ECONOMIC DEVELOPMENT FOR KANSAS

A SECTOR REPORT ON ITS

Agriculture
Education and Research Resources
Financial Resources
Government
Manufacturing and Industry
Mineral and Water Resources
Population and Labor Force
Recreational and Cultural Resources
Trades, Services and Construction
Transportation and Utilities

State Geological Survey of Kansas
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ECONOMIC DEVELOPMENT FOR KANSAS

A Sector Report on Its

MINERAL AND WATER RESOURCES

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PREFACE

This is one of eleven monographs concerning ten major sectors of the Kansas economy and its over-all operation. All investigations were undertaken and approved by the Governor's Economic Development Committee pursuant to Senate Joint Resolution No. 2, Chapter 421, Session Laws, 1961.

This report has been prepared largely by the staff of the Kansas Geological Survey as an added assignment to regular duties; much of it during leisure time and without remuneration. Their contribution is gratefully acknowledged. The work is, however, a Committee report.

Paul L. Hilpman, Robert O. Kulstad, Walter H. Schoewe, Jean Dutcher, Marydel Couch, and Edna Torneden, Robert Welch, Thomas Thompson, Roberta Gerhard, and Rhetta Jo Noever were of great assistance in compilation, computation, and typing. Lila Watkins typed the final draft of the manuscript with assistance from Sandra Schroeder, Suzanne Wright, Patricia Scott, and Carol Smith. Ronald Obenchain, Marlyn Lehman, and Kenneth Badger prepared the illustrations. The assistance of the Kansas Water Resources Board, in permitting Robert L. Smith to prepare the section on water, is appreciated.

December 31, 1962.

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Chapter I

KANSAS MINERAL RESOURCES IN PERSPECTIVE

BACKGROUND FOR UNDERSTANDING

The buffalo and prairie grass no longer dominate the Kansas landscape; wheat, cattle, oil wells, and cities have taken their place. Such generalities as these point out the inevitability of change. The purpose behind the preparation of this report is to determine if Kansas can exert any influence upon the use of mineral and water resources which will direct change to the benefit of the Kansas economy. Because the economic well-being of any state has its roots in the resources it possesses, it is of utmost importance that mineral and water resources be used in the most efficient manner possible. Only a limited amount of change occurs each day, but the seemingly unimportant change may have effects that will be significant for the years in the future—the period of most interest to The Governor's Economic Development Committee.

Mineral resources have special significance in the economy of an area and have peculiarities shared by few other commodities or resources. Minerals, unlike many other basic resources, do not renew themselves. Even water, a resource that is replenished upon the earth and below the surface locally, should not be used foolishly or wastefully because the consequences of depletion may be disastrous. However, exploration and discovery of mineral resources make replenishment of depleting reserves a normal event, and improved techniques provide means for higher prospective ultimate recovery of the raw material product from known deposits. Furthermore, demand for many commonplace minerals may change rapidly as new uses are found for these materials.

In an industrialized society, minerals make up an important segment of the raw material base for industry. More than 95 percent of the harnessed energy is of mineral origin; minerals are the raw materials for a variety of manufactured and processed products, including the machines used in the manufacturing processes; minerals also are primary construction materials and fertilizers to enrich the soil.

The minerals of Kansas played an important role in the struggle to make the state a more desirable place for people to live. The development of minerals and the resulting growth of the state present an aura of romance to the 20th century citizen as he views the historical struggle. Too often the intimate connection between historical events and the presence of minerals and water is forgotten. The basic turmoil of the period, excluding the Indian conflicts and the Civil War, grew out of the search for profits in land and minerals. Land booms, railroad booms, the natural gas boom—all these were tied to mineral resources. The land boom, closely related to the railroad boom, gave birth to the coal industry; then came natural gas, salt, and gypsum. Speculation was an integral part of the process, for the adventuresome spirit of the speculator in land and minerals was needed for the development of resources. Prudent investors, who wish to protect principal and show conservative gains with little risk, were not a part of Kansas in that day. The speculator, who saw opportunity for a high gain and profit but less security for principal, helped to develop this country.

Unfortunately, uncontrolled development often led to wasteful and destructive production, and governmental regulation and conservation policies were necessary for a more orderly development. Railroads came under federal control early in the history of Kansas, in 1887. Such supervision was necessary because the raw materials—the wealth of the state—would be controlled by a single industry through freight rates. Control by a single industry by monopoly was outlawed about the same time by the Sherman Anti-Trust Act. Kansas began to develop legislation for the conservation and beneficial uses of its resources.

Historically, it has been possible to invest little and gain much in the mineral industry. However, the easily acquired minerals have been harvested, the costs of exploration have increased, and it has been necessary to treat the costs of exploration with consideration. Nevertheless, if Kansas is to move forward in a healthy economic environment, the state must engage in speculation, willingly accepting the risks that necessarily are the costs of potential gains; the state must actively contribute to the promotion of its resources if it is to successfully attract the elements necessary to its economic growth. At the same time, the state must continue to develop prudent conservation policies that prevent wasteful use of natural re-

sources. Kansas must combine the adventuresome spirit of the speculator and the prudence of the conservationist in a subtle blend that will stimulate risk capital and assure the long-term growth of the mineral industry.

The mineral resources of Kansas include liquid and gaseous hydrocarbons, nonmetallic minerals, water, and, to a lesser extent, metallic minerals. Economic development of the resources in each of these broad categories is dependent not only upon characteristics which these commodities have in common, but also upon characteristics which are unique to each category. The study of the mineral resource sector will attempt to characterize the mineral resources of Kansas in as much detail as possible, and will attempt to show relationship to regional and national marketing and production, and delineate the areas in which policy decisions could improve climate for mineral resource development.

DISTRIBUTION OF MINERAL RESOURCES

Mineral resource location is inexorably fixed by the accidents of geologic occurrence; and although other economic factors may determine the location of mineral processing activity, production of mineral resources in any state is determined by geologic occurrence. It seems appropriate to review in sweeping terms the geology of Kansas and show relationship of mineral resources to broad geologic patterns.

The generalized geologic map of Kansas (Fig. 1) shows distribution of outcropping rocks in Kansas and is accompanied by a generalized vertical or

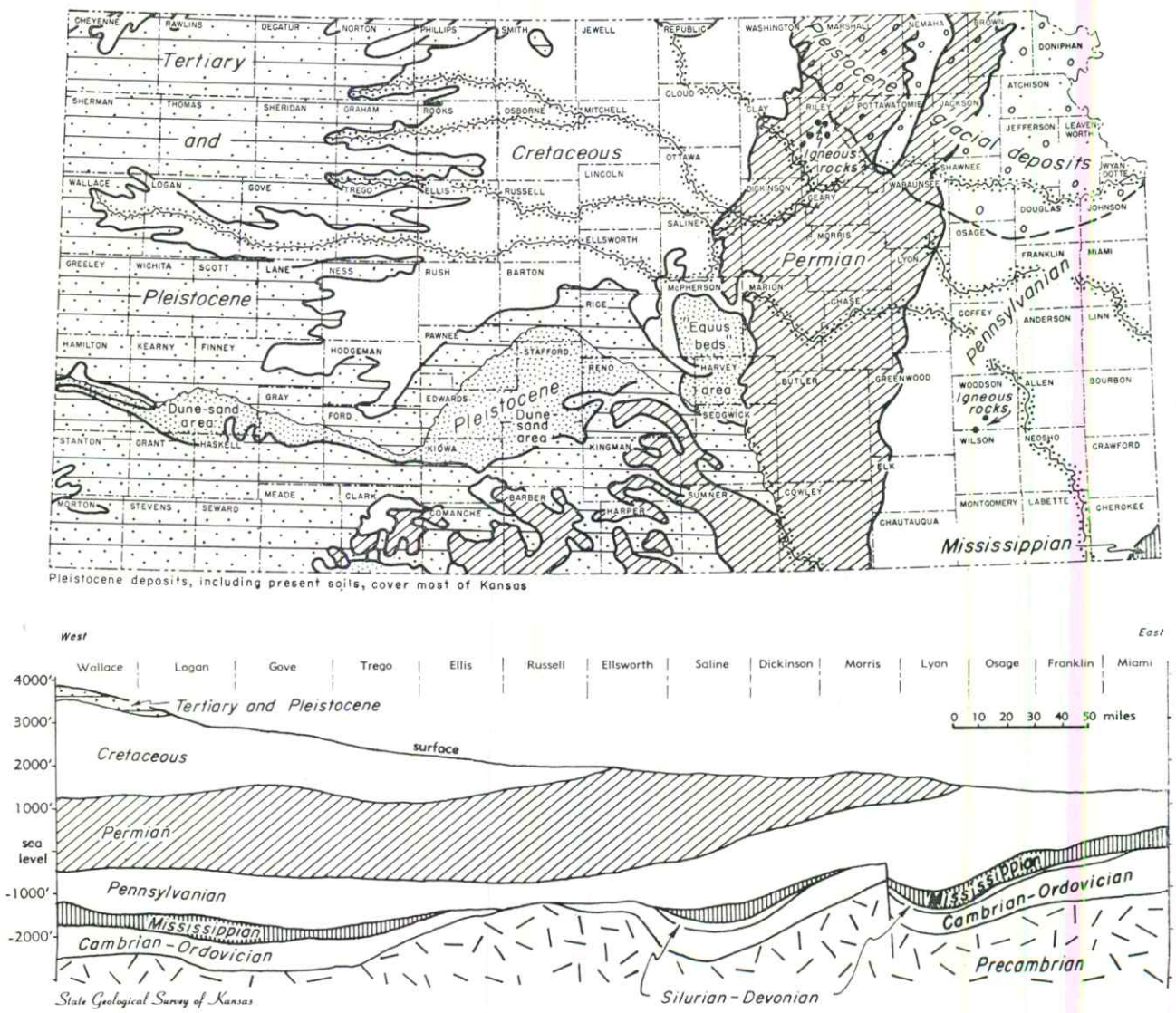

FIG. 1.—Generalized geologic map of Kansas and generalized cross section of Kansas rocks.

cross section of Kansas rocks. Distribution of mineral resources and mining activity is shown in Figures 2 and 3. Comparison of these maps with the geologic map shows the geologic control of mineral deposits. The rocks of major concern range in thickness from 600 to 9,500 feet and rest on very old rocks known as Precambrian. The total amount of recorded vertical movement of these rocks is measured in thousands of feet, but development of major structures has not sharply modified the original horizontal position of the younger rocks overlying the Precambrian. The dip, or inclination from the horizontal, in no place is known to exceed ten degrees and dips of more than a fraction of one degree are rare.

Tertiary and Pleistocene rocks are youngest. These ubiquitous deposits are more widespread than indicated on Figure 1, and even soils are properly classifiable as Pleistocene rocks. Most of these deposits (loess, alluvium, dune sand, and glacial deposits) are unconsolidated. They are generally less than 100 feet thick but locally form a masking blanket 500 feet thick or more. They are especially extensive in the western one-third of the state, along stream courses, and in northeastern Kansas. They are an important source of sand and gravel and contain large quantities of ground water.

Cretaceous rocks, of somewhat older age, occur in western and northcentral Kansas. They dip generally to the west, as do most rocks in the state. The maximum thickness occurs near the northwestern corner of the state where some wells penetrate nearly 3,000 feet of these beds. They consist of brown sandstone, dark shale, and chalky limestone. Characteristically, they are exposed as a broad belt across the central part of the state, except where covered by younger beds. Lignite, chalk, clay and shale for ceramic use, and building stone are produced from Cretaceous rocks.

Lying next below Cretaceous rocks is a great thickness of Permian rocks, which are still older. They have a different structure from the younger rocks but, in general, dip under Cretaceous rocks toward the west from an outcrop belt in the eastern one-third of Kansas. The Permian consists of shale and siltstone, many of them red, anhydrite and gypsum, salt and limestone. There are a few sandstone and coal beds in the Permian. Salt, gypsum, limestone for cement, building stone, and aggregate are produced from Permian rocks. Because salt and

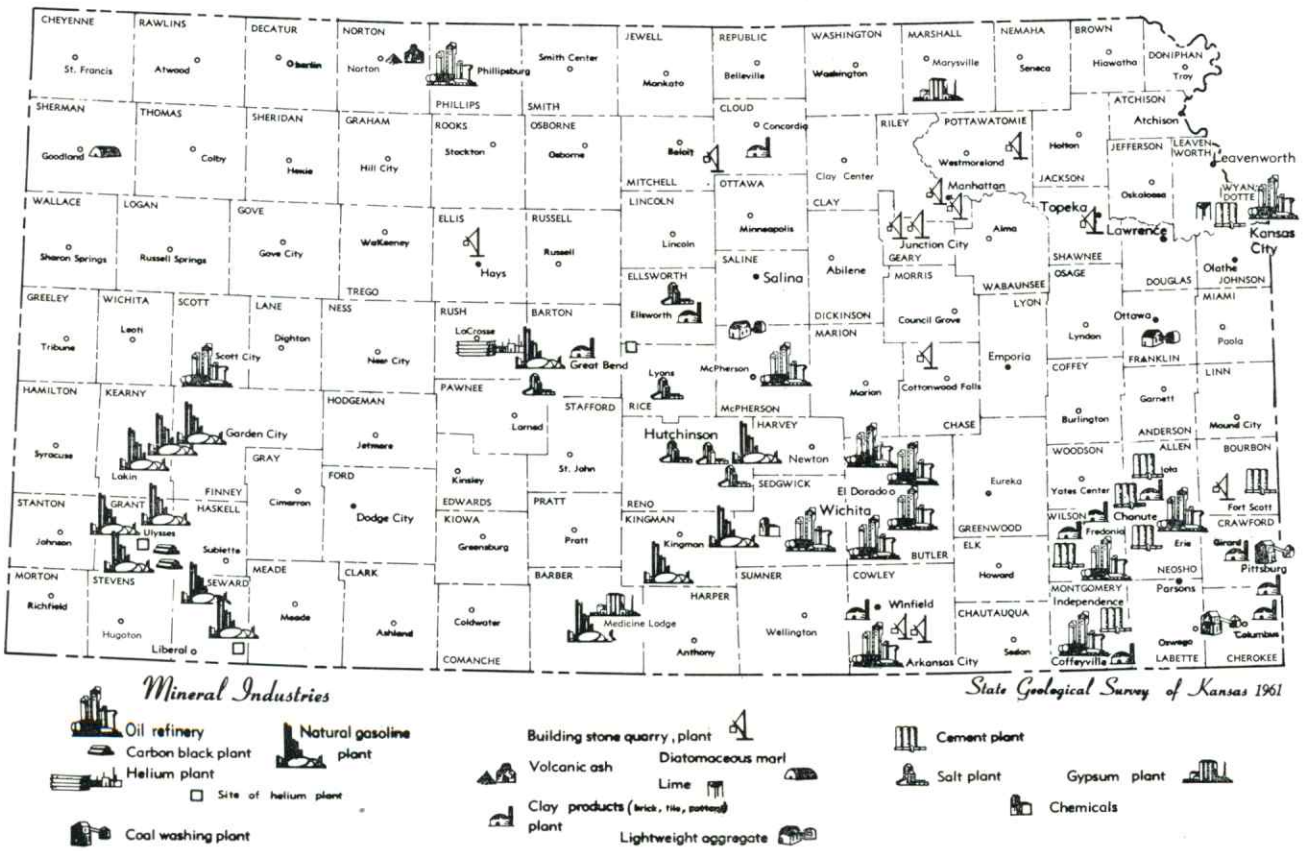

FIG. 2.—Map showing location of principal mineral industries in Kansas.

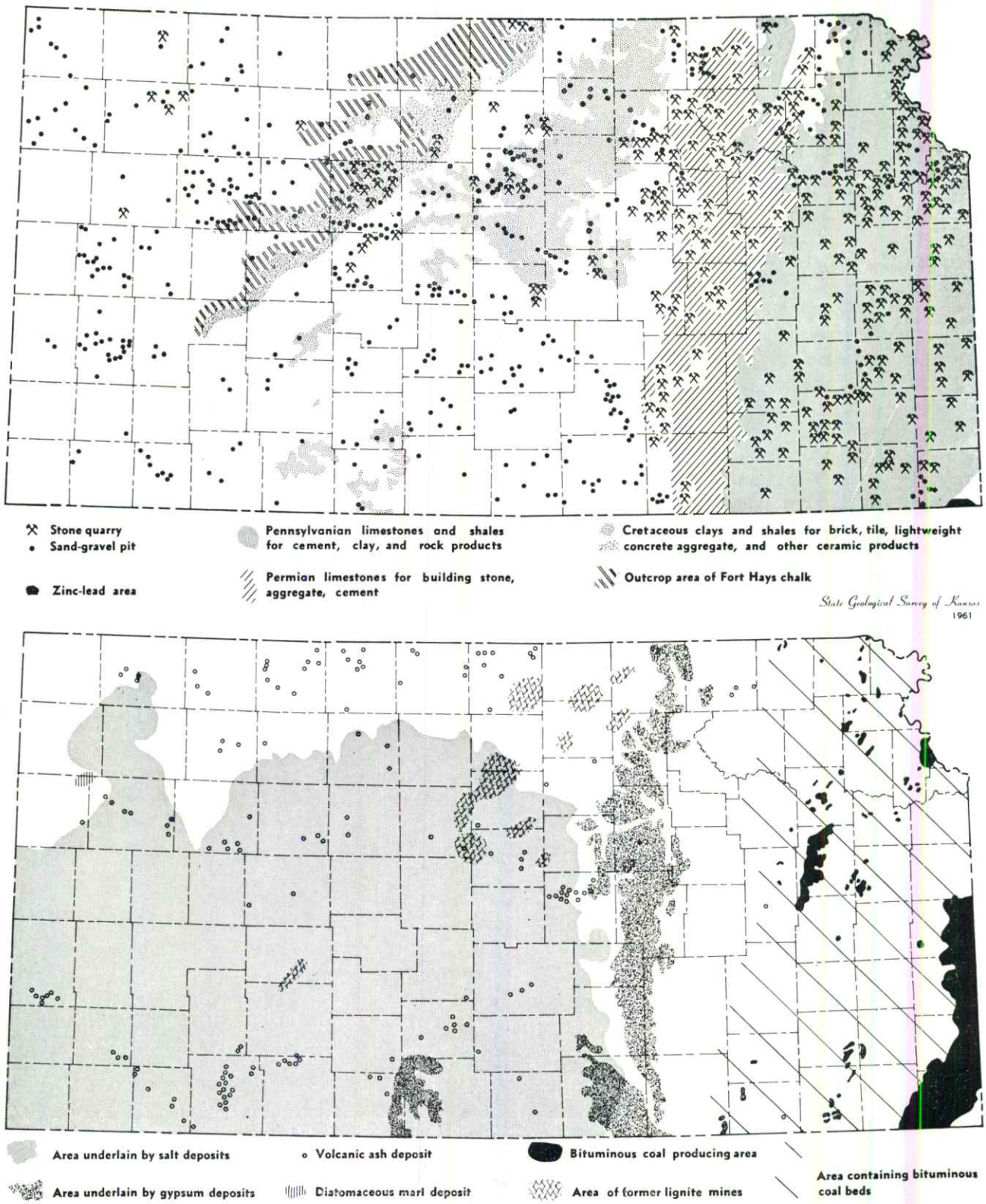

FIG. 3.—Maps showing location of principal mineral deposits, exclusive of oil and gas, in Kansas.

