anadarko Prod. Co. & Tesoro Petroleum 1 Schneider "D"	Doniphan 14-2S-20E	1,741	Mississippian	Forest City Basin
9	R.W. Thierolf & Assoc. 1 Culp	Mitchell 3-6S-6W	4,300	Reagan	Salina Basin
9	Simpson Oil & Gas Co. 1 Pfaff	Mitchell 26-9S-9W	3,994	Arbuckle	Salina Basin
10	Ablah & Exploration Funds, Inc. 1 Falk	Morris 25-14S-8E	3,041	Hunton	Nemaha Anticline
11	Tomar Petroleum, Inc. 1 Fordham	Pottawatomie 10-7S-12E	3,515	Precambrian	Nemaha Anticline Casey Field

Table 3. Selected List of Discoveries, Kansas, 1974

Map Index No.	Operator Well Number, and Lease	County and Location	Total Depth (Ft)	Pay Zone and Production	Field Name	Exploratory Class
KANSAS						
12	Petroleum Mgmt. 1 Thurlow	Clay 23-10S-3E	2,200	Miss. 20 BO + water	Bateham	WF
13	Raymond Oil Co. 1 Dreiling	Ellis 27-12S-19W	3,825	Lansing 100 BO + 20% water	Glathart SE	WF
14	Nat'l Coop. Ref. Assoc. 1 Hauser	Kingman 20-28S-9W	4,471	Viola 260 BOPD + 2% water	Pat Creek North	NP
15	O.A. Sutton 1 Barricklow	Ness 33-20S-22W	4,410	Osage(Miss) 150 BOPD	Barricklow	WF
16	Frontier Oil Co. 1 Finger	Pawnee 31-20S-16W	3,811	Arbuckle 10 MMcfg/d	Lucas	WF
17	Donald C. Slawson 1 Meek "A"	Thomas 32-10S-32W	4,630	Lans + Cher 150 BOPD	U Pac	WF

Kansas oil-well completions during 1974 (993) increased 40% over the 592 reported in 1973. The 385 gas-well completions comprised 27.8% of all producing wells.

Thirty holes changed classification between the spudding of the hole and completion. Of these, 26 new-pool test wells were completed as out-post-extension wells, and four testing potential producing zones below present pay zones in fields were completed as field development wells.

The producing zones in the 131 field discoveries were divided among the following geologic divisions: Permain, 7; Pennsylvanian, 60; Mississippian, 50; Ordovician (Viola and Simpson), 8; and Arbuckle, 6 (Fig. 2).

Fifty-six new-pay zones in producing fields were also found; 14 were gas-zone discoveries, 35 found oil, and 4 were reported to have both oil and gas. Four were in rocks of Permian age, 36 were Pennsylvanian, 13 were Mississippian, and 3 were in Arbuckle rocks.

In 1974, 5 fields were combined with nearby fields, as the result of new drilling, and 18 fields that had been abandoned were revived.

A comparison of new producing-well completions with former producing wells that have been plugged shows that 29% more were plugged than completed during a 9-year period. A year-by-year listing follows: 1966-1, 193 new wells/1,867 producing wells plugged; 1967-1,397/ 1,826; 1968-1,296/ 1,720; 1969-1,152/1,805; 1970-1,150/2,109; 1971-1,211/1,550; 1972-1,248/ 1,421; 1973-976/1,232; and, 1974-1,378/2,043. During this period,11,011 oil and gas wells were completed, and 15,573 depleted wells were plugged. Holes in all categories plugged during this time totaled 30,667.

About one-half of the 385 gas wells completed during 1974 were drilled in Bradshaw, Greenwood, Hugoton, and Panoma Gas Areas, in southwestern Kansas. Panoma field, with 142 wells, led in completions, and has added 590 wells producing from Council Grove rocks in the past 3 years. Hugoton field yields about 70% of present natural gas production in Kansas, from