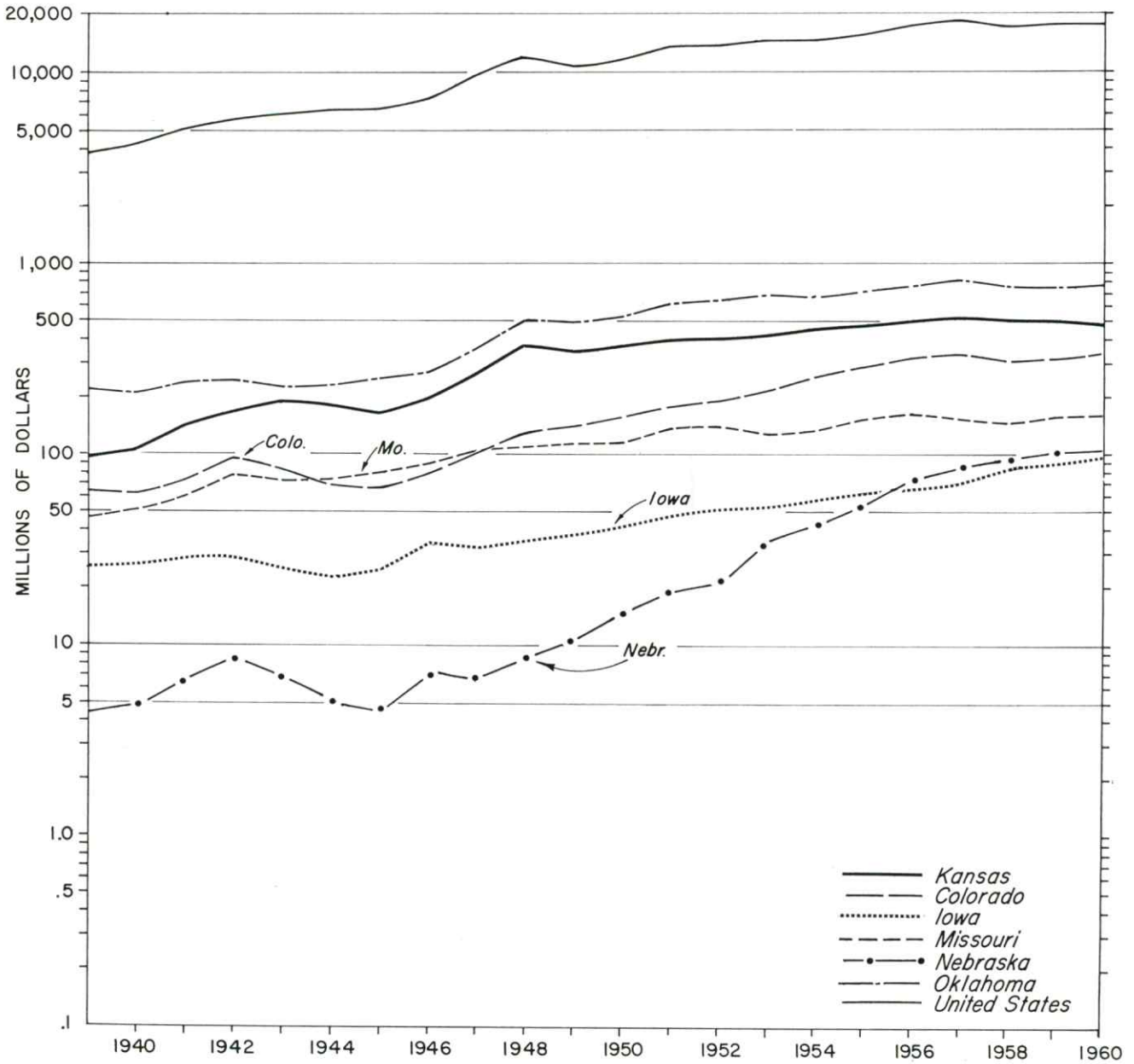

FIG. 4.—Total value of mineral production for the United States and selected states, 1939-1960, semilog scale. (Based on Table 1.)

gypsum are soluble, they are not usually found in the outcrop; distribution of these commodities is determined, nevertheless, by the occurrence of Permian rocks.

Pennsylvanian rocks, older than Permian, dip westward and crop out in the eastern part of the state. They consist of alternating layers of shale and limestone, but there are lenticular sandstone bodies and coal is characteristic of many parts of the sequence. In addition to coal, limestone is produced for cement, building stone, and aggregate; and shale is a raw material for cement and clay products.

A small part of southeasternmost Kansas contains outcrops of Mississippian rocks. These rocks are found extensively in the subsurface. Mississippian rocks are characterized by dominance of limestone and chert and are the host rock for lead and zinc.

Older rocks known as Cambro-Ordovician and Silurian-Devonian are nowhere exposed at the surface in Kansas. They consist chiefly of limestone and dolomite but contain some sandstone and shale.

The occurrence of oil, gas, and water also are determined by rock type distribution and structure. This subject will be discussed more fully in subsequent sections of the report.

Chapter II

THE BROAD VIEW OF ECONOMIC ACTIVITY IN MINERAL RESOURCES

Kansas has been one of the leading mineral producers in the nation for the last thirty years. In 1960 the value of Kansas mineral production was nearly $500 million. The total value of minerals produced in Kansas since 1861 is approximately $9 billion. The principal mineral commodities in order of value are petroleum, natural gas, cement, stone, and salt. Kansas ranked tenth in the nation in value of minerals produced in 1960. As impressive as these data may be, especially for a state that generally is classified as an agriculture state, they tell very little about economic activity in mineral resources in Kansas, nor do they disclose how this sector of the Kansas economy has been performing relative to the nation and the neighboring states of Oklahoma, Colorado, Missouri, Nebraska, and Iowa. In this part of the report, performance will be evaluated through use of historical data that are indicators of economic activity. Such useful indicators include value of production, employment, and wages and salaries generated.[1] Continuous data for employment in mining are not readily available for various states, except from appropriate state agencies; these data are not completely comparable but are useful in defining trends. In a subsequent section of this report, a detailed analysis of commodity activity is presented.

VALUE OF MINERAL PRODUCTION

The value of mineral production in the United States and a six-state area from 1939 to 1960 is shown in Table 1, subdivided into categories of total production, fuels, and nonfuels. In general, economic activity in the mineral resource sector is a reflection of general economic activity. The graph showing total value of mineral production for the United States (Fig. 4)[2] reflects the brief decline in the growth of the nation's economy following the close of World War II in 1945; the rapid rise to a postwar peak in 1948 to meet the demand for consumer goods; the business recession of 1949; and a subsequent rise with minor cycling until the close of the Korean War in 1953. General activity faltered somewhat following Korea, and then regained stride for an upward climb. Comparison of the curves for fuels (Fig. 5) and nonfuels (Fig. 6) shows no significant difference in activity in these two broad commodity categories until 1956, when an essential difference between them becomes evident. The nonfuels group reached a peak in 1956 and subsequently declined until 1958. The fuels group did not reach a maximum until a year later; during 1956, the closing of the Suez Canal caused a sudden surge demand for maximum production of domestic crude oil for world-wide markets. Although this demand was satisfied prior to peak production in 1957, the petroleum industry was not easily able to respond to this changing demand immediately. The nonfuels curve includes value of both metal and nonmetallic commodities in the United States; the nonmetallic commodities contributed a significant part of total value in the United States and in the six-state area. Although the national trends of general business activity also are evident in the graphs for the six states, comparisons are worthwhile in showing how the Kansas economy is performing relative to the other states. These states range widely in total value of mineral production as shown in Figure 4. Among the large producing states, crude oil and natural gas generate the largest dollar value.

Some appreciation of relative growth in value of mineral production can be gained by examining the percent change in value by decade (Table 2). Although Kansas enjoyed a phenomenal growth of about 260 percent during the 1940-1950 decade, this growth declined to about 31 percent during the 1950-1960 decade, the lowest growth rate for the six-state area. Kansas, Missouri, and Oklahoma all show growth rates below the national growth; whereas, Nebraska, Iowa, and Colorado show a rate greater than the national growth for the 1950-1960 decade. In fuels, Kansas again showed a high growth rate with a 294 percent increase for the 1940-1950 decade, greater than the national growth, but only a 33 percent increase for the 1950-1960 decade and a continuing decline since 1957. The 20-year period shows the emergence of Nebraska and Colorado as oil-producing states. The per-

1. Value of mineral production was obtained from annual numbers of the Bureau of Mines *Minerals Yearbook*, and data for wages and salaries from Bureau of the Census, *The Survey of Current Business;* these data are comparable in every respect.

2. Figure 4 and certain other figures comparing Kansas, neighboring states, and the nation are shown on semilog paper. Thus, the measure of economic activity is plotted on a logarithmic scale, whereas time is plotted on an arithmetic scale. The slope of any curve is determined by selecting any two points on the vertical or "y" scale and any two corresponding points on the horizontal or "x" scale and computing the relationship $\frac{y_2 - y_1}{x_2 - x_1}$. This relationship becomes $\frac{\log y_2 - \log y_1}{t_2 - t_1}$ or $\frac{\log \frac{y_2}{y_1}}{t_2 - t_1}$ on the semilog graph. The slope at any point on such a curve is the log of a ratio of change per unit time and the curve shows rate of growth. Such graphs permit us to show values with different orders of magnitude on the same graph. Slopes are identical if ratio of change is identical.

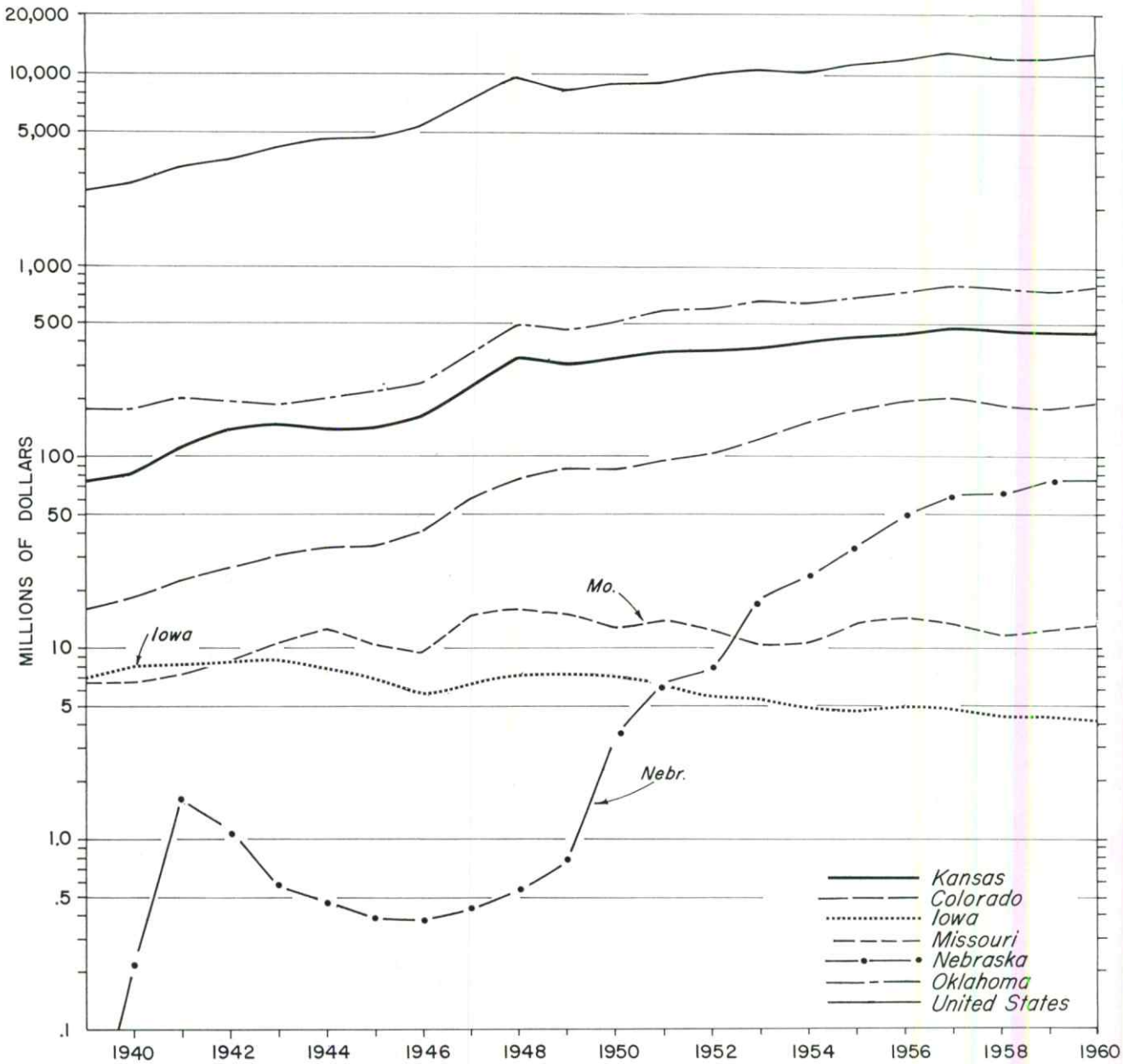

FIG. 5.—Value of fuel production in the United States and selected states, 1939-1960, semilog scale. (Based on Table 1.)

cent change in Colorado is more significant than the change in Nebraska because Nebraska began with almost no production prior to 1940. In non-fuels, Kansas lags behind the national change for the 1950-1960 decade; a fact further demonstrated in Figure 6 where Kansas is shown to have continued a decline after 1958 while most of the other states show an appreciable rise.

Because the base from which these percent changes are computed varies significantly in the six states, comparisons are also shown in Table 3 using annual index of change from 1950. In this comparison, Kansas, again lagging behind the United States and most of the neighboring states, shows the least economic activity for most of the decade and 1960. Again, it is interesting to note that Nebraska and Colorado show the best performance record; the activity in Colorado probably is more significant than activity in Nebraska despite the numerical difference in index because the Colorado activity began earlier and started from a higher base.

An appreciation of state contribution to total value of the nation's production can be gained by examination of Table 4, which shows percent of total value in a somewhat more detailed commodity

breakdown, at 10-year intervals beginning in 1940. Only Kansas, Colorado, and Nebraska contributed more to total value of the nation's mineral production in 1960 than in 1940, and Kansas contributed less in 1960 than in 1950. Nevertheless, Kansas and Oklahoma contributed about 7 percent of the total production and nearly 10 percent of the fuels. The entrance of Nebraska and Colorado into the fuels picture also is demonstrated, and it is interesting to note that Colorado is the only significant producer of coal in the six-state area. Perhaps more importantly, both Kansas and Oklahoma show a significant decline in the percent of nonfuel production, and Colorado has the largest share of this group of commodities. In general, the largest part of the nonfuel category consists of nonmetallic minerals whose growth follows population increase and construction activity. Part of the decline for Kansas and Oklahoma is a reflection of decline in metals production from the lead-zinc area of Kansas, Oklahoma, and Missouri; and a part of the Colorado growth can be attributed to metals production inasmuch as Colorado is the largest producer of metals in the six-state area.

The contribution of the various categories of minerals to the total value of mineral production in the United States and each of the states is shown in Table 5. These values further serve to define the essential character of mineral production in each state. For example, it can be seen that petroleum and natural gas contributed 86.1 percent of the total value of mineral production in Kansas for 1960 and that this part of the total production has increased steadily since 1940. Part of the reason for this increase in petroleum and natural gas can be attributed to the marked decline in coal production and the decline in metals hidden in the nonfuels category. By contrast, the largest part of mineral production in Missouri can be attributed to nonfuels, including a significant metallic contribution stemming from discovery of important metallic ore deposits in Missouri. Colorado shows the most balanced economy in terms of mineral production.

In summary, Kansas has maintained its position in its share of the nation's total mineral production, but there is evidence of a gradual decline in fuels that probably cannot be reversed except for short

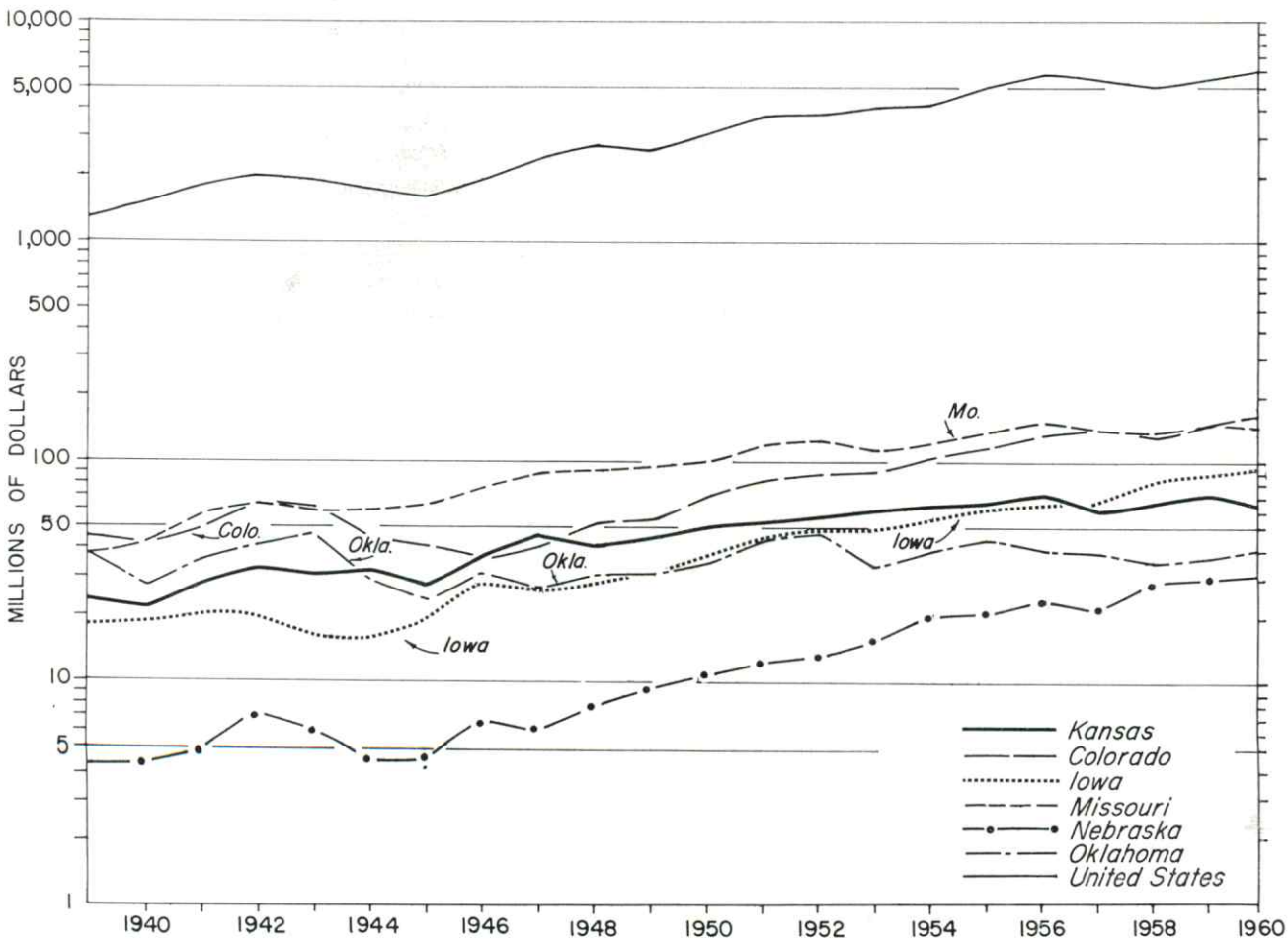

FIG. 6.—Value of nonfuel production in the United States and selected states, 1930-1960, semilog scale. (Based on Table 1.)

periods, and a declining rate of growth in nonfuels that probably will continue unless there is marked reversal of present trends in a low rate of population increase. In general, Oklahoma, Kansas, and Missouri exhibit a mature mineral industry economy, whereas Colorado and Nebraska exhibit a youthful, vigorous mineral industry economy.

EMPLOYMENT

Employment is another indicator of economic activity in the mineral industry sector that serves to give additional insight into long-range changes and trends. Employment data are shown in Tables 6 through 11 for the nation, Kansas, Colorado, Oklahoma, Missouri, and Nebraska (Iowa data not available). Where possible, continuous historical data are given for 1947 to 1961 for the categories of total nonfarm or nonagricultural employment, total mining, metal mining, bituminous coal, crude petroleum and natural gas, and mining and quarrying of nonmetals exclusive of fuels. These data are not entirely comparable because the Bureau of Labor Statistics is the source for the United States, whereas state information was secured from an appropriate state agency; it is doubtful that the base was the same in each case. These data, nevertheless, serve to indicate trends. For purposes of comparison, data from Tables 6 through 11 are plotted in Figures 7 and 8. Employment by the mining industry for 1950 to 1960 is shown in Figure 7. The general decline in employment in Kansas and Oklahoma since 1956 is clearly evident, whereas the rise in Colorado and Nebraska tends to reinforce the picture derived from total value of production. The employment in petroleum and natural gas indicates very clearly the dependence of the total employment upon the petroleum and natural gas industry in Kansas and Oklahoma (Fig. 8). The balanced economy in Colorado, referred to earlier, also is shown. Data are not available for Missouri, which is a coal-producing state, nor for Nebraska, which produces essentially no coal. General economic activity tends to be reflected in the employment data for nonfuels; and the vigor of the Colorado nonfuels industry is demonstrated and shown to be rising most recently whereas both Kansas and Oklahoma show a decline (Tables 7, 8, and 9). Data are not available for Missouri and Nebraska.

The significance of employment changes in various categories of nonagricultural employment can best be appreciated by reference to Table 12. Except for Missouri, all states in the five-state area show an increase in the 1950-1960 decade at least

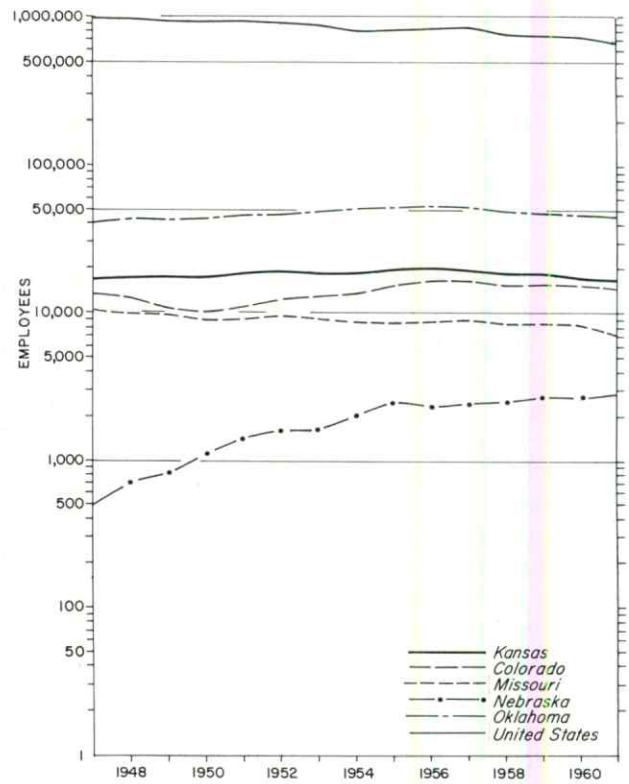

FIG. 7.—Employment in the mining industry for the United States and selected states, 1947-1961, semilog scale. (Based on Tables 6, 7, 8, 9, 10, and 11.)

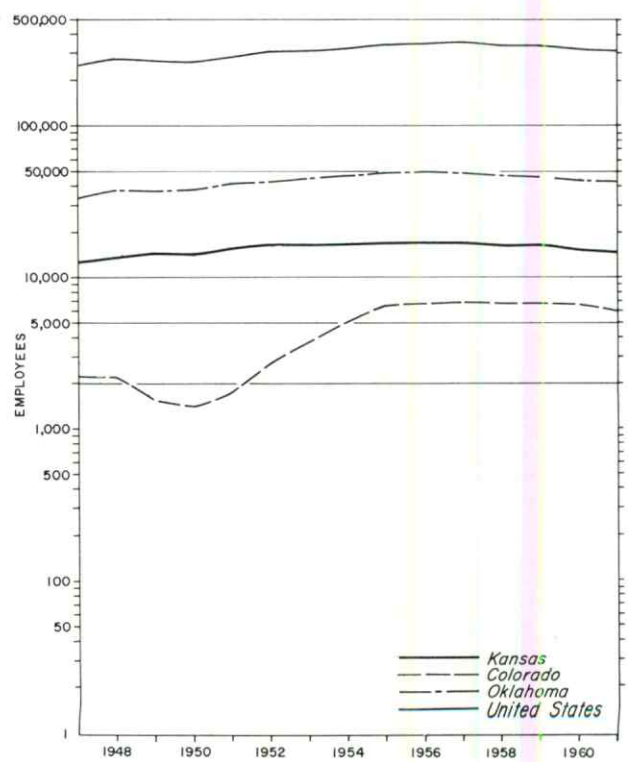

FIG. 8.—Employment by the crude petroleum and natural gas industry in the United States and selected states, 1947-1961, semilog scale. (Based on Tables 6, 7, 8, and 9.)

equal to that of the nation, and Colorado again leads the list. However, mining has not fared so well inasmuch as total mining has shown better than a 21 percent decrease for the nation. All of the states have done better than the nation in percent change, but Kansas experienced the lowest increase with the exception of Missouri which showed a marked decrease. The decrease in metal mining and bituminous coal contributes most significantly to the lower rate of increase in Kansas, or as in the case of Missouri, a decrease in total mining employment; whereas crude petroleum and natural gas and nonmetals have, in general, shown an employment increase, which is reflected in the total mining employment.

Again, because percent changes tend to be misleading, depending upon whether the base is large or small, employment data for the period 1950 to 1961 are computed with a 1950 base equal to 100 in Table 13. On this basis, the United States shows an index number of about 79 for the year 1960. All states have performed better than the nation with Colorado and Nebraska again demonstrating the greatest vigor in total mining. Kansas has an index number of about 99, placing it close to Missouri in showing least growth in total mining. Similar data are shown for crude petroleum and natural gas only; in this category both Kansas and Oklahoma rank below the nation whereas Colorado again demonstrates its youthful vigor.

In summary, one could say that Kansas has done better than the nation in employment in the mineral industries, but has shown an over-all decrease of 1.2 percent since 1950 and a much greater decrease since a period of peak employment in 1956. Greatest losses have occurred in the area of metal mining and bituminous coal. On the whole, Kansas has not done as well as its neighboring states (except Missouri) in offering opportunity for employment in the mining industry. Significant growth is to be seen in the category described as mining and quarrying, the area of activity described in other places as nonmetallic mineral industry. This aspect of the mineral industry economy should assume increasing importance, as suggested by data showing value of production. This growth is further emphasized when one relates nonmetallic commodities to primary manufacturing, including contract construction and stone, clay, and glass products. Employment data can be used to show the multiplier effect produced by processing of raw materials and, to a certain extent, by petroleum refining (Table 14). For example, in 1961 total mining employment in the United States was 663,000 (Table 6). By contrast, 757,100 persons were employed in petroleum refining and stone, clay, and glass product industries. Consequently, total employment in processing and refining raw materials is as great as or greater than the employment needed to produce the raw materials. In Kansas, the mineral industries employ 16,200 persons whereas refining and processing of stone, clay, and glass products employ an additional 11,400 people. The importance of primary processing of mineral raw materials is a significant factor in the economy of the mineral industries, a factor which will be stressed later in this report.

WAGES AND SALARIES

Although personal income generated by the mineral industries would be a somewhat better indicator of economic activity, unfortunately only wage and salary data are available for the classification *Mining* in *The Survey of Current Business.* The petroleum industry, especially, generates personal income in the form of royalties, bonuses, and lease payments; this income for large petroleum-producing states is significant. Data showing total personal income, total wages and salaries, and wages and salaries in mining are tabulated in Table 15 for the nation and the six-state area including Kansas, Oklahoma, Colorado, Missouri, Iowa, and Nebraska, 1939 through 1960 (and certain data for Kansas for 1961). Mining wages and salaries only are plotted for the six states and the nation in Figure 9. Total wages and salaries for Kansas show a general decline following the peak year in 1956; a similar decline is shown for Oklahoma. Colorado and Nebraska again show growth in wages and salaries, and even Missouri shows some slight recovery. The contribution of wages and salaries from petroleum and natural gas to total wages and salaries in Kansas and Oklahoma declines for both states (Fig. 10). The vigorous growth of petroleum activity in Nebraska and Colorado is evident.

Percent change by decade (Table 16) for the nation and the six states gives a somewhat better picture of long-range trends but may be somewhat misleading because major declines took place after 1956. Kansas realized a phenomenal growth of nearly 164 percent for the 1940 to 1950 decade and a lesser growth of about 33 percent during the 1950-1960 decade. Growth in wages and salaries for mining in Kansas, however, is better than the record for the United States but well below the activity for the six-state area except for Missouri. In wages and salaries disbursed from the fuels

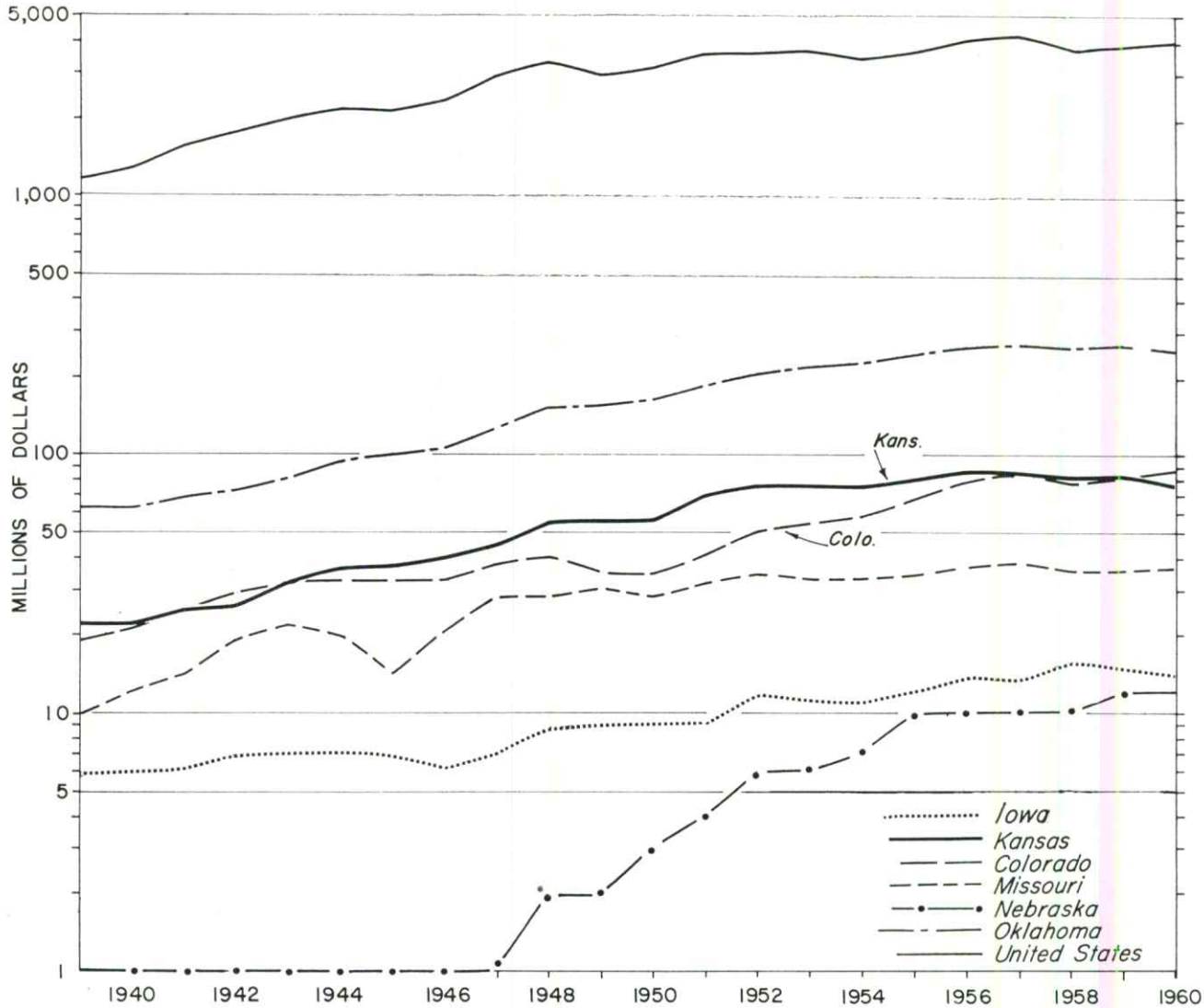

FIG. 9—Wages and salaries disbursed by the mining industry in the United States and selected states, 1939-1960, semilog scale. (Based on Table 15.)

industry, Kansas again did better than the nation. The activity in Colorado and Nebraska is spectacular in terms of change in wages and salaries. Kansas lagged behind the 75 percent gain for the nation in mining and quarrying, or nonfuels, with an increase of about 14 percent. This is one of the poorest records in the six-state area, although Oklahoma showed no change for the decade 1950 to 1960.

Wage and salary data are tabulated in Table 17, using a 1950 base equal 100. The annual index of change in total wages and salaries for mining indicates that again Kansas has done better than some of its neighbors over the 40-year period although it is declining at present. This index also serves to indicate the tremendous growth in wages and salaries in Colorado and Nebraska. In the field of petroleum and natural gas, Kansas' growth lagged behind that of the nation. The marked growth of wages and salaries derived from the petroleum and natural gas industry in Colorado and Nebraska since 1950 is demonstrated.

The contribution of the mineral industries to total wages and salaries in the United States and in each of the six states is shown in Table 18. In general, the mineral industries have contributed a decreasing share of the total wages and salaries for most of the states. Nebraska has shown a long-range trend of increasing contribution until 1959 when a slight decline set in. It is interesting to note that even Colorado, from 1956 onward, did not experience as great a growth rate from mining as from other sources of wages and salaries.

The contribution of each of the states to total

United States wages and salaries by the mineral industries is shown in Table 19. For the most part, state contribution in most categories has not changed appreciably over the last decade. The Kansas and Oklahoma contributions from petroleum and natural gas have suffered serious and continuous declines. Colorado shows a significant increase. Specifically, Kansas' contribution consisted of 1.84 percent of total wages and salaries for mining in the United States in 1950 and increased to 2.01 percent in 1960. There is little appreciable change from about 0.2 percent in bituminous coal throughout the decade, a change from 4.95 percent to 3.91 percent in crude petroleum and natural gas, and a serious lag in mining and quarrying from a little more than 1 percent to about 0.7 percent.

In summary, Kansas has done better than the nation in generating wages and salaries in the mineral industry except in the nonfuels category. Wages and salaries in nonfuels are closely allied to population changes and concomitant construction and consumer goods demand. As in other criteria for economic activity Colorado and Nebraska show the most spectacular changes during the last decade.

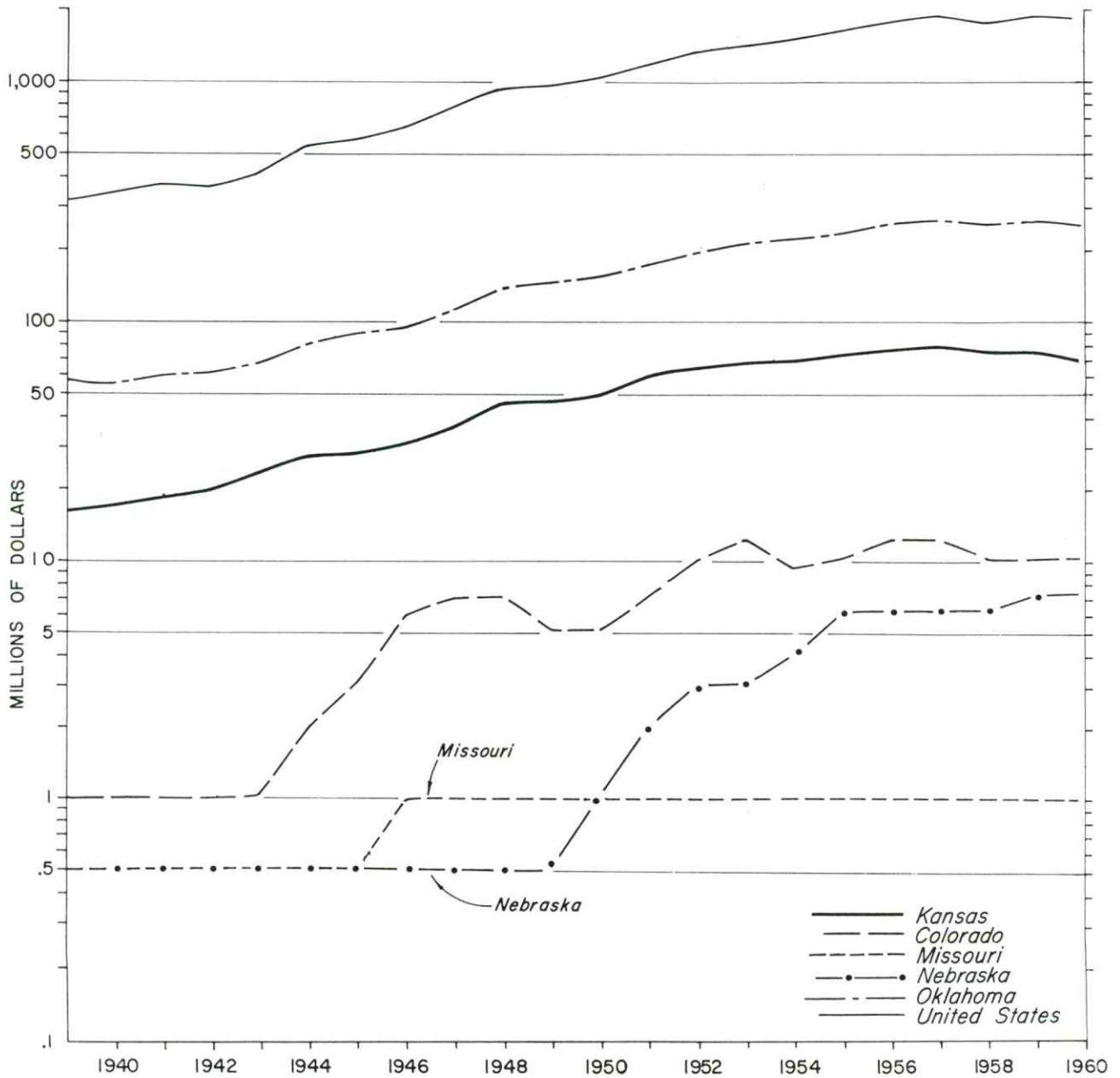

FIG. 10—Wages and salaries disbursed by the petroleum and natural gas industry in the United States and selected states, 1939-1960, semilog scale. (Based on Table 15.)

Chapter III
FOCUS ON MINERAL COMMODITIES

The total character of the mineral resource and water sector of the Kansas economy is the sum of its parts. Only by examination of activity in the individual commodities can one realize the underlying causes for change. Furthermore, review of the history of commodity development gives insight as to the reasons for particular patterns of development.

LIQUID AND GASEOUS HYDROCARBONS

Industry Facets [1]

The contact of the average citizen in the United States with the petroleum industry is with his distributor at the local level. Yet, the petroleum industry probably is the most complex of all economic entities in the United States. It comprises many thousands of companies and people in a free enterprise situation. Its parts include the integrated company, the local distributor, the oil refinery, the transportation of the gaseous and liquid hydrocarbons, the independent oil producer, and the landowner or royalty owners. There are also specialized groups such as drilling contractors and service and supply companies, all keyed to exploration for oil and gas. Superimposed on these parts are the regulatory and conservation practices within various states and national regulation of some facets of the industry.

An integrated oil company engages in operations from the oil field to the distributor. An integrated company could, through various wholly-owned subsidiaries, compete against itself in any marketing area by selling fuel oil for heating purposes through one distributor and natural gas through its locally-owned gas distributor.

Oil marketing is a separate entity in the petroleum business because the refiner sells his products to wholesalers. Normally, a jobber buys only from a specific refinery, which may be either an independent company or a major company. The retailer, who distributes at the local level and with whom the general public is most familiar, may be an independent operator who buys his products from the jobber of his choice, or he may be a lease operator from a wholesale distributor of a major company.

The refiner accepts the raw material and finishes it into gasoline, heating oil, petro-chemicals, and other products. In order to assure a continuous supply for refining, many refining companies have in the past entered into actual production of the raw materials.

Pipeline transportation is a separate facet of the petroleum industry, but most of the major interstate pipeline companies are owned by or affiliated with major oil companies. Some independent petroleum pipeline companies do exist, however. Pipeline companies gather oil and natural gas in the field and transport it to the refinery or to the market.

An important distinction between the oil and gas industries within the petroleum industry is that the interstate transportation of petroleum is regulated as a common carrier, whereas interstate gas transportation takes on aspects of a public utility under the Natural Gas Act, 1938 and is subject to regulation by the Department of Commerce and the Federal Power Commission.

The independent producer is an integral part of the petroleum industry. It is estimated that there are more than 40,000 operators of this kind in the United States. Most of the independent operators confine their efforts to exploration and production. Many independent producers operate on a farm-out or subcontract basis from large leaseholders or major companies, and they arrange the financing of ventures in such a way that many people share in the risk. The independent operator's function normally ends when the oil that he has produced is sold to a purchasing company.