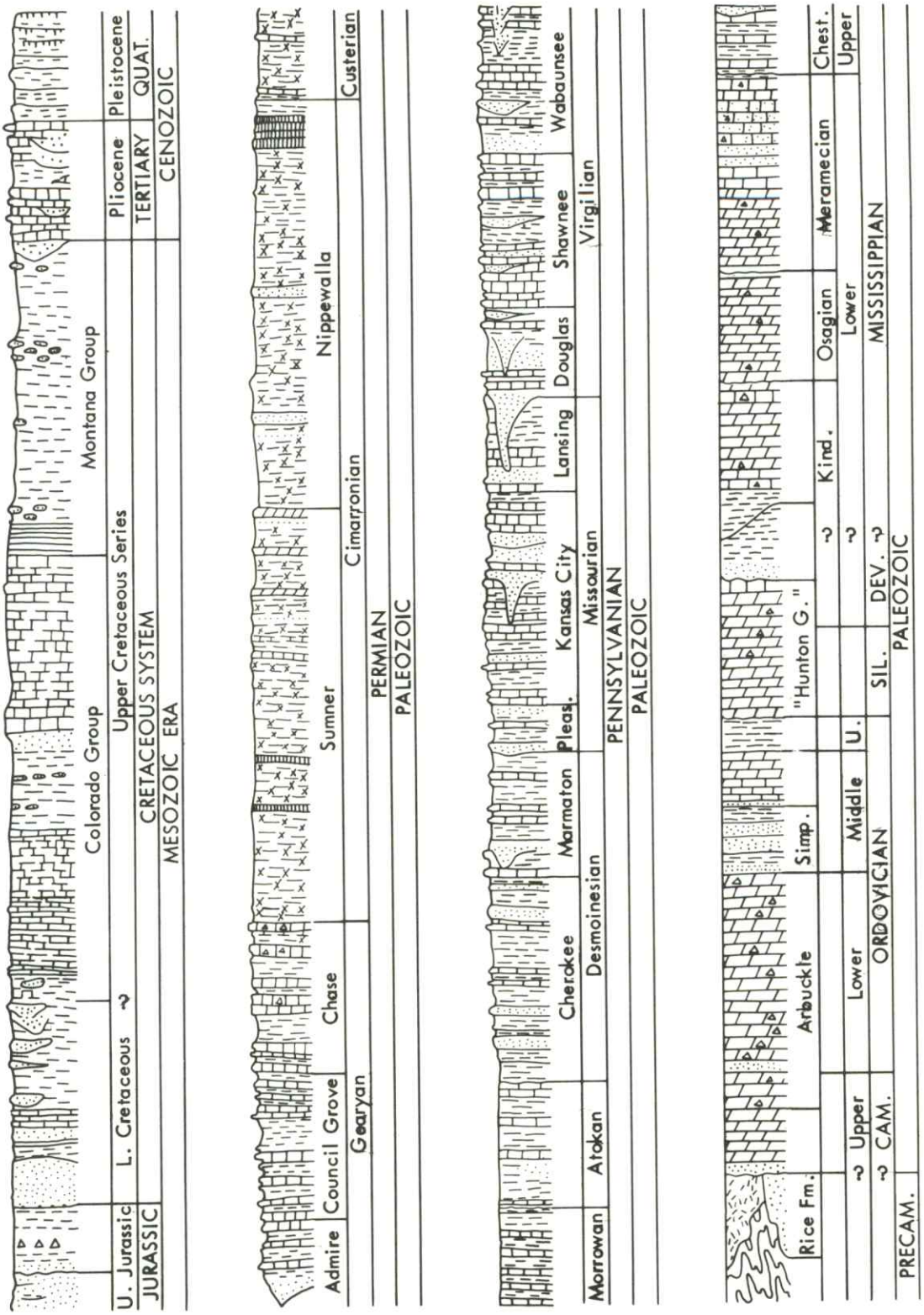

Figure 2. - Classification of rock in Kansas (Oros, 1971, modified from Jewett, in Zeller (ed.) 1968).

the Chase Group, and Panoma which lies stratigraphically below it, is second in volume of production.

One of the large gas wells found in south-central Kansas in 1974, was Imperial Oil Company's 1-23 Sanders Ranch in Angell field, Meade County (12)*, completed for 54.3 MMcfg/d from Morrow sandstone at 5,631-57 ft. Hibbord NE field, Harper County (13), had 6 new wells; the best was Robinson Oil, Sweetman Drlg., and Southwest Petro-Chem's 1-1 Gates "A". It had an I.P. of 61.5 MMcfg/d and 5 bbl distillate per MMcfg, from Mississippian rocks at 4,560-67 ft. In Perry Ranch field, Barber (14) and Comanche (15) Counties, National Oil Company completed 2 wells in Mississippian rocks with I.P.'s of 31 and 50 MMcfg/d. Frontier Oil Company's 1 Finger, the discovery of Lucas field, in Pawnee County (10), offsets a dry hole drilled in 1952. It was completed for 10 MMcfg/d from Arbuckle rocks at 3,793-3,811 ft.

Many holes were drilled on the southwestern flanks of the Central Kansas Uplift. Ness County (9) has 126, including 2 new field discoveries among its 49 producing wells; Hodgeman County (16), with 1 new field discovery and 18 producing wells out of 49 holes drilled; and Lane County (17), with 3 new field discoveries in the 14 producing wells found by 44 tests. Cowley County (18), on the Oklahoma border, led in total completions with 133 holes, of which 77 were producers.

The 18-mile long series of Virgil, Virgil North, and Dunaway fields, in Coffey (19), Greenwood (20), and Woodson (21) counties, recorded 24 new oil wells. A new well with Peru sandstone (Marmaton) production, a new pay zone for these fields, joined other wells producing from Bartlesville, Mississippian, Viola, Simpson, and Arbuckle rocks.

Glacier Petroleum Company's 53 Green found oil in Viola (Ordovician) rocks in the Teeter-Scott field, Chase (22) and Greenwood counties, where

*The numbers in parentheses refer to Figure 1.

production since 1920 has been entirely from Bartlesville sandstone (Cherokee Group). The new pay zone is only 500 feet deeper than the old producing zone. This well was completed in late December, and its depth and significance as a deeper-pool opener was overlooked at that time.

Exploration was widespread in a search for stratigraphic "pinch-outs" in Lyon (23), Coffey, Franklin (24), and Osage (25) counties. The newer fields in that area produce from Mississippian, Viola, Simpson, and Arbuckle rocks.

Southeastern Kansas, southwestern Missouri, and adjacent areas in northeastern Oklahoma are heavily leased and are being explored by the drilling of many tests. A number of these, especially in Missouri, are less than 100 feet in depth, but were drilled through sands that in many places are saturated with low-gravity oil. Some of the companies are exploring for lead and zinc, rather than oil, as the Tri-State mining district is nearby, but well records only identify the holes as stratigraphic tests. Many of the 22 holes drilled in Bourbon (26), 36 in Cherokee (27), 32 in Crawford (28), and 74 in Labette (29), counties were in this oil and/or metal exploration program. Results of these tests, for the most part, have not been made public.

About 50 shallow-depth Pennsylvanian natural-gas wells were drilled in eastern Kansas by owners of farms and small manufacturing plants to offset the higher prices being asked for natural gas and propane. Crawford County recorded 21, Miami County (30) had 11, and the other wells were drilled in several bordering counties.

Development of one LPG and 2 natural-gas storage areas was authorized during 1974. Northern Natural Gas Company is converting Lyons field, in Rice County (31), and Colorado Interstate Gas Company will use Boehm field, Morton County (32) as new natural gas storage reservoirs. An abandoned salt mine near Little River, Rice County, will be converted to storage of LPG products on a warehouse basis by Sentry Underground Storage Company, a subsidiary of Ferrellgas, Inc.