Landowners and royalty owners in the United States enjoy a unique situation. In most countries, the property owner does not own the minerals beneath his land. In the United States, mineral rights to land may go with the ownership of the land or they may be leased. Many thousands of landowners in the country have leased their land. It is possible, then, to be a royalty owner through purchase of royalty rights, yet not actually hold land in ownership. Since royalty owners derive their income from productive wells and normally do not participate in the cost of exploration and drilling, their interest lies in the most rapid production of the oil or gas.

This simplified picture of the petroleum industry is presented in order to offset partially the general impression of the American public that the petroleum industry is controlled by a few major companies. All the aspects of the petroleum industry described thus far are characteristic of the industry in Kansas.

1. James A. Clark, "The Many Facets of the Petroleum Industry," *The Humble Way*, April, 1960, p 22. The basic organization and concept was derived from this article.

Geology of Liquid and Gaseous Hydrocarbons

Oil, gas, liquid condensates (natural gasoline and liquefied petroleum gas), helium, and oil-field brines are included under this heading because they occur together and behave in a similar fashion. These hydrocarbons are generated from organic material deposited in a shallow marine environment. Accordingly, limestone and shale are the source rocks that incorporate oil, gas, and salt water. These source beds are compressed during geologic time by the weight of overlying sediments; and the oil, gas, and water move into more porous rocks (such as sandstone) and may travel relatively great distances. Wherever these liquids and gases are prevented from migrating, or are trapped, a reservoir occurs. Unlike coal, oil is not continuous in one rock unit but occurs in isolated reservoirs. The capacity of a reservoir rock to contain these liquids and gases and transmit them under pressure to an area of lower pressure is determined partly by the composition and texture of the rock itself and partly by the properties of the liquids and gases. In most places, oil, gas, and water are found in the interstices or openings between individual grains or in fractures and fissures in the rock. Thus the porosity or void space determines how much fluid or gas can be held, and the permeability or ability to transmit fluids determines how much oil or gas can move. Reservoirs may be classified according to whether the principal component is gas or oil. The oil, gas, and water separate in the reservoir so that there may be a density stratification of gas, oil, and water with gas on top; gases also may be dissolved in the fluids. These fluids, in general, wet the solid surfaces in the reservoir so that a large part of the oil is not easily recoverable until this adhesion is overcome. The production of oil and gas depends upon some propulsive energy for displacement; this energy for movement into the well is provided by gas and water. Expansion of gas, for example, moves the liquids and gases through the rock in response to lowering the pressure at some point, as at a well. Once at the well, oil, gas, and water can be brought to the surface by natural flow if there is sufficient energy available, or by a process of artificial lift. As the natural energy of the system declines, a process called secondary recovery is used to replenish the energy of the system by injection of additional fluids or gases. Oil and gas should be produced from a reservoir at an optimum rate, established by engineering studies, so that the natural energy of the reservoir is not depleted too rapidly and the maximum amount of oil is economically recovered.

In the discussion so far it has been established that commercial quantities of petroleum accumulate in reservoirs or "traps," that energy must be present for displacement of the petroleum, and that a well must penetrate the stratum containing the petroleum in order to create an area of lower pressure so that the reservoir energy will displace the oil to the well bore whence it can be brought to the surface.

Natural gas liquids are those liquid hydrocarbons that are either in the gaseous state or in solution in crude oil in the reservoir. At the surface they are recovered as liquids by separation from natural gas by such processes as condensation or absorption. Natural gasoline, condensate, and liquefied petroleum gases fall in this category. Propane and butane, common commercial and industrial fuels, are examples of these gases, which are easily converted to liquids. Propane liquefies at a pressure of 85 pounds per square inch, and a temperature of 60° Fahrenheit; butane condenses to a liquid at a pressure of 26 pounds per square inch and 60° Fahrenheit. Helium, a rare and inert gas, also occurs in extremely small quantities in the natural gas of the Hugoton field of Kansas. Because of the large volume of natural gas produced annually, some of the nation's new helium extraction plants are under construction in the field or on the main transmission lines from the field.

Conservation and Legal Aspects

The term *waste,* used in the Kansas general rules and regulations for the conservation of crude oil and natural gas, is taken to mean and include economic waste, underground waste, surface waste, waste of reservoir energy, and the production of crude oil or petroleum in excess of transportation to market facilities or reasonable market demands. The State Corporation Commission is authorized to regulate the taking of crude oil or natural gas from any pool or common source of supply to prevent waste as defined above.

An oil or gas reservoir is a natural unit in which the common supply of oil and gas accumulated during geologic periods without respect to property lines or fences; like an "open range." Land surface above oil or gas fields is often held by divided ownership, and mineral rights are transferrable by lease. Therefore, conflict arises between adjoining landowners and/or leaseholders when each seeks maximum recovery of the valuable hydrocarbons from the common source of supply.

Ownership in Kansas is confined to that mineral material that lies within the geographic confines of

surface ownership at a given time, and the surface owner is entitled to that oil and gas which he can withdraw from the common source of supply within the confines of his own ownership according to the "rule of capture"; that is, title to the oil and gas is established by reducing it to possession at the surface of the earth. Formerly, the landowner who drilled the most wells in the shortest space of time on his land, or who had the wells with the largest flowing capacity, and who held the greatest storage capacity on the surface or had a pipeline outlet, recovered a disproportionate share of the oil and gas from the common source of supply relative to the amount of surface area he owned. This practice led to waste of oil and gas, because rapid production can result in low ultimate recovery and long-term above-ground storage results in reduction of value through evaporation of some lighter hydrocarbons.

As a result of demand that waste be prevented, the system of proration was inaugurated by leading oil-producing states. Under this system in Kansas, the State Corporation Commission is charged with responsibility for determining the existing market demand for oil in the state each month. In making determinations of the reasonable market demand, the Commission is authorized to take into consideration proper factors including: the estimated consumer demand; offers to purchase and the good faith thereof; the price or prices offered in relation to the prevailing price of crude oil generally in the state (nothing contained in the statutes is intended to vest the Commission with authority to fix the price of crude oil); the prevention of waste in any pool; the quantity of oil that will be produced from nonprorated pools (secondary recovery production and other exceptions); and the efficient utilization of reservoir energy.

Allocation of production between oil fields and among wells within each field for the entire state is based on a definite formula that recognizes potential production capacity. The division of ownership is still based upon reduction to possession, but the rate and amount of production is regulated. Under certain circumstances, production is regulated also by orders stipulating the spacing of wells and the assignment of production on a spacing and depth formula.

Secondary recovery wells, although listed on the proration orders, are not reduced in allowable production because intermittent operation is thought to lead to waste of reservoir energy and possible reduction of ultimate recovery. Whether or not the production rate of secondary recovery projects should be controlled by proration is a controversial question.[2] The State Geological Survey each year compiles data on the quantity of secondary recovery oil production by projects. These data are supplied on a voluntary basis by the industry, but less than 30 percent of the known operating projects are represented.

Upon their initiative those operators who have agreed upon a plan of development may apply to the Commission and get a basic or a spacing order for their field. When it appears to the Kansas Corporation Commission that those having the right to drill into and to produce oil from part of any prospective pool have unanimously agreed upon a plan for the development of a pool or part of a pool or for the distribution of allowed production from the pool, then the Commission has authority to approve the development or distribution plan after notice and hearing. This procedure results in voluntary unitization of the pool.

Compulsory unitization statutes of varying scope have been enacted in 27 states. Some states prohibit compulsory unitization. The term compulsory unitization is a misnomer, because before unit plans may be initiated there must be agreement among a majority of lessees and royalty owners that prevention of waste and protection of correlative right will be a result of such unitization. Compulsion is then exerted only on the recalcitrant lessees and royalty owners who block the wishes of the majority. In Kansas, it has been estimated that about 1 percent of the wells drilled over the next five years would be affected by a compulsory unitization statute.[3]

The authority to supervise and protect the correlative rights of individuals in Kansas is given to the Kansas Corporation Commission. Correlative rights mean that each owner and producer in a common source of supply is privileged to produce from it only in such manner or amount as not to injure the reservoir to the detriment of others or to take an undue portion of the oil and gas, or to cause undue damage between developed leases. Accordingly, most operators in Kansas agree to offset drilling, meaning that should a well be completed successfully within a certain distance of a lease line, then those persons owning the offset or adjacent acreage have the right to demand exploration on their property from their leaseholder.

2. Interstate Oil Compact Commission, "A study of the Effect of the Curtailment of Production on Oil Recovery from Waterfloods and Other Secondary Recovery Projects, 1960."

3. Kansas Independent Oil and Gas Association, *More Kansas Oil and Gas*, 1962, p. 12.

Gaseous hydrocarbons and helium have natural characteristics which group them with petroleum. In many respects, however, they are vastly different. Interstate transmission of gas takes on aspects of a public utility and is subject to regulation by the Department of Commerce and the Federal Power Commission. Reserves of gas from some fields are dedicated to interstate pipeline companies, prices are fixed, and new pipelines must be authorized. Furthermore, the prolific Hugoton Gas Area of southwestern Kansas is prorated by the Conservation Division of the Kansas Corporation Commission. A basic well-spacing order of 640 acres per well has been established and allowable gas production for wells or groups of wells is established on a monthly basis. During the past several years, the allowable production has not been met and less gas seemingly has been produced than is marketable. The origin of this situation possibly lies in the fact that many of the original contracts, as written by interstate pipeline companies and approved by the Federal Power Commission, established a rate as low as 10 cents per thousand cubic feet and contained no "take or pay" condition, a clause that requires the purchaser to take the contract quantity or pay for it. Some companies subsequently wrote "take or pay" contracts at higher rates on the Oklahoma and Texas parts of the field outside of Kansas. Accordingly, these companies are obliged to take the contract production outside of Kansas but are not obliged to do so in Kansas. Until 1960, Kansas had been depleting its reserves at a much slower rate than Oklahoma, a seemingly desirable situation except that the pressure history of the Hugoton field in Kansas and Oklahoma from 1944 to 1960 showed a greater rate of pressure decline in Oklahoma than in Kansas.[4] From 1944 to 1959, the average pressure of Oklahoma wells declined from 404.2 to 288.9 pounds per square inch, while the average pressure declined from 394.7 to 340.9 pounds per square inch in Kansas wells. The decline rate in the two states was more equitable from 1959 to 1962 when Kansas average dropped 28.2 and Oklahoma dropped 32.1 pounds per square inch. As established previously, the Hugoton field transgresses the state's border, and in a continuous reservoir such as this gas moves through the reservoir to an outlet in response to lowering the pressure at some point, as at a well. Seemingly, some Kansas gas is moving into the Oklahoma portion of the field. Kansas royalty owners have taken this matter to the courts in order to protect their correlative rights.

4. Kansas State Corporation Commission, *1962 Hugoton Field Tests, Summary Sheet,* Richard C. Byrd, Chairman.

Although it is not possible presently to free dedicated interstate reserves for the large-scale development of industry in Kansas, additional gas is being discovered that could play a vital role in this development. These new reserves are and probably will be in southwestern Kansas where water supply is limited. Intrastate pipelines could make these new undedicated reserves that are not within the jurisdiction of the Federal Power Commission available for industrial development in places such as Kansas River valley, where water is abundant.

Helium is extracted from natural gas, mostly in plants owned by the federal government. In Kansas, the United States Bureau of Mines operates a plant at Otis. The gas is important to our defense program; and the combination of factors of depletion through transportation to fuel markets and tenfold increase in consumption led to the development in 1961 of an intense government-supported helium conservation program. The nation's greatest helium reserves are located in the Hugoton Gas Area, partially in southwestern Kansas.

History of Oil and Gas

A review of the history of the Kansas petroleum industry accentuates the importance of the industry's growth in the state's general industrial growth and its association with the state's periods of "boom" development. Dating from the early 1860's, oil and Kansas essentially grew up together.

Within a year after the completion of the Drake discovery well in Pennsylvania (1859), Kansas oil development began in Miami County, where early settlers reported oil seeps from springs along the Wea and La Cygne streams. Several wells were drilled, and although the first Kansas oil company was a casualty of the Civil War, Paola (in Miami County) became the center of Kansas oil activity between 1870 and 1880. Gas for fuel was supplied to Paola by a line laid from a field seven miles northeast of the town in 1884, Kansas' first oil refinery was built in Paola in 1886, and oil for lubricating purposes was sold in the area for $3.00 to $5.00 a barrel.

The year 1873 marks the discovery of the large and important Iola Gas Field, Allen County, but it was 20 years later, between 1892 and 1893, that an abundant gas supply was found. At Independence, Montgomery County, activity in the petroleum industry began about 1884, but gas in large quantities was not discovered until about 1893.

About 1895 Chanute, Neosho County, was reported to be the first municipality in Kansas to own its own gas supply from wells the town had drilled.

An economic effect of the large quantities of cheap gas on industrial growth in Kansas is shown by the reported use of gas by over 15,000 domestic customers in the year 1903. By 1905, the number of glass works in southeastern Kansas supplied by natural gas increased to 20, the number of brick plants increased to 33, and other commercial users served with gas to 527.[5] At the peak, there were 9 smelter plants in a five-mile radius of Iola, which according to the Iola Register, October 25, 1947, was the largest concentration of zinc smelting in the world at that time.

In Kansas, the transition in public demand from natural gas to oil began in the middle 1890's. A marked increase in the demand for oil in southeastern Kansas followed the building of the Standard Oil Company refinery at Neodesha, Wilson County, in 1897. In 1903, the southeastern Kansas oil fields topped all other areas in the United States in oil activity. Both oil and gas production leveled off after the years 1906 and 1908 and did not again reach a peak until 1916, when discovery and fast development of the Augusta and El Dorado Fields skyrocketed the production of oil and gas.

Prices of crude oil for the first few years of the century were low, as low as $0.53 a barrel in 1905. Concern over the low price in southeastern Kansas caused the Kansas Legislature to pass a bill that would establish an oil refinery at state expense at Peru. The refinery was to be operated by a branch of the State Penitentiary; however, the State Supreme Court declared the refinery law unconstitutional.

Gas production, which had reached a crest of 80 billion cubic feet in 1908, dropped to 22 billion cubic feet in 1913 and 1914. It was not until 1937 that gas production in Kansas again passed the 80 billion mark because of increased production from the Hugoton Gas Area in southwestern Kansas.

Previous to World War I gas and oil were used primarily in industries such as zinc smelting and brick and tile manufacturing. Other uses, however, were developing. For example, the popularity of the Model T Ford brought on an increase in demand for gasoline. In July, 1905, the Atchison, Topeka, and Santa Fe Railroad ran the first train in the Midwest pulled by an oil-fired locomotive, the Oil Flyer. Also, oil burning ships increased demand. These demands were met, in part, by the discovery of the Cushing Field in Oklahoma in 1914. That year Cushing added more than 36 million barrels of crude oil to the Oklahoma-Kansas total of over 100 million barrels of oil, and prices for Kansas-Oklahoma crude oil dropped from $1.05 to $0.55 a barrel. Some oil was sold for as low as $0.40 a barrel, and it was reported that about 20 percent of the 1914 yield went into storage unsold. Consequently, gasoline prices throughout the nation dropped.

Within a year, this condition reversed itself, because the Cushing Field, following the large "boom," declined in production, and the automobile age was at hand. (The National Automobile Chamber of Commerce forecast that the 1915-1916 car production would exceed one million compared with 700,000 the preceding year.) Kansas-Oklahoma oil prices rose to $2.25 a barrel, and thus free enterprise, stimulated by the high crude prices, gave the petroleum industry much needed capital for expanding drilling campaigns. In the light of that development, large new reserves were discovered. The important discovery of oil in the Augusta and El Dorado Fields in Butler County in 1915 touched off an oil boom of major proportions. From an average of less than 3 million barrels of oil a year before 1916, Kansas' production jumped suddenly to 8 million barrels in 1916, to 36 million barrels in 1917, and to 45 million barrels in 1918.

By November of 1916, the price of Kansas-Oklahoma crude oil was down to $0.90 a barrel. In 1918, because of the wartime demands for crude oil, supplies were short and refineries in Kansas and Oklahoma could not run at capacity; there was feverish explorational activity to find new reserves. In 1920, Kansas-Oklahoma crude oil reached $3.50 a barrel, the highest price since the motor car became a factor in consumption. After the war, demand decreased and by 1923, the price had dropped to $1.00 a barrel.

Following the development of the El Dorado and Augusta Fields, oil activity in the state generally moved westward. The first important oil discovery in western Kansas was the Fairport Field in Russell County in 1923. At about the same time, an important well was drilled in Seward County in southwestern Kansas; this well led to the huge Hugoton Gas Area. By 1931, the Hugoton was contributing significantly to total gas production; gas production has increased in Kansas every year since then. The year 1931 also saw the discovery of several important oil fields throughout central Kansas, but little activity took place in the Kansas oil fields during the depression years.

5. Nixon, Earl K. "The Petroleum Industry in Kansas," *Transactions of the Kansas Academy of Science*, vol. 51, No. 4 (1948), pp. 369-424.

Kansas oil production rose steadily following the depression as new fields were discovered and demand increased. World War II brought marked changes to the Kansas industry. Civilian consumption was curtailed, but military and wartime industry requirements created a demand for production and exploration that was hampered by material and transportation shortages. Kansas production increased in response to demand during the war years despite OPA price ceilings; the price of $1.17 a barrel for Kansas crude oil in early 1946 was representative of the war period.

With removal of price ceilings and controls in 1946, renewed consumer demand for gasoline, and the advent of the diesel-burning locomotive, the industry found new stimulation for exploration and production following World War II.

The production of crude oil in Kansas in the 1950's reflects the national demand—influenced by the Korean War in the early 1950's and the Suez closing in the middle 1950's, and climaxed by a peak production in 1956. More detailed information on the 1950-1960 decade is included elsewhere in the report.

Geographic Distribution and Current Statistics

The year 1960 marked a century of oil exploration in Kansas. The birth of the industry in the state was discovery of oil near Paola in Miami County in 1860. At that time the industry consisted of one well that produced one barrel of oil or less per day. Now the total industry in the state consists of more than 41,000 producing oil wells and 6,000 gas wells which are widely distributed geographically (Fig. 11), yielding more than 112 million barrels of crude oil and 676 billion cubic feet of natural gas in 1961.

Cumulative production of crude oil exceeds 3.4 billion barrels and natural gas 9.2 trillion cubic feet; a fantastic volume of gas, inasmuch as it is more than double the *total* gas production in Kansas prior to 1949 and four times the amount prior to 1938. The value of the raw materials of the petroleum industry in Kansas (crude oil, natural gas, natural gas liquids, carbon black, and helium) comprise about 85 percent of the total value of all minerals produced in Kansas annually. During certain years, the total value of the hydrocarbons (excluding coal in Kansas) has exceeded the value of the wheat crop (Merriam and Goebel, State Geological Survey of Kansas 1960, unpublished manuscript).