A fuel shortage surfaced in the United States early in 1972, and reached crisis proportions the following year. In the summer of 1973, the Federal government initiated a 2-tier price system for crude oil, in hopes of furthering exploration for new supplies. Prices paid for "old oil" (from wells producing more than 10 bbl/d in mid-1973) are now held at $5.15/bbl and the price of oil from newly discovered wells and from the low-producing "stripper" wells is allowed to seek its own price level.

It is difficult to determine the amount of oil sold at the different price levels, but one estimate is that the average price paid for crude oil in Kansas in 1974 was about $9.44/bbl, with a total estimated value of $55.3 million for the oil that was produced. This was 92% above the value of oil produced in 1973 when prices ranged from $3.65 to $10/bbl. Prices offered for natural gas, especially for that used intrastate, have also been rising.

Another change which greatly benefitted eastern Kansas operators who are the principal producers of low-gravity oil, was the modification or elimination of price differentials based on oil gravity. Since the early 1900's, crude-oil price has been related to gravity of oil, as refineries received higher prices for their lighter liquid petroleum products. With improvements in refining techniques, the value of refined products obtainable from a barrel of low-gravity crude oil is now nearly the same as that derived from oil of higher gravity. The traditional 4-cents/bbl price differential per degree of gravity, for crude oil with gravities below 40° API, was reduced to a 2-cents differential on March 1, 1974, and in some areas of the United States was entirely eliminated.

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METAL MINING POTENTIAL IN KANSAS

P. Berendsen

At present no base-metal mines are in operation in the state of Kansas. Historically, the only base metals mined were lead and zinc, with small amounts of cadmium and germanium as by-products. For several reasons, only two of which are mentioned, the need to explore for and develop new domestic resources is believed to become more apparent as time goes by.

First, the increasing dependency of the United States on foreign or imported raw materials and the resulting difficulties associated with it, may give rise in the future to more protectionist policies, thus favoring development of raw mineral resources within the United States. On the other hand, the potential for protectionist policies by foreign government may force us to develop more of our own resources.

Secondly, as the living standards of people all over the world are elevated and the need for more raw materials increases, the prices of these commodities will undoubtedly rise, resulting in new exploration efforts.

The potential of finding ore deposits under or within the sedimentary cover in the midcontinent area is considered to be good. Increased knowledge of the tectonic history of the region, including more information about the basement rocks as well as the sedimentary cover will undoubtedly lead to additional discoveries.

It is believed that there is a potential for finding additional or new deposits of at least three metal commodities in Kansas: lead and zinc, copper, and uranium. The rest of this article will deal with these three

base metals in succession and generally outline why the possibility of finding ore deposits of this kind is considered to be quite good.

Lead & Zinc

Lead and zinc mining operations started about 1870 in southeastern Kansas. The first ore was discovered in carbonate rock outcrops of Mississippian age and subsequent mining operations up to recent times were limited to depths of 150 to 400 feet. The average zinc content ranged from 2-3%, and the lead content from 0.6-0.7%. A combination of factors such as 1)discovery of new and/or higher grade ore deposits, both within and outside the United States, 2)depletion of known reserves in the district, and 3)environmental legislation and economic considerations has forced the closure of all mines. No production has been reported from southeast Kansas since 1969.

However, each of the factors that helped influence the closure of the mines may change at any given time. New operations would stimulate the depressed economy of the region as well as contribute to the well-being of the state.

Although the lead and zinc mining industry contributed less than 1.0% to the total dollar value of mineral commodities in Kansas during the last 10 years of its existence, it has been important at other times. Around 1925 it contributed up to 50% of the total dollar value and in 1944 it still accounted for about 10%. The geologic conditions favorable for ore deposition and localization are believed to be good over large areas generally, but not exclusively, restricted to southeastern Kansas. However, most of the large near-surface ore bodies have probably been found and exploited. The Mississippian rocks that are host to the ore-bodies dip gently in a westerly direction and are overlain by successively younger rocks. Occurrences of lead and zinc mineralization usually associated with carbonate rocks have been recorded from several counties, outside the Tri-

State mining area, mainly as a result of drilling for hydrocarbons. Of course, there is a limit as to how deep mineral commodities can be mined profitably at any given time. For example, the 7-8% of zinc ore reported from a well in western Kansas at a depth of about 5000 feet (Evans, 1962) is at present too deep to be of economic interest. However, there are large areas where the carbonate rocks are close enough to the surface and where the right combination of geologic factors may be considered favorable for continued exploration.

Although mining operations have ceased, exploration activity has continued at a modest pace, and seems to have increased slightly with new exploration being conducted outside the traditional mining areas.

Copper

Although no copper has been mined in Kansas, it is common knowledge that copper mineralization occurs in several places throughout the south-central part of the state (Evans, 1962; Hill, 1967; Waugh and Brady, 1974). The mineralized rocks are of Permian age and extend in a southerly direction into Oklahoma and Texas. Copper mineralization in the last two states was described in papers as early as the beginning of the 20th Century. Continued interest and work resulted in the 1960's in the discovery and development of an ore body at Creta, Oklahoma (Johnson and Brockie, 1973). Because of the nature of the ore deposit it is referred to as a stratiform deposit. It occurs essentially in a single horizon in shale and siltstone of Permian age. Most of the other occurrences are of the same nature, with mineralization localized in shales, siltstones and sandstones and thin dolomite beds. The mineralization in Kansas occurs in the same types of rock and preliminary studies show that mineralization in dolomite beds is widespread. The environment in which these deposits are concentrated is believed to be brackish-water or shallow-marine (Johnson, 1974). The fact

that widespread mineralization has been observed indicates that favorable conditions for mineralization did exist.

More work to try to understand the nature of the ore deposits as well as additional exploration is warranted and could result in locating commercial quantities of ore.

Uranium

Of the three metal commodities discussed in this short article, the least is known about uranium. However, the potential of finding uranium ore deposits is considered to be as good as for the other two commodities. It may even be that with the increased demand for energy and the predicted shortage in uranium to fuel nuclear reactors, this commodity will be more important than the other two in the near future. Most exploration and essentially all mining for uranium takes place in the western United States. However, since the "energy crisis," more money and effort is being spent on exploration for uranium, and attention is slowly shifting to potential uranium-rich areas elsewhere in the United States. More than 75% of all uranium mined comes from rocks of early Tertiary and Jurassic age and the host rocks for 90% of all deposits are coarse sandstones and conglomerates.

Generally speaking, the two formations in Kansas which could be host rocks for uranium ore bodies are the Ogallala formation of Late Tertiary age and the Dakota Formation of Cretaceous age. Together, they cover most of the north-central and northwestern part of the state. Even though these formations are not of early Tertiary or Jurassic age, they are considered favorable areas for exploration for uranium. These formations exhibit some of the characteristics of known uranium-bearing rocks, e.g., they contain sandstones, coarse clastics, carbonaceous material, lignite, and associated volcanic ash deposits. Other indicators of possible uranium are gamma ray anomalies as recorded in drill holes.

The main purpose of this article is to focus attention on the potential of metal occurrences within the state. Even though there is no mining and only limited exploration activity at the present time, the geologic conditions for ore localization in Kansas are quite good.

As a closing note, a word about the environmental problems related to the mining industry.

The last decade has seen increased concern about the environment which, in cases, has delayed or indefinitely postponed the development of new resources. Many states and the Federal Government have enacted legislation dealing with these concerns. However, many of the rules and regulations were formulated after certain developments were already in progress. Knowing that the state of Kansas has definite mineral development potential (open-pit as well as underground mining), it would be useful to develop a certain set of guidelines covering the basic responsibilities of operators concerned with the extraction of mineral commodities. Potential developers could use these guidelines while planning their operations.

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HELIUM IN KANSAS

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Kansas is in the unique position of being one of the few areas in the world where helium is associated with natural gas in quantities that allow for volume extraction at reasonable costs. The helium-rich gas in the Hugoton field in the southwestern part of the State has endowed Kansas with a substantial portion of the nation's helium reserves, and the extractive capacity in Kansas is the largest of the four states currently producing helium. In recent years the uses of helium have grown far beyond its major historical use as a lifting gas in military lighter-than-air craft, and helium is expected to play an important part in the future provision of electrical energy. Yet, at a time when conservation of exhaustible resources is experiencing a revival, on the order of six million cubic feet of Kansas helium is being vented into the atmosphere every day. This seemingly inconsistent position will be one of the topics explored in this article on the current status of the small but important helium industry in Kansas. Some of the interesting properties of and uses for helium are reviewed in section 1. A brief account of the recent history of the helium industry is given in section 2 with special emphasis on the short-lived Federal conservation program and its effect on Kansas. The need for future helium conservation and some alternatives for doing so are discussed in sections 3 and 4, respectively.

1. Helium and Its Uses[1]

Helium is found as a naturally occurring constituent of natural gas in amounts varying from less than a trace up to 8% by volume. It is currently considered economically feasible to extract helium from natural gas containing 0.3% or more helium.

In its gaseous state, helium is colorless, odorless, chemically inert, and the lightest of all gases except hydrogen. It has the lowest liquifaction point (-452 F) of any known substance, and is the only material known to remain liquid down to absolute zero (-459 F).

Some of the uses of helium are listed below:

(a) Leak Detection: Helium has the ability to flow through the minutest opening. Therefore it is used to check the components of many systems which must be leakproof for safe and acceptable performance.

(b) Controlled Atmospheres: Helium is used to provide an inert atmosphere of high thermal conductivity. For example, in the growing of germanium and silicon crystals for transitors used in modern electronics.

(c) Pressurizing and Purging in Rockets and Spacecraft: During 1974, about 28% of domestic helium sales were for this purpose, primarily in the U.S. space program. Helium is used to pressurize hypergolic (self-igniting) propellants such as liquid hydrogen and oxygen, and to purge oxygen from hydrogen pipelines and engines.

(d) Lifting Gas: Helium has historically been used in lighter-than-air craft, especially during World War II. Although not as light as hydrogen, the noncombustibility of helium made it preferable to the highly flammable hydrogen. Helium continues to be used as a lifting gas, for example, in some weather balloons.

(e) Welding: Last year, 17% of domestic helium demand was used in shielded arc welding, where helium is particularly useful in increasing efficiency and penetration.

(f) Cryogenics: Because of helium's unique low temperature properties, it is virtually essential in the rapidly growing field of cryogenics. For example, helium can provide a suitably low temperature atmosphere for nearly friction free transmission of electric power.

(g) Other: Helium is also used in synthetic breathing mixtures for seep sea work; as the prefered coolant in nuclear re actors; and in supersonic research.

There are known although less desirable substitutes for helium in some uses; however, for all cryogenic applications where very low temperatures must be maintained, helium is considered to be essential. We will see in section 3 that this field may become increasingly important in the future provision of energy.

2. Recent History of the Helium Industry

Before 1950, the only periods of substantial helium demand were for military use in the World Wars, the largest volume was used as lifting gas in lighter-than-air craft. As the post-war demand for helium began to climb rapidly due to increased use in industry, defense, research, and, significantly, the burgeoning space program, the Federal Government became concerned that production from the two helium extraction plants in the U.S. (which it owned and operated through the Bureau of Mines, Dept. of Interior) would soon be inadequate to satisfy Federal needs, much less private demand. Therefore, in 1960, Congress passed the Helium Amendments Act, the intent of which was to: (1) encourage private industry to set up helium extraction plants; and (2) to maintain a Federal program of conservation storage of helium. The entire program was to be operated by the U.S. Bureau of Mines.