More than 88 of our 105 counties have had oil or gas production and more than one-third of the total land area is considered under lease. There are about 15,000 people engaged in crude oil and nat-

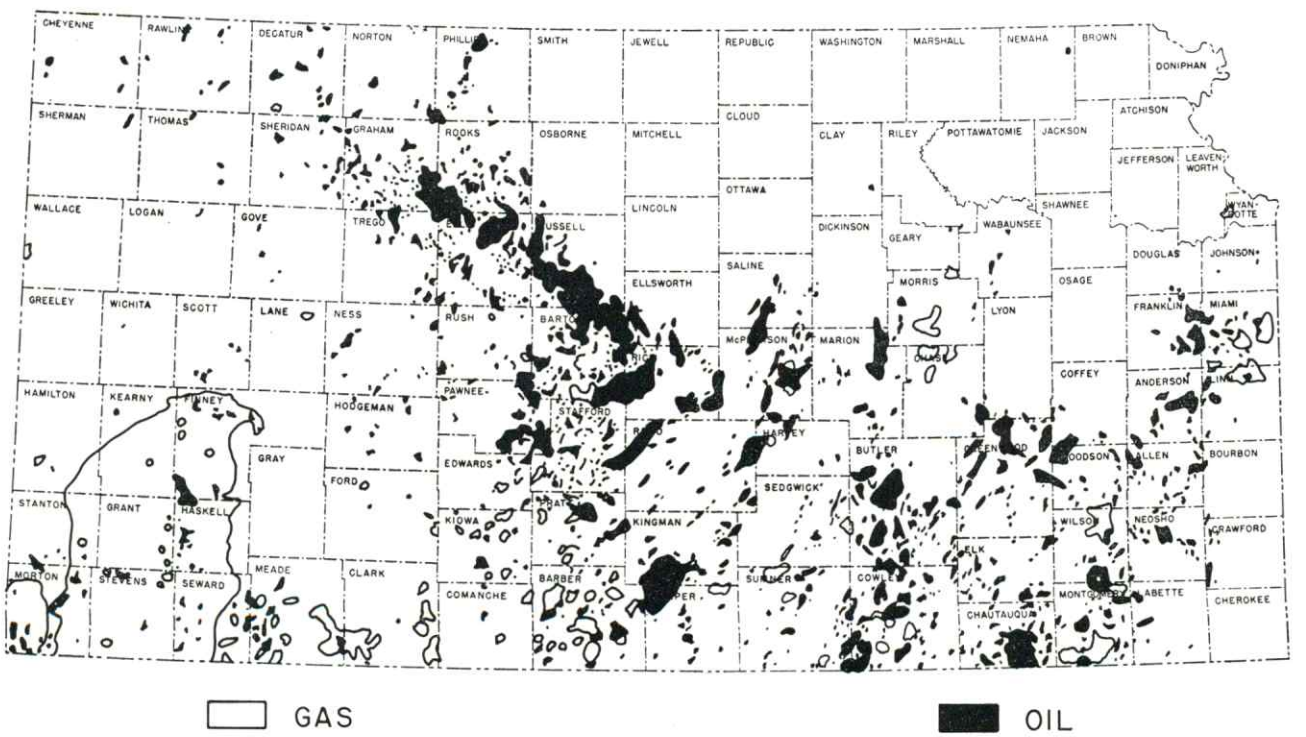

FIG. 11.—Map showing location of oil and gas producing areas in Kansas, 1961. (E. D. Goebel and others, *Oil and Gas Developments in Kansas During 1961*, Kansas Geological Survey Bulletin 160.)

ural gas exploration and production in Kansas. Figure 12 presents the annual oil and gas production in Kansas since 1890 and shows the discovery years for important producing areas.

Table 20 presents a summary of data on the Kansas petroleum industry, giving percentage changes for Kansas and the United States from 1960 to 1961. Kansas crude oil production declined 1.0 percent, whereas the nation's production increased 1.65 percent. Kansas' share of the domestic market for crude oil declined from 4.6 to 4.5 percent. Kansas production of natural gas rose 6.9 percent compared to 2.8 percent for the nation.

Production from Kansas oil fields in 1961 (112 million barrels, 4.5 percent of the nation's total) was good enough for sixth place in the annual production among the states. First place is held by Texas (898 million), second by Louisiana (366 million), third by California (299 million), fourth by Oklahoma (188 million), fifth by Wyoming

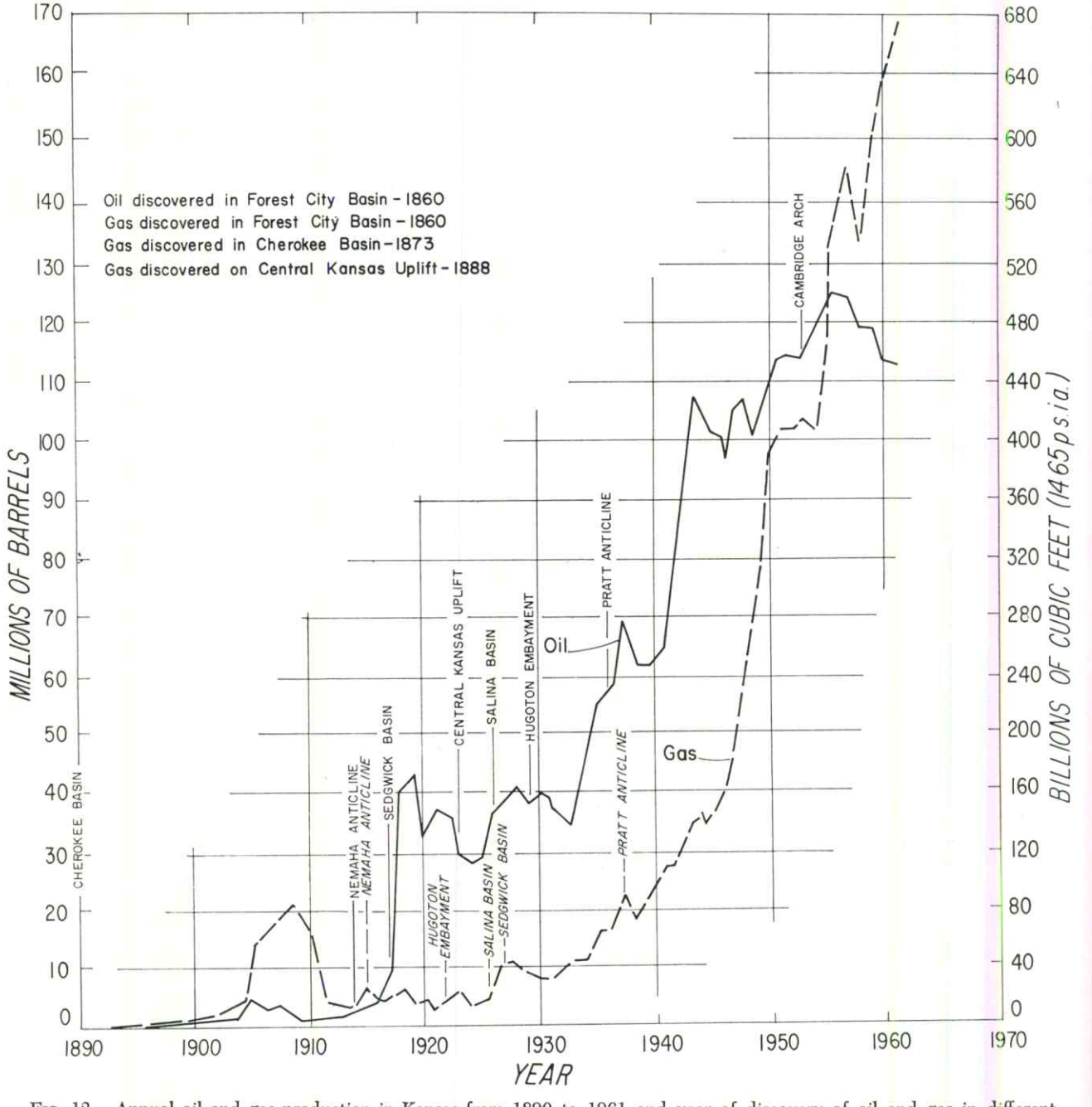

FIG. 12.—Annual oil and gas production in Kansas from 1890 to 1961 and year of discovery of oil and gas in different structural provinces. (Kansas Geological Survey Bulletin 160.)

(143 million), sixth by Kansas, and seventh by New Mexico (109 million). Kansas held fifth place until replaced by Wyoming in 1959.

During 1961, Nebraska produced about 25 million barrels of oil and a small quantity of gas; Colorado yielded about 49 million barrels of oil and about 95 billion cubic feet of gas. Missouri's oil and gas production was so small that it was not reported.

In 1961 Kansas experienced a decline in crude oil reserves of more than 5.8 million barrels from 1960,

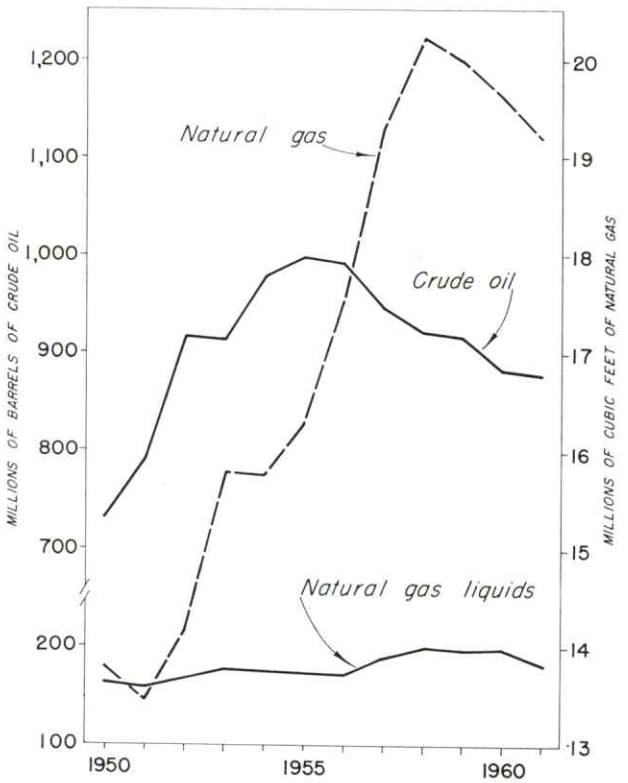

FIG. 13.—Annual estimates of reserves of liquid and gaseous hydrocarbons for Kansas, 1950-1961, by the American Petroleum Institute and American Gas Association. (Tables 21, 22, 23, 24.)

as shown in Table 21 and Figure 13. Estimates for the end of 1961 placed Kansas reserves at 878 million barrels (seventh in the nation). Reserves of crude oil for Colorado, Kansas, Nebraska, Oklahoma, and Wyoming from 1950-1961 are given in Table 22.

Kansas, at the end of 1961, was third in the nation in natural gas reserves (19.2 trillion cubic feet, Fig. 13) with a slight decline from the previous year—yet fifth in net natural gas production (676 billion) during 1961. Table 23 presents natural gas reserves by years since 1950 for Colorado, Kansas, Nebraska, Oklahoma, and Wyoming. New Mexico was reported as fifth in natural gas reserves and fourth in production, whereas Oklahoma was fourth in natural gas reserves yet third in production. Texas and Louisiana led all states in production and reserves of natural gas during 1961.

Kansas is sixth in reserves of proved natural gas liquids (184 million barrels, Table 24) and seventh in production (258 million gallons, Table 20). Estimated proved reserves of natural gas liquids are given in Table 24 for Colorado, Kansas, Nebraska, Oklahoma, and Wyoming.

Some 18 percent of the crude oil produced in

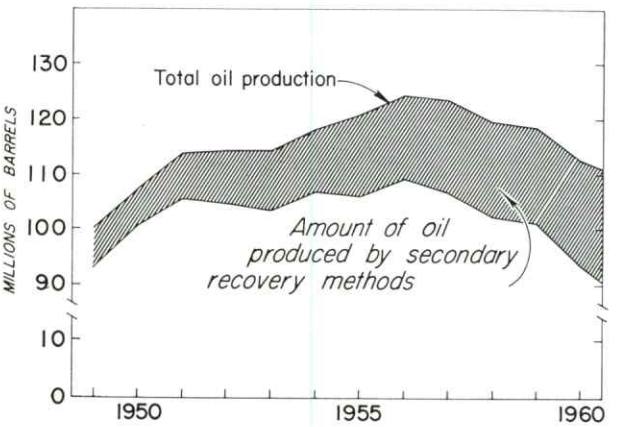

FIG. 14.—Amount of oil accredited to oil production by secondary recovery methods in Kansas, 1949-1961. (Production figures given in Table 25.)

Kansas during 1961 was from secondary recovery projects (Table 25). Each succeeding year in Kansas has found a larger number of new applications and extensions of secondary recovery projects, and each year has found a larger share of the annual crude oil production credited to secondary recovery (Fig. 14). It is expected within the next 10- to 15-year period that a continued development of secondary recovery projects, both in number of projects and quantity of oil produced, will occur in Kansas.

Kansas has a large share in the future of helium conservation and production; three multi-million dollar extraction plants in Kansas now have government approval and are under construction. Table 26 presents helium extraction and value since 1951 and carbon black production and value since 1948. Kansas has thirteen operating refineries, fourteen natural gasoline plants, and three carbon black plants.

The average depth per well in Kansas is about 3,700 feet for exploratory wells and 2,700 feet for developmental wells. Total holes drilled in Kansas exceed 130,000. About 110 rotary-tool (working in Kansas) and 125 cable-tool rigs drilled an estimated 4,239 wells of all types in 1961. Most of the oil

wells in Kansas are on artificial lift because of low natural reservoir energy.

Crude oil presently sells in Kansas for about $2.97 a barrel and natural gas prices at the wellhead vary from $0.11 to $0.25 per thousand cubic feet.

Economic Analysis

Cost of Doing Business

During the early history of the petroleum industry in Kansas, many oil fields were discovered that had large potential production. The costs of finding, at that time, were relatively low. During more recent years, the discovery of new fields with large potential production has steadily diminished. More holes are being drilled to find the same amount of oil; and more money is spent to find the same amount of oil. At the present time, Kansas produces oil in quantity, but daily average production from each well is about 7.5 barrels, as shown in Figure 15 and Table 27. This condition has bearing on the economics of oil and gas production and the background of this situation is outlined below.

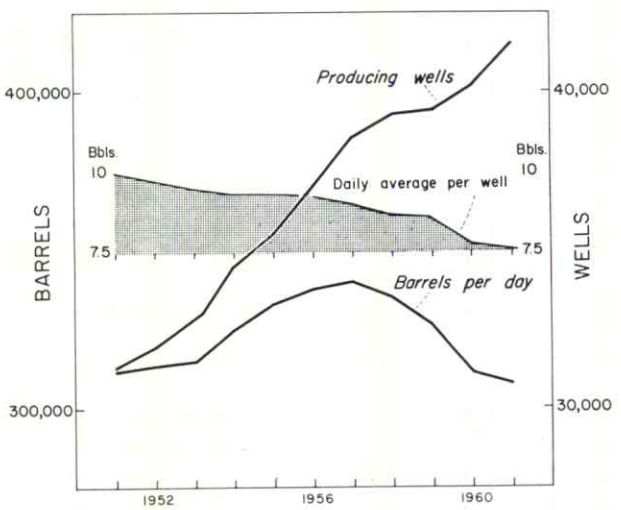

Fig. 15.—Graph showing Kansas' daily average crude oil production, number of producing wells, and daily average production per well, 1951-1961. (Table 27.)

The finder or explorer must produce enough oil and gas during the first few years of the history of a well to pay for the costs of finding and drilling so that his capital will be available for further finding to replace the oil he produces. Any factor which tends to diminish capital tends to discourage the finding of new oil. As soon as the producer begins to produce oil and gas, he begins to deplete his product and is given a limited depletion allowance to invest in the finding of more of his product. Conservation practices and proration limit the rate at which initial costs can be amortized. Dry holes, those which are unsuccessful or noncommercial, are straight business losses. In Kansas, low unit production per well, and thus a long pay-out period, tends to reduce capital by tying it up for long periods of time. (Compare with other states, Table 29.)

Property taxes on oil and gas production and ad valorem taxes on equipment constitute a large operating expense and tend to reduce available capital. Oil companies, large and small, pay all the taxes that any other company pays. Furthermore, the cost of regulating the petroleum industry in Kansas is paid by the industry. A fee of one cent per foot, or a minimum of $10.00 per hole, is charged for supervision of plugging. Oil production is assessed at the rate of 0.001 cent per barrel and gas production at 0.00025 cent per thousand cubic feet for regulatory purposes.

Accordingly, for some or all of these reasons many major exploration companies no longer see an adequate return on invested capital in Kansas compared to other states and have moved to states with larger production potentials, no proration, or more favorable tax structure. Much of the continued development of oil and gas reserves has depended upon the independent producer who generally seeks risk capital from individuals with excess personal income in a high tax bracket. If the venture is successful, he may then take a limited depletion allowance. If he is unsuccessful, he may take a business loss which is favorable for taxation purposes. The petroleum industry is a mining industry and one cannot fertilize, irrigate, plant, and harvest another crop. Without this opportunity for risk capital to invest in exploration, production of oil would diminish rapidly in Kansas and the nation.

In order to arrive at an approximate figure for the amount of investment in drilling each year by the petroleum industry in Kansas, exploratory drilling footage (exploratory wells drilled at some distance from known production, or into unexplored strata, are called wildcat wells) has been utilized. The American Association of Petroleum Geologists breaks down exploratory drilling on the basis of wells that were successful and those that were dry holes. An estimated drilling cost of $4.00 a foot for holes completed as oil or gas wells and $3.00 a foot for dry holes may be applied to the footage figures of Table 28. The resultant figures indicate the amount of money invested annually, just by the drilling industry in Kansas, in exploratory drilling. For example, exploration drilling investment exceeded an estimated $21 million in 1960, one of our poorest years. The calculations in no way should be construed to mean that drilling

costs have declined. The amount of investment in developmental wells, all of which are not successful, adds an enormous quantity of money to the explorational estimate.

An average, completed developmental well of 3,500 feet depth costs a minimum of $20,000. The 1960 *Oil and Gas Journal* survey of drilling and equipping costs for 4,059 Kansas wells amounted to more than $92.7 million, or about $23,000 per well.[6] Many businesses in Kansas are not capitalized for that amount. Therefore, a decrease in drilling and exploration in any one year of 100 wells in Kansas could result in a lost investment of $2 million.

Income

Oil and gas activity is important to the landowner because substantial income is received from subsurface rights through lease bonuses, delay rentals, production royalties, and sale of these rights. Lease bonuses are bonus payments to the landowner, generally for the completion of a leasing agreement. Delay rentals are payments for continuation of leasing agreements. Production royalties comprise payments (usually ⅛ before costs) to royalty owners.

Income from land in delay rentals and lease bonuses in a 13-state area including Kansas, Oklahoma, Colorado, Wyoming, and Nebraska is estimated at about $275 million per year since 1950.[7] This amount is equivalent to 3 percent of the annual gross cash return from agricultural production in these states. It represents a larger proportion—possibly as much as 20 percent—of the total net income to land. A study of a three-county area in Oklahoma revealed that 62 percent of the farms received rentals and bonuses from 1938 through 1947. The average annual income from these sources amounted to $1.50 per acre actually under oil and gas lease, and $0.38 per acre for the area as a whole. This income was estimated to be about one-third as great as the net income to land from surface uses.[8]

Royalty income paid to landowners and other holders of oil and gas rights in producing acreage is much larger than lease income on nonproducing acreage, *but* it is concentrated among fewer recipients. Since 1948, royalties paid by the oil industry in a 13-state area (including Texas, Oklahoma, and Kansas) have ranged from $562 million to $751 million annually. About one-third of all the landowners in the 13-state area received delay rentals and bonuses on leases but probably fewer than 1 percent of them received royalty payments. At the end of 1954, Kansas was estimated to have 37 percent of its total land area under lease for oil and gas. Present estimates (1962) place the total oil and gas lease area as about 30 percent of the state.

A little-appreciated factor of the oil business is that the long-term return to the landowner is more often greater through renewals and payments of rentals on leases than the development of oil or gas fields on the land. Many a Kansas farmer looks forward to annual renewal of lease rentals on his farmland to pay tax bills. Furthermore, the lease value on land adjacent to newly discovered oil wells can increase ten- to fifteenfold.

Wages and Salaries

Unpublished statistics, using Standard Industrial Classification, on income generated by certain parts of the petroleum industry in Kansas are available from the Employment Security Division, Kansas Department of Labor. Standard industrial classifications are interpreted differently by different state agencies, and data for different states are not always comparable.

Nevertheless, general trends over a 10-year period of wages and salaries should be significant. The industrial classification descriptions involved are Crude Petroleum and Natural Gas.[9] Table 15 (the latter in section on Mineral Economics Relations of Kansas to United States and adjoining states) shows the trends in wages and salaries and income, 1950-1960, by the above-described income-generating group in Kansas, Nebraska, Colorado, Missouri, Oklahoma, and the nation where applicable.

Nebraska and Colorado, both nonprorated states, exhibit a general upward trend. Crude oil production in Nebraska, considered with respect to the base year of 1950, amounted to only 1.3 million barrels and has risen steadily to 25 million in 1961. Reserves of crude oil in Nebraska rose from 9.7 million barrels to over 100 million barrels during

6. "Deep-drilling Raises Well Costs," *The Oil and Gas Journal*, Vol. 60, No. 32, (August 6, 1962), pp. 77-80.

7. Parcher, Southern, and Voelker, "Mineral Rights Management by Private Landowners," *Great Plains Agricultural Council Publication 13*, 1955.

8. Parcher, "Underdeveloped Mineral Rights as a Source of Farm Income in Western Oklahoma," *Oklahoma Agricultural Experimental Station Bulletin B-337*, 1949.