As a result of the Helium Act, contracts were made with Phillips Petroleum Co., Cities Service Helex, Northern Helex, and National Helium Corp., for sale of helium in its crude state (a mixture of approximately 70% helium and 30% nitrogen) to the Bureau of Mines. The locations of these "conservation" plants, capacities, and contract prices are listed in Table 1. The amount shown in the table for maximum annual payment by the Bureau to each company refers to the stipulation in the Helium Act that the annual purchase of helium for conservation storage could not exceed $47.5 million.

The intention of this farsighted program was to save helium (in its crude state) while supplies of rich helium bearing gas (0.3% or more helium) were available. Then, as gas supplies became exhausted and/or too lean in helium for economic (cheap) extraction, the Federally owned crude helium would be taken out of storage and refined for sale at one of the Bureau of Mines plants listed in Table 1.

TABLE 1

CONSERVATION PLANTS

	Northern Helex	Cities Service Helex	National Helium Corp.	Phillips Petroleum
Plant Location	Bushton, Kansas	Ulysses, Kansas	Liberal, Kansas	2 plants: Dumas, TX; Hansford Co., TX
Initial Operation	December, 1962	June, 1963	July, 1963	December, 1962
Nominal Annual Capacity	675 MMcf/yr.	610 MMcf/yr.	1,053 MMcf/yr.	788 MMcf/yr.
Initial contract price	$11.24/Mcf	$11.78/Mcf	$11.78/Mcf	$10.30/Mcf
Maximum Annual Payment under Conservation Program	$9.5 million	$9.1 million	$15.2 million	$13.7 million

BUREAU OF MINES PLANTS

	Excell Plant	Keyes Plant
Location	Masterson, Texas	Keyes, Oklahoma
Initial Operation	March, 1943	August, 1959
Nominal Annual Capacity	360 MMcf/yr.	420 MMcf/yr.

Source: U.S. Bureau of Mines

The relative proximity of the conservation and Government plants is far from accidental. Although proved reserves of helium-rich natural gas are considered by the Bureau of Mines to cover 101 fields in 10 states[2], an estimated 83% of these reserves are found in the Hugoton, Keyes, and West Panhandle fields of Kansas, Oklahoma, and Texas, respectively. Figure 1 shows the location of this tri-state area along with the geographic locations of the extraction plants in the conservation network and the Federally financed pipeline system that connects the various plants with the Bureau's underground storage facility in the Cliffside field near Amarillo, Texas.

The conservation program was a bonus for Kansas in terms of initiating the development of an extraction capability for a resource which otherwise may have remained in the natural gas going to fuel markets, subsequently it would have been dissipated into the atmosphere when the gas was burned. Through the incentives of the conservation contracts, three plants were constructed in Kansas with a combined capacity for extraction of more than 2.3 billion cubic feet of helium per year. Furthermore, these plants were guaranteed annual revenues up to $33.8 million from the sale of helium to the Bureau of Mines.

Soon after the very promising helium conservation program began, it found its financial position unexpectedly eroding. The Helium Act had instructed the Bureau of Mines to liquidate the program's debt to the U.S. Treasury, with interest, by 1995. To do this, the Bureau raised its price of high purity helium in 1961 from $15/Mcf for Federal uses and $19/Mcf for non-Federal, up to $35/Mcf for both buyers. These prices would assure liquidation of the program's debt in the time stipulated by Congress, assuming certain projections of Bureau sales would materialize. At the time the helium conservation program was conceived and legislated, the Bureau of Mines was the sole supplier of high purity helium in the nation. However,

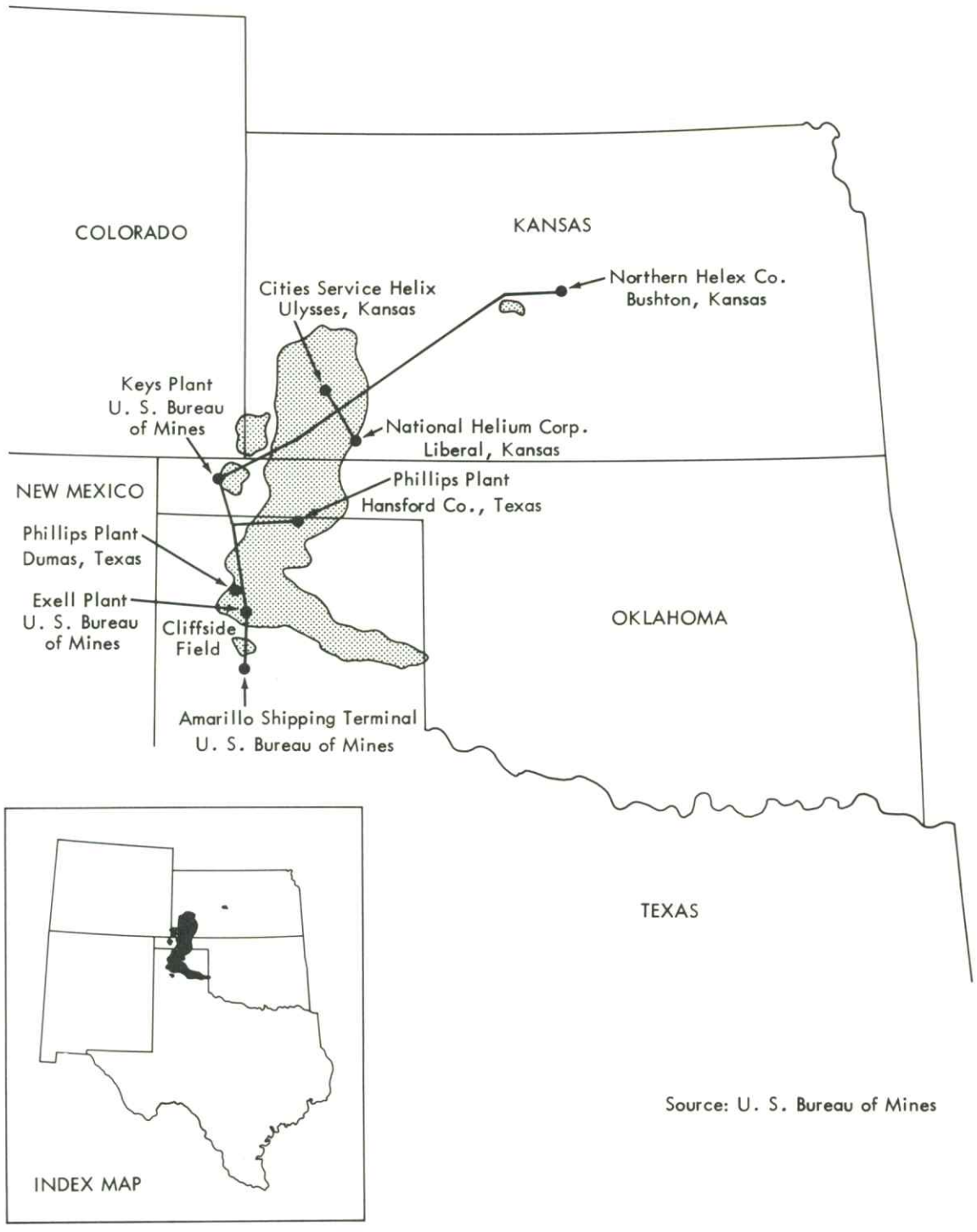

Figure 1. - Index map to helium-containing natural gas fields and related pipelines and plants.

its monopoly position was quickly challenged by the entrance into the market of the following four private firms operating completely outside the conservation program.

TABLE 2

PURIFICATION PLANTS

Plant	Location	Initial Operation	Capacity
Kansas			
Kansas Refined Helium	Otis, KS	April, 1966	180 MMCF/year
Alamo Chemical Co. Cities Service	Elkhart, KS	Dec. 1966	140
Cryogenics, Inc.	Scott City, KS	Oct. 1968	200
Kansas Total			520
Arizona			
Kerr-McGee, Inc.	Navajo, AZ	Nov. 1961	75
U.S. Total[3]			595

The firms listed in Table 2 found they could produce high purity helium for approximately $21/Mcf, substantially below the Bureau's $35/Mcf. Figure 2 shows the increasing erosion of the Bureau of Mines' share of the market. (The unexpected slack in demand starting in 1969 was mainly due to cutbacks in the space program.) This share would undoubtedly be even smaller if it were not for the reservation of the Federal market to the Bureau of Mines by the Helium Act and the subsequent stipulation by some agencies that their contractors purchase Bureau helium for use in Federally funded projects.

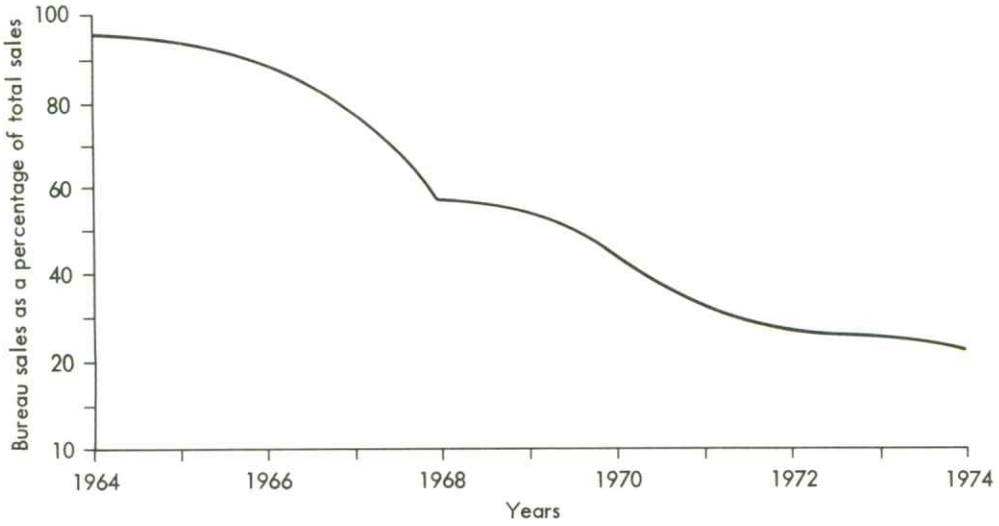

Figure 2. - Bureau of Mines sales as a percentage of total high purity helium sales.

In 1971, just ten years after the conservation contracts had been drawn up, the Secretary of the Interior effectively ordered the cessation of the helium conservation program. Termination notices were sent to three of the contractors who forestalled the order by obtaining a temporary court injunction. The lengthy litigation which followed finally ended in favor of the Government concerning the legality of contract termination, and in November 1973 the Bureau of Mines stopped accepting helium for conservation storage. The fourth firm in the program had previously considered its contract void on the grounds that the government had materially breached its contract. This assertion was upheld by a court ruling in January 1972. A decision was reached in December 1974 by the trial judge of the U.S. Court of Claims to award $78 million for this material breach. This decision, however, is subject to review by the full Court.

The termination of the program has left 80% of Kansas' extractive capabilities "unused." The plants are on-stream, extracting hydrocarbon gas liquids and helium, but there is effectively no place for the helium to go except into the atmosphere. There is no established storage facility and the helium market is not yet strong enough for any but an insignificant sale of crude helium to the high purity private plants for refining and sale.