9. Crude Petroleum and Natural Gas, Major Group 13. This major group includes establishments primarily engaged in: (1) producing crude petroleum and natural gas, (2) recovering oil from oil sands and oil shale, and (3) producing natural gasoline and cycle condensate. Types of activities included are exploration, drilling, oil and gas well operation and maintenance, the operation of natural gasoline and cycle plants, and the mining and extraction of oil from oil sands and oil shale. This major group also includes such basic activities as emulsion breaking and desilting of crude petroleum to render the oil marketable. Pipeline transportation of petroleum, gasoline and other petroleum products except gathering lines classified in Major Group 46-Pipe Line Transportation; and of natural gas in Major Group 49-Electric, Gas, and Sanitary Services; establishments primarily engaged in petroleum refining and in the production of lubricating oils and greases classified in Major Group 29; also excluded is income derived from lease bonuses, delay rentals, production royalties, exploration by major companies, or marketing.

the same period. Colorado rose from 23 million barrels production and 340 million barrels reserves in 1940 to 50 million barrels production and 419 million barrels reserves in 1961.

In Kansas from $60 million to $70 million a year has been disbursed as wages and salaries each year since 1950. A gentle decline occurred from the high year 1957 ($74 million) to $67 million in 1960, reflecting the over-all decline of the Kansas industry. Oklahoma wages and salaries rose from about $150 million in 1950 to $250 million in 1957. Since that time a slight decline has occurred.

Wages and salaries disbursed by the petroleum and natural gas industries from 1950-1960 in Kansas amounted to about 3 percent of total state wages and salaries. There was a high of 3.5 percent in 1951 and 1955, and a gentle decline to less than 3 percent in 1960. Oklahoma has experienced a decline in this category from 11 percent to 9 percent since 1957. Since 1955, Nebraska has been steady at about 0.5 percent, and Colorado has been steady at about 1.5 percent after rising from less than 0.5 percent in 1950. The total wages and salaries of the petroleum and natural gas industries in the United States are consistently less than 1 percent of all wages and salaries.

In analysis of the index of annual change of wages and salaries (base year 1950 equals 100) of Kansas, its neighboring states, and the United States; Nebraska and Colorado show as much as a 600 percent increase. The trends for Kansas, Oklahoma, and the United States are similar, with a rise to a high in 1957 and general decline to 1960. The 1960 wage and salary index of Kansas is about 135.

In summary then, at the present time, wages and salaries of the petroleum and natural gas industry in Kansas amount to about $65 million per year, or about 2.5 percent of all wages and salaries disbursed in Kansas. However, may it be reemphasized that income generated by the petroleum industry is difficult to measure by standard industrial classifications.

Trends and Characteristics

Reliability of Statistics

Various state and federal agencies, including the Kansas Geological Survey and the United States Bureau of Mines, and trade and professional journals annually publish statistics on drilling and exploration. The Kansas Geological Survey's annual summary of oil and gas developments during the previous year generally reports more wells drilled than do other organizations making similar tabulations. The Kansas Survey relies on information supplied by the Kansas Corporation Commission, which requires the filing of new drilling starts (intent-to-drill regulation). Thus, a large number of wells (unclassified) are drilled each year, especially in eastern Kansas, that are not reported by other agencies or journals. These organizations rely on scout information and eastern Kansas is not "scouted" by major oil companies or by any commercial scouting service. For the past several years, these unreported and generally unclassified wells have averaged about 900 per year. These wells usually are shallow, meaning less than 2,000 feet deep.

Furthermore, total number of wildcat wells reported by various sources is likely to differ, because the location of boundaries of producing areas is arbitrary, and because definition of wildcat wells (exploratory) also may be somewhat arbitrary.

In the following consideration of the trends and characteristics of the Kansas petroleum industry, consistent data are used for comparisons with other states and the nation.

Exploratory and Production Trends

The unique character of the petroleum industry in Kansas can be demonstrated through development of exploratory and production data and comparisons with prorated and nonprorated producing states. For example, Table 27 shows the daily average production and the number of producing wells in Kansas for the period from 1952 to 1961. The computed daily average production per well has declined from 9.8 barrels in 1952 to 7.5 barrels in 1961. Comparable data are shown in Table 29 for 1961 only for neighboring states and Wyoming. The daily average production per well for Colorado was 58.1 barrels, for Wyoming 52.2 barrels, and for Nebraska 39.0 barrels. These states are not prorated and have a youthful industry. The Oklahoma daily average production per well was 6.5 barrels and Oklahoma is a prorated state. These data illustrate that more wells are needed to produce less oil and that Kansas wells are growing old.

Figure 16 demonstrates for Kansas, adjoining states, and Wyoming the percent of successful exploratory wells drilled from 1950 to 1960, as reported by the American Association of Petroleum Geologists. Figure 17 shows exploratory drilling in Kansas. Oklahoma (Fig. 16) has shown a striking trend upward since 1950 to a high of nearly 39 percent successful exploratory wells in 1960. Kansas reached a success peak of about 33 percent in 1956, and has declined from that peak to near its 1950 low of 24 percent in 1960. Wyoming and

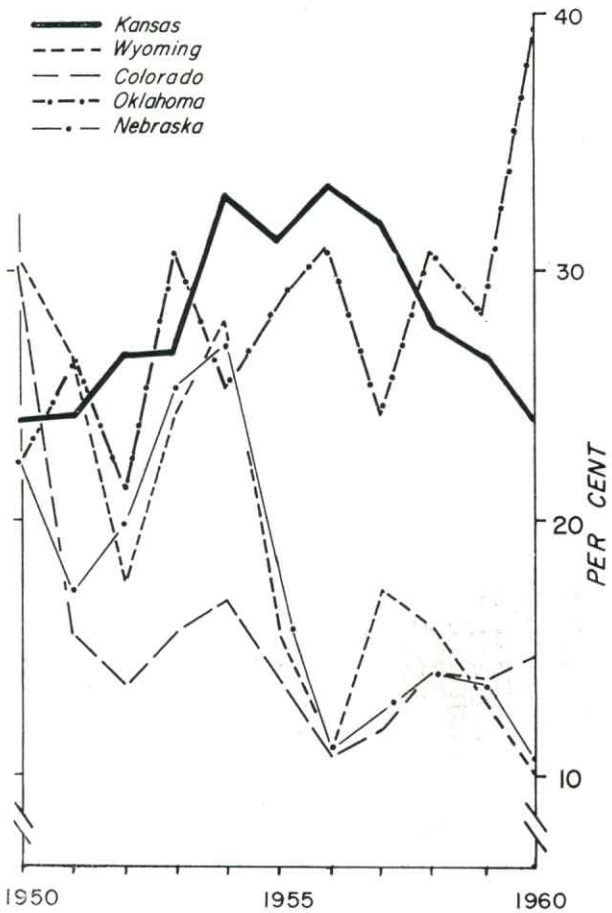

FIG. 16.—Percent successful exploratory wells in Kansas and selected states, 1950-1960. (Adapted from *American Association of Petroleum Geologists Bulletin,* Annual June Issues.)

Nebraska exhibit general declines from highs in 1954 to all-time lows in 1960. Colorado had an increase between 1959 and 1960. Caution must be used in drawing conclusions from Figure 16 because, although Oklahoma and Kansas generally have had a higher percentage successful of exploratory wells drilled in the past decade, the initial potential or the producing capacity of the successful wells is not indicated. Kansas initial potentials for new wells generally have been considerably lower than potentials for those new wells that found new fields by exploratory drilling in nonprorated Colorado, Nebraska, and Wyoming. It is possible that Kansas and Oklahoma have a built-in deterrent to initial large potential productivity tests on new discovery wells because they are under rigid proration order, and there is little incentive for producers to put forth extra expense or maximum effort to attain maximum productivity tests when their wells are not al'owed to produce at maximum productivity.

In summary then, thus far it has been shown that fewer exploratory wells are being drilled in Kansas (Table 28). Also, it now takes more wells in Kansas to produce less oil than in the past, and the new discovery wells have had generally lower initial potential than those in adjoining states.

The reserves of crude oil in Kansas are in about a 9 to 1 ratio to current annual production. This ratio has been maintained for the last ten to fifteen years primarily because of energetic exploration for new fields. The ratio probably will decrease during the next 15 years. From Figure 17 and Table 28, showing the exploratory wells drilled in Kansas over the last 20 years, it can be seen that since the peak year of 1956 more footage has been drilled each year to find fewer new oil and gas fields. According to a wildcat ratio report for 1961, wildcatting in the nation and the success ratio of wildcatting have set some new low marks for all time.[10] The average depth of exploratory holes drilled in Kansas during 1960 was 3,659 feet. It can be estimated that the average depth of drilling in the state to find additional reserves of crude oil and natural gas over the next 10 years will increase each year. Although many oil fields are found each year in Kansas (Table 30) and many will be found during the next 10 or 15 years, the chances of finding a field with a large potential production grows slimmer every year. In 1951, the chance of finding a one-million barrel field was calculated to be about 1 in 6 new discoveries.[11] By 1956, only 1 in 24 newly discovered fields was estimated to have reserves in excess of 1,000,000 barrels.[12]

Table 31 shows that the percentage of producing wells drilled to total wells decreased from 1954 to 1960. Probably the increase in percentage during 1960 over 1959 reflects a concentration in effort in established fields and fewer "wildcat" locations.

GIANT FIELDS

A giant field is defined as an oil field which may produce 100 million barrels or more of oil. Kansas has, at the present time, six oil fields which have passed the 100-million barrel mark. Oil production during 1961 from giant fields (Fig. 18 and Table 32) in Kansas and selected neighboring and competing oil producing states indicates that there are few giant fields in Kansas and that a small percentage of the annual oil production in Kansas is from giant fields. Our production averages less

10. *The Oil and Gas Journal,* March 26, 1962, pp. 88-89.

11. D. W. Payne, "Developments in North Mid-Continent in 1951," *American Assoc. of Petroleum Geologists Bull.,* Vol. 36, No. 6, 1952, page 1101.

12. G. Q. Williams, "Developments in North Mid-Continent in 1956," *American Assoc. of Petroleum Geologists Bull.,* Vol. 41, No. 6, 1957, page 1079.

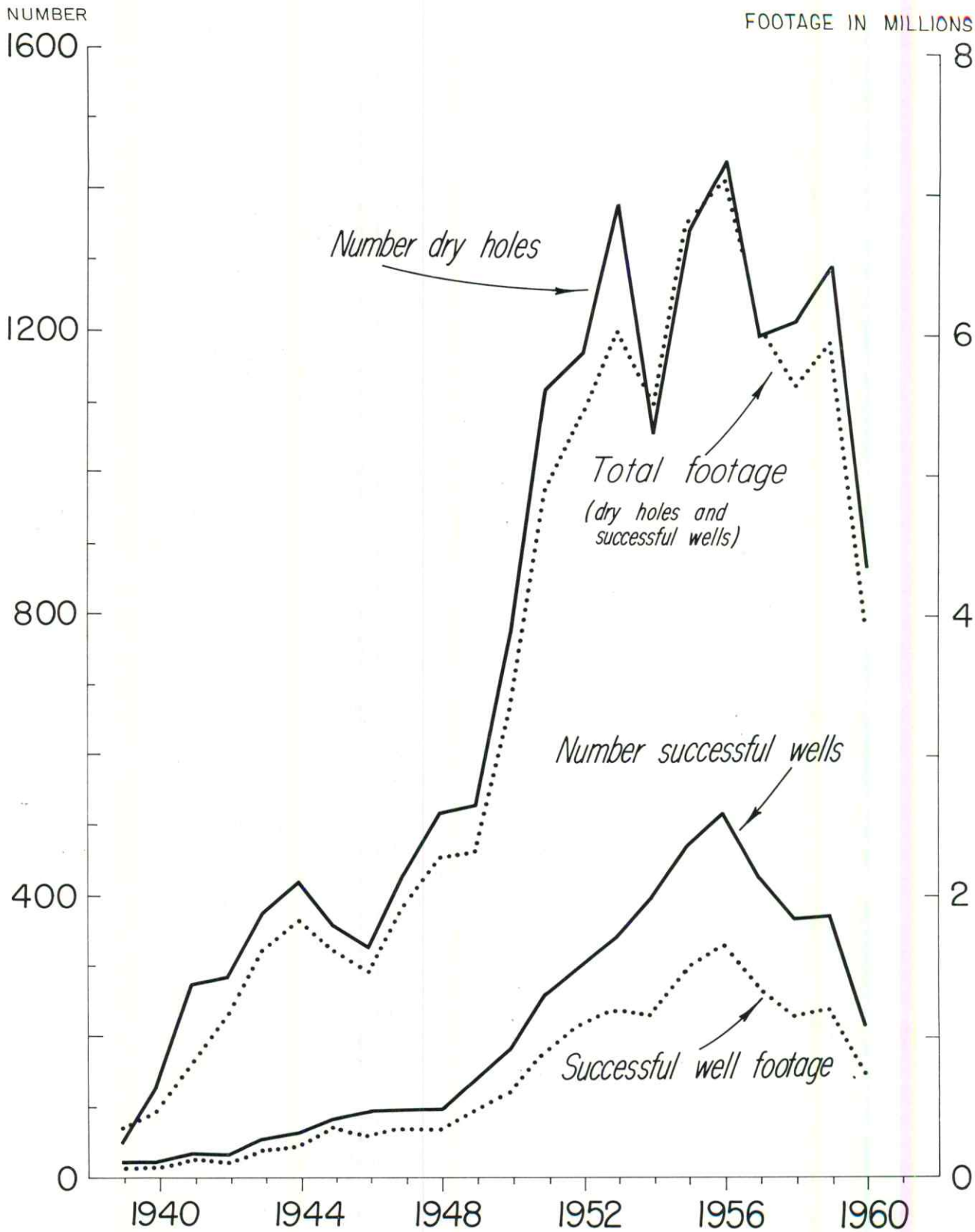

FIG. 17.—Kansas exploratory oil and gas wells, successful and dry, and footage by years, 1939-1960. (Table 28.)

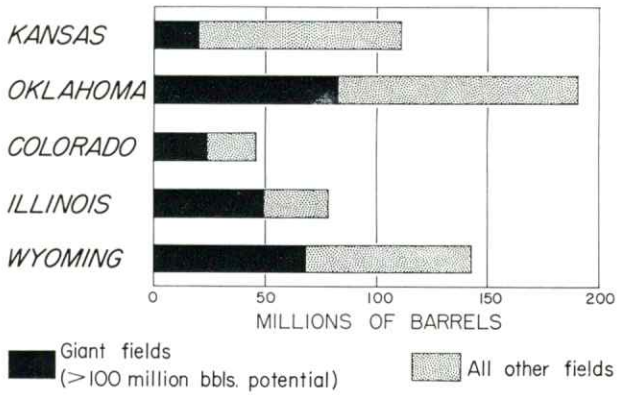

FIG. 18.—Oil production from giant fields in Kansas and adjoining states plus Wyoming and Illinois, in 1961. (Table 32.)

than 7.5 barrels a well and the fields are small and scattered.

Perhaps the fact that few giant fields are, have been, or probably will be found in Kansas may be one of the contributing factors to the decline of

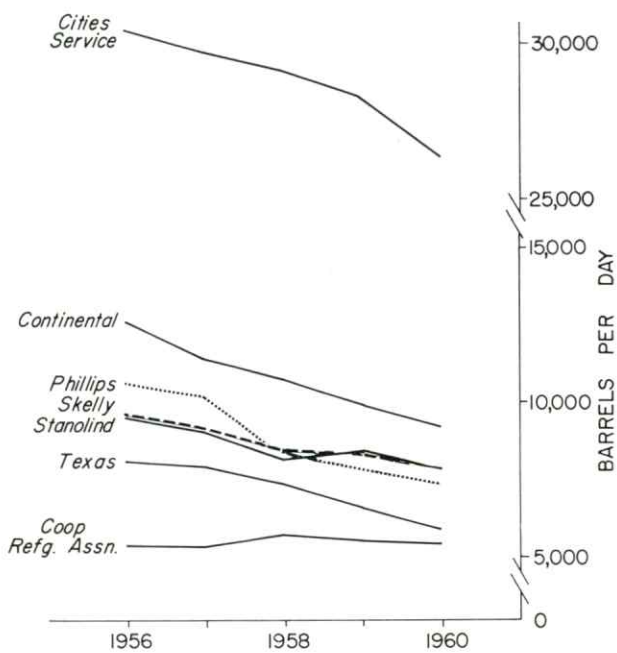

FIG. 19.—Average oil production by selected principal producers in Kansas, 1956-1960. (Table 33.)

major company holdings in Kansas. A survey (Fig. 19) of principal producers in Kansas having better than 3,000 barrels daily average oil production (December only) from 1956 to 1960 shows that the major producing companies in Kansas generally have experienced a decline in daily average oil production. Whereas the total daily average oil production from the principal producers as shown in Table 33 has declined from 165,000 barrels in 1956 to 129,000 barrels in 1960, other producers in Kansas (independents) have gained from 172,000 barrels to 182,000 barrels of oil a day over the same five-year period. The independent and small operator have assumed some of the daily average production that has been vacated by major producers. The small number of giant fields and the generally declining success ratio of wildcat drilling are contributing factors to the withdrawal from major explorational activities in Kansas over the last four or five years.

Farm-outs

Few wells in Kansas are drilled to depths in excess of 7,000 feet; and few exploratory wells are financed by an individual company in Kansas. Usually exploratory wells which a major company drills are on a "farm-out" basis with support from adjacent lease holders. Many of the major companies, which essentially withdrew from exploration in Kansas over the last four or five years, have continued to support exploration within the state in the sense that they have contributed dry-hole money to prove or disprove acreage that they still hold despite their withdrawal from active Kansas exploration.

Reserves and Producing Capacity

Reserves Concept

The reserves concept involves many opinions concerning what quantities should be included and how the statistics should be treated. Professional groups, industry associations, and the federal groups interested in the concept all have conflicting ideas; however, the basic definition is that reserves are those quantities of crude oil, both liquid and gas, which are known to exist and which could be recovered.

Reserves of crude oil commonly are computed in terms of a ratio called reserve life index; the amount of crude oil presently in the reservoir divided by the current annual production. The reserve life index for Kansas is about 9. This index does not mean that all Kansas oil fields would be completely depleted and abandoned in 9 years even if explorational and developmental drilling ceased. The rate at which crude oil can be recovered or withdrawn from the reservoir controls the length of an oil well's life. Undoubtedly, a maximum, emergency, producing capacity could be reached for all wells in less than a year, but ultimate recovery would extend over 30 to 40 years.

Annual 1950-1961 reserve estimates of crude oil, natural gas, and natural gas liquids for Kansas (Tables 22, 23, and 24) by committees of the

American Gas Association and American Petroleum Institute serve as a basis for a reasonably accurate history of past development and production in the United States. They involve no speculation with respect to future discoveries or technology. The reserve estimates refer solely to blocked-out reserves which could be recovered under existing economic operating conditions.

Extensions of existing fields by developmental drilling each year lead to revisions of previous estimates for older fields. Because the full potential or ultimate production from fields are not known until they are fully developed, experience has shown that, generally, earlier estimates are revised upward on a field basis and throughout the nation. From our knowledge of the history of individual oil wells, we conclude that, if there were no further drilling in Kansas or in the United States and if all the oil wells were produced at their producing capacity (the maximum rate of production possible under existing production practices), the *total* rate of production, after initial sharp increase to the capacity rate, would begin to decline.[13] It is evident that additional oil may be recovered from existing fields in future years. This additional oil will come from extensions of existing fields by future drilling, by revisions of recovery estimates as more reservoir information is obtained, and by increased recoveries through application of new techniques.

The National Petroleum Council reaffirms the fact that the increases in estimates of recoverable oil from fields previously discovered do not take place automatically with the passage of time, but instead are the direct result of further drilling, the development of additional information, and the application of improved recovery procedures.[14] The rate at which these activities take place may be accelerated or slowed down, depending upon prevailing opportunities, economic incentives, and other influences including governmental policy. The rate of discovery of new fields and the rate of increase in estimated additions to reserves of existing fields are not simple functions of time but are related to the intensity of the effort expended in the search for oil, in both exploratory and developmental drilling, and in technological development and its application through improved recovery methods. The intensity of these activities depends in turn on the need as reflected in demand and on financial incentives.

13. A. D. Zapp, "Future Petroleum Producing Capacity in the United States," *United States Geological Survey Bulletin*, 1142-H, 1962.