It has been suggested that helium conservation be continued at the state or private level for lack of federal initiative. This suggestion is particularly relevant for Kansas since the natural gas in the Hugoton field is expected to be yielding substantial amounts of helium throughout the rest of this century. Some of the directions Kansas policy could take are sketched in Section 4, after the following short digression on the expected future aggregate availability and demand for helium.

3. Projected Helium Demand and Supply

Several estimates of future helium demand have been made, based on different projected levels of activity for the various uses of helium. Figure 3 shows realized demand from 1952 to 1974 and the range of expected levels of helium demand to the year 2000[4]. It should be noted that the dispersion between the estimates for the years 1980-2000 will tend to diminish if the price of helium is taken into consideration. As demand strengthens and inexpensive helium supplies dwindle, substitutes for helium will become, ceteris paribus, relatively more attractive. Hence, to the extent that feasible substitutes for helium exist and are used, the upper limits of projected demand will tend to lie below those depicted in Figure 3.

The role of helium in the provision of energy supplies will be one particularly important determinant of future demand. Helium is currently the preferred gaseous coolant in high temperature nuclear power reactors. Although similar systems using pressurized water, boiling water, or carbon dioxide are feasible, they are associated with lower operating efficiencies and greater thermal pollution.[5]

Two other energy-related applications of helium stem from developments in the cryogenic field of superconductivity. Some materials have the property of negligible electrical resistence at very low temperatures. The only known

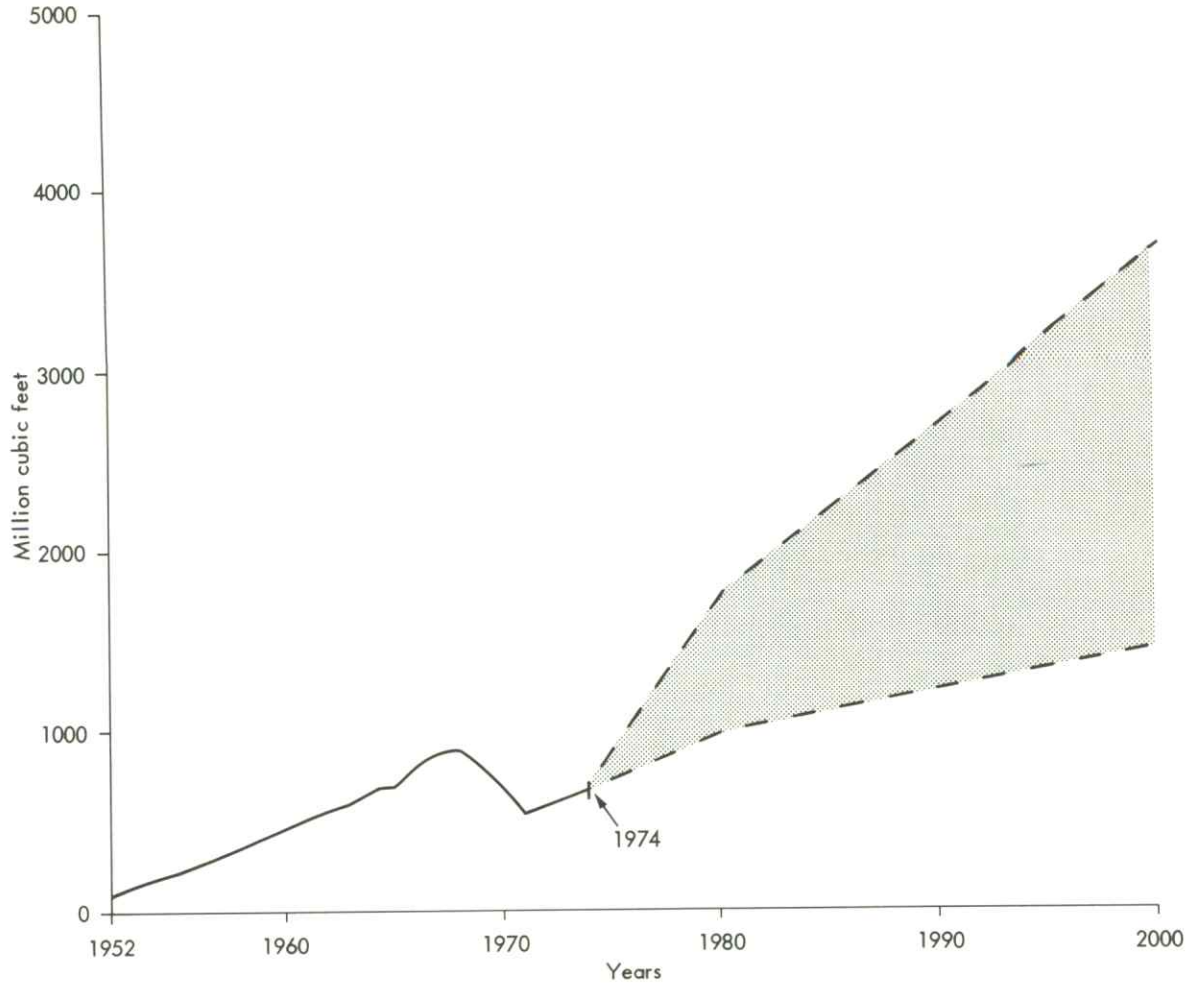

Figure 3. - Helium demand 1952-1974 and projected demands to 2000.

substance that can provide this cold atmosphere is helium. Superconducting cables are able to transmit large amounts of power over long distances with relatively little transmission energy loss. In view of the potential shortage of copper, the use of materials such as a tin-niobium alloy as a replacement for transmission cable may develop. Tin-niobium alloy conducts well only at low temperatures, it becomes a superconductor near absolute zero and, thus, would require helium as a refrigerant. Superconducting magnets, capable of producing large fields at a fraction of the operating cost of conventional magnets, are known to offer substantial increases in the efficiency of nuclear and fossil fuel generating stations. They will also be used for the magnetic containment necessary for widespread adoption of fusion power systems in the beginning of the 21st century.