14. *Proved Discoveries and Production Capacities of Crude Oil, Natural Gas, Natural Petroleum Council, and Natural Gas Liquids in the United States*, 1961.

Reserves by Petroleum Administration for Defense Districts

Estimates of changes in crude oil productive capacity of the United States (1951, 1953, 1954, 1957, and 1960) by Petroleum Administration for Defense Districts (Fig. 20) are presented in Table 34. No breakdown of producing capacity is available on an individual state basis; but because Oklahoma and Kansas are the major producers in District II, comparisons with other districts should be indicative of trends. It is interesting to note that the productive capacity declined in Districts I, II, and V (Table 34) from 1957-1960, and increased only slightly in IV. The reduced rate of increase in productive capacity in District III (1954-1957 and 1957-1960) reflects the reduction in drilling since 1956. The number of wells drilled in the United States (Fig. 21) increased rapidly and continually from 1951 through 1956, reaching a peak in the latter year, but thereafter has declined substantially.

A similar situation has occurred in the Kansas industry. In spite of the reduction in drilling and reduced rate of increase in productive capacity, there was a substantial net gain of productive capacity of crude oil relative to production for the United States as a whole (Fig. 22), representing a net increase of spare productive capacity for 1957-1960.

A similar summary of productive capacity of natural gas in the United States as of January 1, 1960, is given in Table 35. It must be pointed out that productive capacity is not the same as availability. Presently available facilities limit the use of natural gas that could be produced. In present practice, storage of gas has been restricted largely to the storage of limited quantities in natural underground reservoirs near the market to improve the load factor of the pipelines. The total productive capacity of natural gas is dependent on the maximum rate of oil production because much gas occurs with oil.

Because natural gas liquids are not produced as such from underground reservoirs but become available slowly by separation from natural gas, availability depends directly on the rate of production of natural gas and oil and requires existence of adequate handling facilities. Table 36 presents the maximum productive capacity of natural gas liquids in the United States by defense districts.

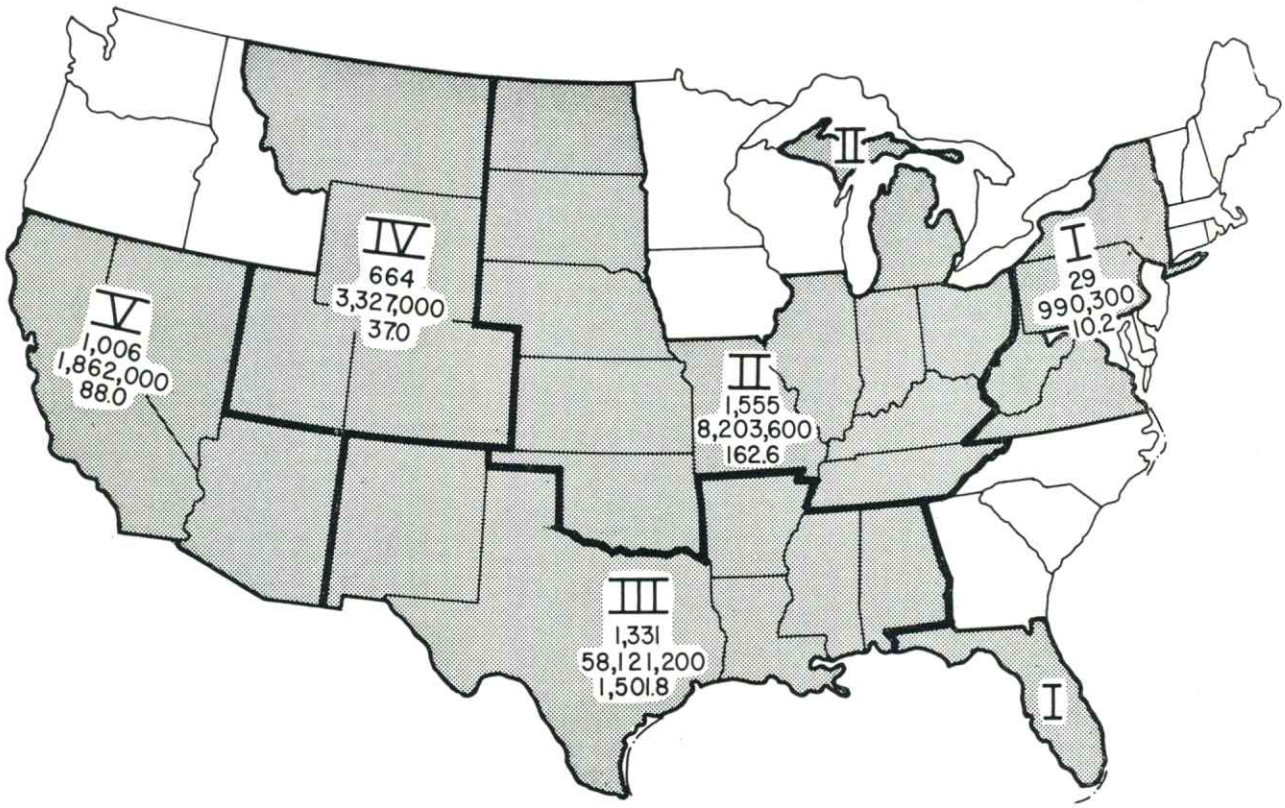

FIG. 20.—Petroleum Administration for Defense districts and producing capacities of crude oil, natural gas, and natural gas liquids, January, 1960. (Compiled from *National Petroleum Council Report,* 1961.)

RELIABILITY OF RESERVE STATISTICS

Reserve and reserve producing capacity of Kansas and the nation must be evaluated in the light of the reliability of the information upon which these reserves and producing capacity are calculated. Two features must be considered: (1) lack of uniformity among the different states in field tests (states with proration have governmental supervision of field tests while nonprorated states often lack this supervision); (2) the reliability of reported productive capacity. In Kansas, monthly proration orders give the producing capacity (producing capacity determined by the most recent field test on individual well basis); however, a total of the proration-order productive capacity by wells from Kansas would not give a true picture of the productive capacity of the wells. Because of the

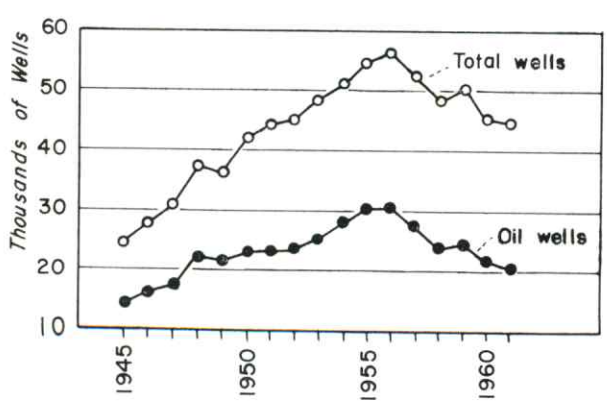

FIG. 21.—Total wells drilled in search of production and the new crude oil wells completed in the United States since World War II. (Adapted from Zapp, "Future Petroleum Producing Capacity of the United States," *United States Geological Survey Bulletin,* 1142-H, 1961.)

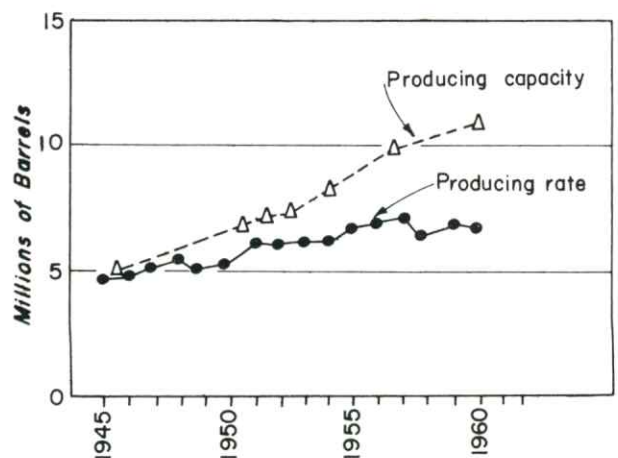

FIG. 22.—Increase in crude oil producing capacity and reserve producing capacity in the United States since World War II. (See note for Figure 21.)

presently depressed market, there is little incentive for the operators to achieve a maximum test at annual testing time when most of the wells in Kansas are on a minimum daily allowable. It would not be in the interest of conservation to direct the operators to assume added expense in making field tests to achieve maximum productivity tests on individual wells when their wells are only allowed to produce a minimum amount. The productive capacity of Kansas wells as estimated as of the first of January, 1962, was 360,000 barrels of crude oil per day.[15] The producing capacity of wells for the nation as of January 1, 1960, was 10,585,000 barrels per day.[16] The refining capacity of Kansas is about 346,000 barrels per day.

Because of these considerations, the reliability of the producing capacity by states, even from prorated states where figures are available on individual wells, is not uniform. This fact tends to refute the statement by Zapp that, "These quantities, although estimates (crude oil production capacity since World War II), rather than actual measurements, on the date of the survey, must by their nature have a high degree of accuracy."[17]

Undeveloped Reserves

Zapp states that geological evidence from the nation indicates there is little likelihood that the quantity of undiscovered oil will impose a limitation on the industry's ability to continue to increase crude oil producing capacity at least for the next 10 to 20 years and probably for a considerably longer time.[18] It is felt that there is an abundance of unexplored rock in the United States, geologically favorable for the occurrence of petroleum. As pointed out previously, more than 130,000 exploratory wells have been drilled in Kansas. However, the density distribution of these wells is such that there are entire counties in Kansas with fewer than a dozen exploratory wells drilled in them.

Generally speaking, success ratios for new oil wells for the nation have been maintained. However, as pointed out earlier, success ratios in Kansas have been disappointing the last few years. Zapp[19] states that future petroleum producing capacity in the United States will be controlled principally by the rate of completion of new producing wells, which in turn will be controlled by the rate of drilling in search of production and the degree of success of such drilling. Economic recession and a sharp increase in the quantity of imported crude oil and crude oil products since 1956 have resulted in a decreased domestic share of the market and a decrease in drilling effort in the United States. Zapp's 1961 prediction that the amount of drilling will increase at a somewhat slower rate in the future was good prophecy. For the nation this has been true, but for Kansas the decrease set in several years ago. Two factors influence this change: increased imports of crude oil are filling more of the market demand in the United States; and increased use of natural gas liquids are replacing crude oil in the energy markets.

Production of natural gas and natural gas liquids has been increasing at a somewhat faster rate than the production of crude oil. At the same time, increasingly greater relative quantities of natural gas and natural gas liquids are being discovered as the average depth of exploration increases.[20]

Drilled Out Areas and Negative Exploration Philosophy

Many areas in Kansas (specifically eastern Kansas) are places where intense oil field exploration and development took place 50 years ago. In the eyes of the major operator these are "worked out" areas. Little investment capital can be accumulated from an out-of-state source or from a source that is not familiar with these areas. Unfortunately this concept is only partially true, for if one removes all of the oil and gas producing well symbols from a map of southeastern Kansas and leaves only symbols for holes that penetrated below the relatively shallow Pennsylvanian rocks, one could see that this area could be considered a "wildcat" area for exploration at depths below the Pennsylvanian rocks, stratigraphically and geographically. Although there are some scattered Mississippian and Arbuckle oil pools (below Pennsylvanian) in southeastern Kansas, certainly the area cannot be written off yet.[21]

One deterrent to exploration in Kansas is artificial and results from managerial desire to lessen the expenditures in any one venture. It is common in explorational thinking to say "the Salina Basin contains no large oil fields" even though the basin is inadequately explored. Or it is heard often

15. H. A. Beverlin, Oil Proration Analyst, Kansas Corporation Commission, personal communication, 1962.
16. National Petroleum Council, 1961.
17. Zapp, p. 8.
18. Zapp, p. 2.
19. Zapp, p. 27.
20. Zapp, p. 32.
21. For additional information on the nature and occurrence of hydrocarbons stratigraphically, by petroliferous provinces, and structural provinces in Kansas refer to the *Oil and Gas Journal*, Merriam and Goebel, "Kansas' Structural Provinces Offer Varied Types of Traps," April 30, 1956; "Alert Explorers Find Kansas Oil," March 2, 1959; and "Where's the Oil in Kansas?", March 9, 1959.

that in western Kansas "we can drill two holes to the top of the Mississippian rocks for the expense of one hole through the Mississippian to the top of the Arbuckle Dolomite." This type of "lore" is not confined to independent operators and forms a very real block to exploration in Kansas.

It is true that the character of the oil business in Kansas is somewhat similar to the character of the oil business in Oklahoma in that both have areas which are considered to be worked out and are unattractive for additional exploration. It is also true that there are large unexplored areas in Kansas for which predictions of additional reserves of crude oil would be difficult. Included among these areas are the Forest City Basin in northeastern Kansas and the Hugoton Embayment in southwestern Kansas. It is in southwestern Kansas beneath the huge Hugoton Gas Area (restricted stratigraphically to the Chase Group of the Permian shallow beds) that the state's best hopes for an additional 100-million barrel (giant) field is to be found.

Refining and Natural Gasoline Plant Capacities

Refining Capacity

At the refinery, crude oil is broken down or "cracked" into component parts such as gasoline, kerosene, fuel oil, and lubricating oils. Figure 23 and Table 37 show that national petroleum refining capacity has increased 88 percent between 1946 and 1961, whereas the refinery capacity in Kansas has increased 83 percent. The total crude oil refinery capacity for both the nation and Kansas has increased annually whereas the number of refineries generally has decreased. The location of the Kansas refineries is shown to be concentrated in south-central Kansas (Fig. 2).

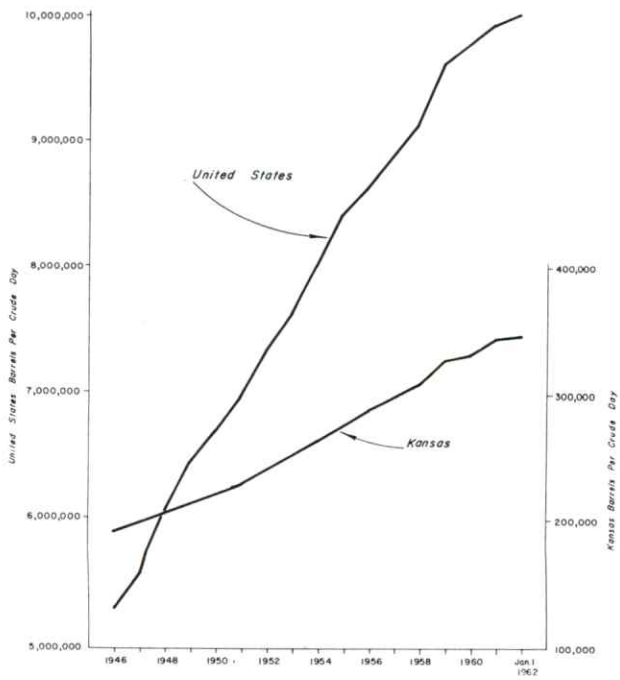

Fig. 23.—Crude refinery capacities, Kansas and U. S., 1946-1962, in barrels per crude day. (Table 37.)

Refining Capacity of Natural Gas Liquids Plants in Kansas and the Nation

Capacities and production of natural gas liquids have increased at a faster rate for the nation than for Kansas (Fig. 24 and Tables 38 and 39). Production of natural gas liquids in Kansas remained steady, between 4.5 and 5 million barrels a year, from 1951

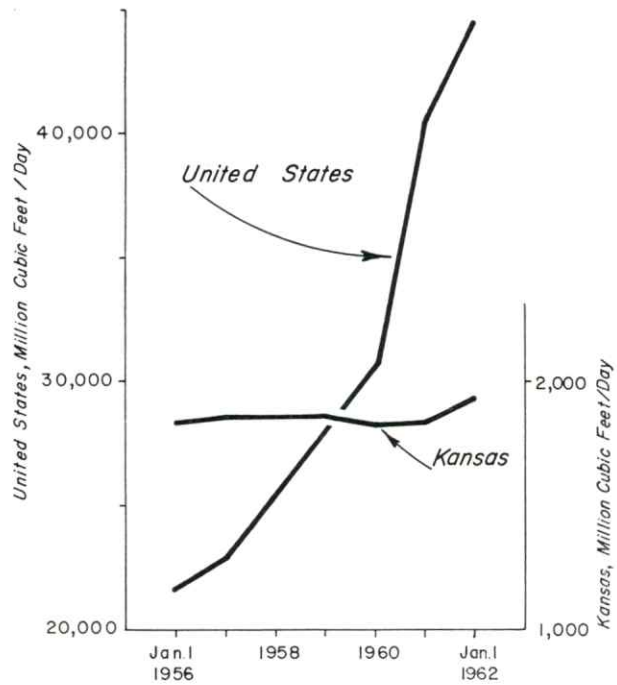

Fig. 24.—Natural gasoline and LPG plant capacities, Kansas and U. S., 1956-1962. (Table 38.)

to 1960 and jumped to 6.2 million barrels in 1962. This growth is not commensurate, however, with the growth of the national production of natural gas liquids for the same period. The capacity of the Kansas plants for recovery of natural gas liquids has increased only slightly since 1956, whereas the nation's capacity for recovery of natural gas liquids more than doubled during the same period of time.

As established earlier in this paper, natural gas liquids become available only by separation from natural gas at the wellhead or at natural gasoline plants during transmission of the natural gas to market. In 1945 there were 8,260 miles of natural gas transmission pipeline (excluding field gathering

and distribution lines) in Kansas compared to 77,280 miles of such pipeline in the United States. In 1960 the United States mileage was 181,940 compared to 11,620 miles for Kansas.[22] The major increase in supplies of natural gas discovered since World War II is from "wet gas" areas (containing high yields of LPG) outside of Kansas. Kansas natural gas is comparatively dry gas.

Market and Trends

Kansas Export Market Trends

The opportunity to produce oil in Kansas has diminished during recent years partly because national markets have been captured by cheaper imported oil. Although imports are federally allocated and controlled, increasing import quotas have decreased the state markets. Increased production from nonprorated states has claimed some of the (traditional and historical) Kansas markets. "Export of crude oil to Illinois and Indiana from Kansas pipelines declined from about 106,000 barrels daily in 1956 to 85,000 barrels daily in 1960. Meanwhile shipments to the same markets from Rocky Mountain states (generally unprorated) increased from 145,000 barrels daily in 1956 to 239,000 barrels daily in 1960." [23]

Kansas was listed as among the four oil-prorated states that bore the brunt of crude oil-production cuts during 1960, whereas nine others (some nonprorated) had increased production.[24] The question "What is Kansas' share of the national market?" is pertinent, and future study is obviously necessary to determine how to get this share; and, even more important, how can Kansas increase this share?

Kansas Share of Market

Detailed study of what is a state's fair share of the national oil market is being made by a special

22. American Gas Association, *Gas Facts, 1945-1960.*

23. *Oil and Gas Journal,* March 27, 1961, "Texans Lose Crude Markets in Their State and in Other Areas," Vol. 59, No. 13, pp. 58-60.

24. *Oil and Gas Journal,* February 26, 1962, "What is a State's Fair Share?," Vol. 60, No. 9, pp. 91-101.