The question of future supplies of helium is inseparable from that of natural gas. As the supply of helium-rich streams diminishes, extraction will have to be from gas containing less than 0.3% helium, which is undoubtedly going to be more expensive. As an indication, the following cost estimates are often cited for a Mcf of helium from various gas streams:

$15/Mcf from gas containing 0.5% helium;
$80-90 from 0.2% gas;
$150-175 from 0.09-0.19% gas;
on up to $600-800 from 0.006-0.007% gas.

Existing private and government plants are probably capable of satisfying U.S. demand for the next ten or fifteen years. In the last decade of the century, either available leaner gases will be processed for (higher priced) helium or demand will be met by depletion of the 38 billion cu. ft. of conservation helium stored in the Cliffside field. While it may be desirable to forestall use of the Cliffside helium as long as possible, higher helium prices or internal pressures for quick repayment of the Helium Conservation Program's debt to the Treasury may cause the opposite action. The supply of helium for the years 2000-2050 will depend on the confirmation of possible and speculative helium-bearing gas reserves in amounts that will allow economic extraction.

There is one known alternate source of naturally occurring helium. The atmosphere contains about five parts per million helium. Although this is a theoretically unlimited source, the costs of extraction are virtually prohibitive - the tremendous energy cost and related pollution would send the social cost of producing helium from air well beyond the estimated dollar cost of $1,000-$3,500/Mcf.

4. Future Conservation of Helium

In face of expanding demand and uncertain supplies, many have urged that conservation of helium be resumed if not expanded. The termination of the Federal program may result in a loss to the atmosphere of as much as 45 billion cubic feet of relatively inexpensive helium from known reserves of helium-rich natural gas. Most of this will be from Kansas fields.

U.S. Congressman Keith Sebelius of Kansas (Rep. 1st district) has introduced a bill (HR 1503) which requires the Federal government, through the Bureau of Mines, to accept and store helium without cost. Essentially, this is a continuation of the terminated program except that no payment for the helium would be given and ownership would reside with the companies. The bill eliminates the major operating expense of the Federal helium program while recognizing that the initial fixed costs of reservoir preparation of Cliffside and installation of a pipeline network have already been incurred and need not be duplicated.

The Sebelius bill is a quick, simple, and equitable solution to a troublesome problem. If the proposed action fails to gain support, then alternate conservation schemes will need to be explored. This will be especially relevant for Kansas with her large proven helium-rich gas reserves and the major portion of the nation's unused extraction capacity. We list some of these alternatives, not as concrete plans but as sketches of schemes from which specific plans could be made.

a. Private initiated storage: It has been suggested that the firms that have excess supplies of helium (either crude or high purity) store the helium themselves for resale at a later date. In view of the initial expenditure on storage site selection, acquisition, preparation, and on pipeline connections, the uncertainty of competing future supplies (e.g. Cliffside helium), and the

timing of future demand may inhibit company financing of this kind of venture. Corporate decisions will be based upon corporate cost, planning horizons, and discount rates, not their social counterparts.

An alternate financing scheme for private helium storage would be for those users who are interested in guaranteeing future helium supplies to help defray the costs of storage--perhaps by current purchase of the helium. An active commodity market might also develop here.

b. State initiated conservation: Helium conservation could be instigated by the governments of the helium-producing states. A state could sponsor private storage by a variety of (not equally popular) incentives such as:

1) legal prohibition of "wasting" helium before it served a useful purpose;

2) tax incentives designed to either recycle corporate taxes back to the firms for storage financing (e.g., income/inventory tax changes) or to generate revenues to defray conservation costs (e.g., taxes levied on current helium or fuel gas sales); or

3) allocation of a conservation subsidy, possibly given with the provision for repayment from future helium sales.

A state government could alternately provide for its own conservation program whereby it would purchase helium and store it in a state owned and operated facility. In essence, this scheme would be a duplication of the Bureau of Mines program. The apparent financial difficulties encountered early in the Bureau's program should not be interpreted to mean that this

type of state action is necessarily unprofitable. Substantial deficits are to be expected in the infant stages due to large initial capital expenditures and purchase of proportionately greater volumes of helium. For the Bureau of Mines program (which has a current outstanding debt to the U.S. Treasury of $400 million)[6], estimates are that even if conservation had continued, the program's debt--with interest--could have been liquidated by the beginning of the 21st century if not by the 1995 date stipulated by Congress.

c. Federally sponsored private or state storage: Inasmuch as helium conservation is likely to benefit everyone, some sort of Federal participation in a private or state storage program is a logical conservation alternative. For example, a variation of the Sebelius bill would be the acceptance and storage of helium in the Federally owned Cliffside field for a fee charged to the helium companies or states. Some short-term storage on this basis has taken place. The fees charged have been based on calculated average costs, given the volume of helium to be stored and the duration of storage. In view of current and near-term helium demand, it is important that parties be permitted and encouraged to store for long periods of time, and that penalizing assessments such as inventory taxes and excessive fees be avoided.

Conservation of helium merits serious consideration. Admittedly, it would be foolish to build a technology on the premise of an inexhaustible supply of helium, unless future research can show that an economic, environmentally acceptable source exists. But it is becoming increasingly apparent that we can not afford to sit back and maintain a blind faith in technology to supply timely substitutes for exhaused resources. Technological advancements too often come in a sequence of stages; maintaining one stage is important for the development of the next. It is the current view of many scientists and engineers that helium will become important long before it can be made unimportant.

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