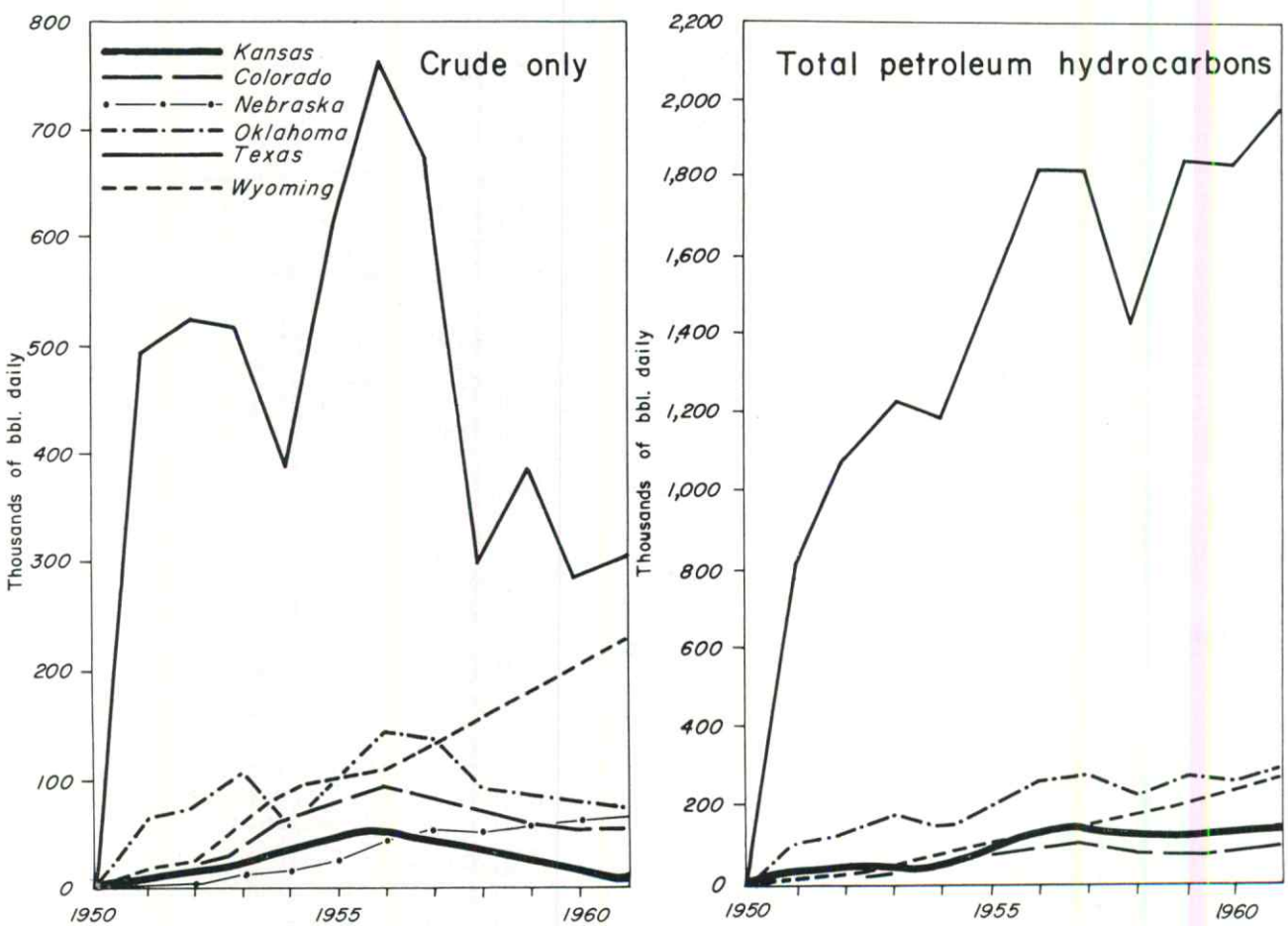

FIG. 25.—Production gains since 1950 (base year). (Adapted from *Oil and Gas Journal,* February 26, 1962, pages 91-101, except data on Nebraska, which was compiled from statistics of the American Petroleum Institute.)

committee of the Interstate Oil Compact Commission. The charge of that committee was to collect "information only" on production and reserves in a number of states and report in June, 1962, at the mid-year meeting at Omaha, Nebraska.

The *Oil and Gas Journal*[25] attempted to evaluate impartially the problems involved in determining each state's "fair share" of the national market. (Figures 25-28 are adapted from that report.) Five categories were considered: production gains over 1950; trends in production expressed in percentage gains over 1950; net additions to reserves, reserves life index or official reserves as of the first of each year divided by the ensuing year's production; and production percentage of the United States total. In the category of crude production gains since 1950 (Fig. 25) Kansas, Colorado, and Oklahoma have similar production gain curves with the highs between 1955-1957, and a decline since then. Wyoming and Nebraska show steady production gains since 1950. Kansas production gains in total petroleum hydrocarbons, including crude oil, natural gas liquids, and natural gas converted to equivalent crude barrels, have not been commensurate with competing nonprorated Wyoming. In the second category which concerns percentage production trends (1950 equaling 100 percent), Texas, Oklahoma, and Kansas (all prorated states) scored only a modest percentage rise over their high output levels of 1950 of total petroleum hydrocarbons, a reflection of their relatively high output in the base year. In crude oil only, Nebraska shows phenomenal growth because of the low base in 1950 (from 1.3 million barrels in 1950 to 23.5 million barrels in 1960), which is equal to a 23-fold increase. In the category (Fig. 26) of net addition to reserves, total petroleum hydrocarbons in Kansas has declined since 1958. Little change occurred in the total petroleum hydrocarbon reserves in Colorado, whereas the reserves for Wyoming show a general increase over the last 10 years. With the relation of production to reserves or the reserve life index (with the United States as a reference point in crude only), Kansas, Oklahoma, and Nebraska remained consistently below the national average while other states varied (Fig. 27). When total petroleum hydrocarbons is used (Fig. 28), Kansas has been above the national average since 1953. This means that Kansas is not producing its reserves at comparable rates with competing states. When the division of the present market is expressed as a percentage of the United States total, Texas still leads all states (Fig. 28),

25. "What is a State's Fair Share?," *Oil and Gas Journal*, Vol. 60, No. 9 (February 26, 1962), pp. 91-101.

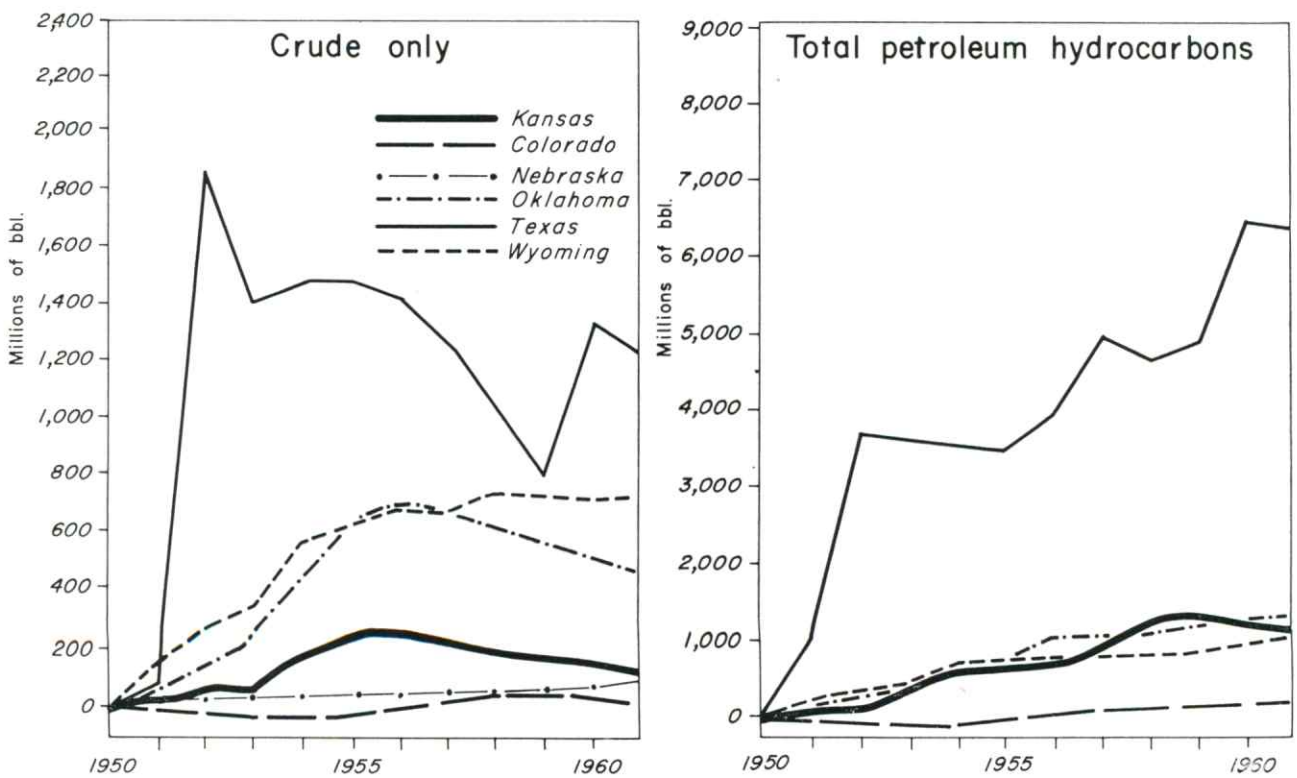

FIG. 26.—Net addition to reserves, 1950 base. (See note for Figure 25.)

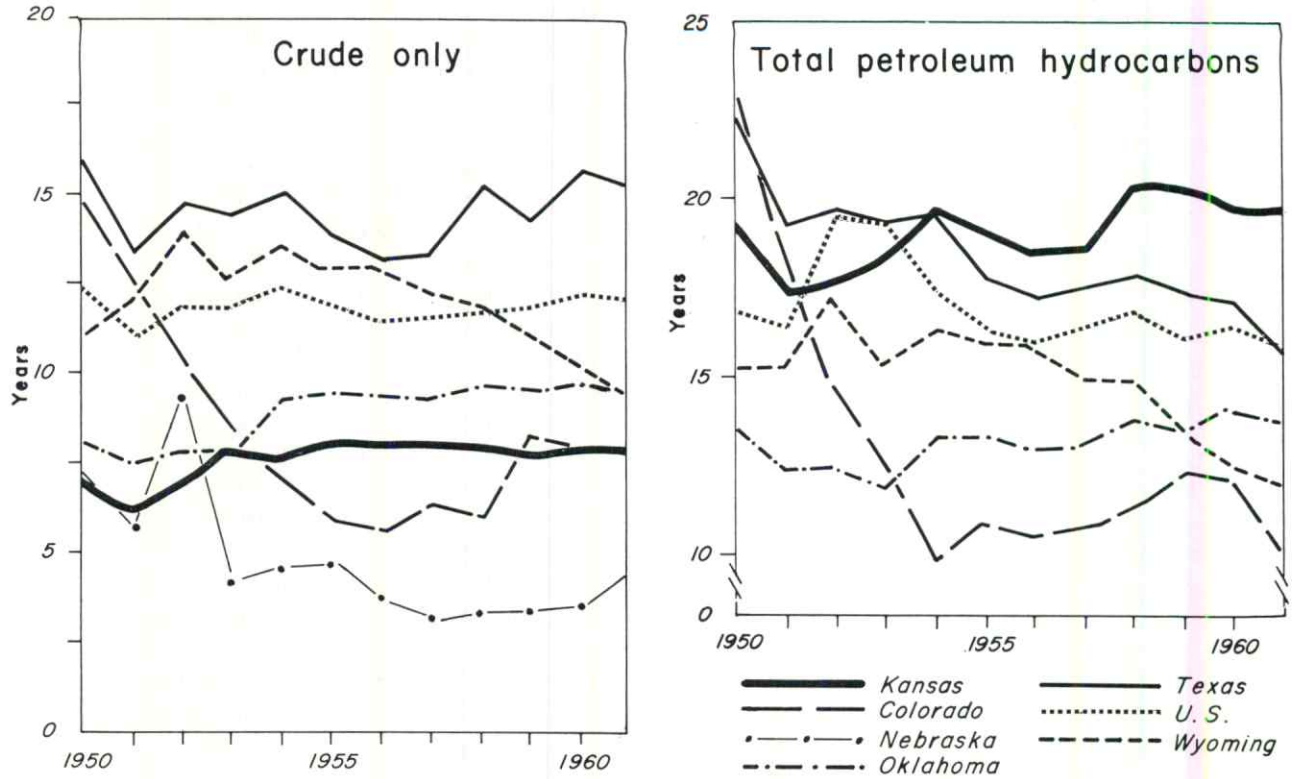

FIG. 27.—Reserve life index (annual production divided into crude reserves). (See note for Figure 25.)

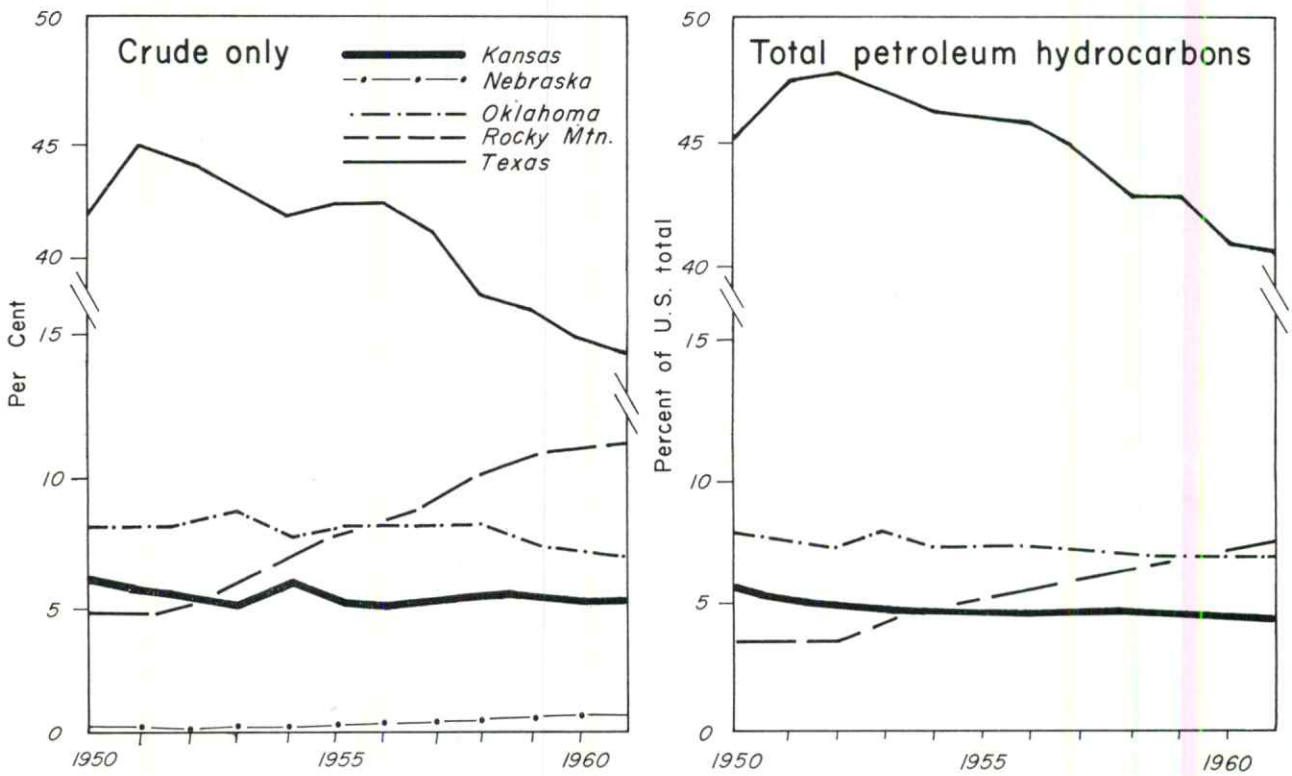

FIG. 28.—Division of natural market; in production expressed as percentage of U. S. total. (See note for Figure 25.)

although its share has decreased the past several years. The mountain states, which include Colorado, Wyoming, Nebraska, North Dakota, and Utah, have steadily increased their share of the national market since 1952. The share of the national market from the prorated states, Kansas and Oklahoma, has shown a general decline since 1950 in all categories.

Domestic natural gas liquids have enjoyed a healthy growth rate in the nation since 1950. Productive capacity for natural gas liquids to January 1, 1962, according to the Independent Petroleum Association, increased 27 percent since 1956, and crude oil capacity from 1956 to January 1, 1962, gained only 13 percent. Some of the domestic crude oil markets are now being absorbed by imports and are also being infringed upon by increased domestic production and marketing of natural gas liquids.

It is sometimes difficult for people in Kansas to realize that the federal program of crude oil import quotas has a marked influence on Kansas production and refining and transportation of Kansas crude oil to points outside of Kansas. The federal government gives quotas of imported crude oil to coastal and inland refineries. Inland refineries then "trade out" their quotas to coastal refineries. The imports of cheaper oil into our nation directly affect the refining and transporting of crude oil in inland states. Indirectly, by satisfying the market needs, crude oil imports reduce production of oil in the inland states.

Unitization

It would be difficult to enumerate all the aspects and consequences of unitization on the Kansas petroleum industry. This discussion is not presented with the idea of determining whether or not unitization is good for the petroleum industry of Kansas, but only to list some of the features of unitization as it affects the economy of the state. A unitized operation is not an end in itself, and the combination of interests does not directly increase recovery or prevent waste. Unitization merely makes possible the development and exploitation of the pool as a single producing mechanism in accordance with accepted scientific and engineering principles. Commonly, the result is maximum economic recovery of oil and gas in place and a division thereof among the respective owners in accordance with the terms of the unit agreement. Unit operations are not feasible in all cases, but in those instances where they can be instituted advantageously, *i. e.*, to prevent waste and/or protect correlative rights, they represent effective conservation and use.

Engineers and geologists are agreed that scientific production of an oil and gas pool must be predicated upon geologic structure and reservoir characteristics and not upon fortuitous property lines. Unit operation, then, requires a recognition of the physical nature of the occurrence of oil and gas in place and the various methods whereby it can be most efficiently produced. Unfortunately, a pool is often unitized so early in development that very little is known regarding the prospective volume of oil or gas underlying each individual property. Without accurate subsurface geologic data (not available until the pool is more nearly developed), the unit development plan is liable to the introduction of waste and inequities. A wide spacing pattern could leave small discontinuous reservoirs undiscovered; similarily, too small a spacing pattern could reduce the unit to the uneconomical level of random drilling. If the interests of economy and conservation are to be served, unitized operations cannot be prudently initiated until substantial geologic and reservoir data are available. Any developmental plan for unitization must be subject to review and alteration as additional drilling adds to knowledge of a specific reservoir.

Summary

Fossil fuels (crude oil, natural gas, natural gas liquids, and coal) are the backbone of our industrial economy. The liquid and gaseous hydrocarbons, we have learned, are involved in our daily existence and in the defense of our nation.

Oil and gas occur underground mostly in the minute pore spaces in discontinuous rock reservoirs not dissimilar to the manner in which water is held in a sponge. Where gas is present under pressure, recovery of the hydrocarbons from the reservoir is akin to opening an agitated or warm bottle of "pop." Unfortunately, most of the oil originally present in our Kansas reservoirs is not gas-capped nor do the reservoirs have sufficient gas in solution for flowing wells. Oil has little self-expulsion energy; therefore, gravity or some displacing fluid under pressure must be relied upon for reservoir energy.

Secondary recovery (repressuring in partially depleted pools) and pressure maintenance programs in new pools are methods used to increase recovery from reservoirs. These are sound engineering programs applied in the petroleum industry. It must be remembered that the extraction of all hydrocarbons constitute a mining industry and

extraction results in depletion. Presently, even with the application of the best known recovery methods, about one-third of the original oil in the reservoir is not recovered.

The Oil and Gas Conservation Division of the Kansas Corporation Commission is charged with the responsibility of protecting the public interest in prevention of waste of any kind and to insure the best use of our natural oil and gas mineral wealth for the greatest number of people. By sound conservation policies and with assessed funds from the petroleum industry, the state regulates the industry, protects correlative rights (insures lease owners a fair share of production and reservoir energy from fields of diverse ownership), and allocates production (assures each operator fair opportunity to monthly markets). Other wastes include flaring of gas and depreciation by excessive above-ground storage of oil.

Unitization is thought to reduce unnecessary developmental wells, resulting through optimum engineering practices (wider spacing, controlled rate of production, etc.) in greater ultimate recovery and therefore in the prevention of waste. Geologic conditions in the reservoirs, however, are not always measurable by engineering methods and a small reservoir could be overlooked and remain undeveloped by wider initial spacing. Any authenticity given to the extent of an oil or gas field by governmental spacing orders, involving undrilled marginal lands, could lead to unwarranted lease speculations. Unitization has been found to be a useful device for preserving equities in secondary recovery and pressure maintenance programs where a common source of supply is held by diverse ownership. Wider spacing generally results in lower investment costs in any given field and thereby lowers the producing costs also. The results are a profit for the operator and available capital for finding more of his product, should he choose to reinvest.

Natural gas entering the interstate systems of transportation is regulated by the Federal Power Commission. Gas is "end-use" controlled in that it is considered as a public utility. Much crude oil and natural gas liquids are exported from Kansas. Interstate pipeline construction is regulated by Interstate Commerce Commission.

Production of crude oil from Kansas (about 4.5 percent of the nation's total) has been declining the past few years while production of natural gas liquids and natural gas has increased. Eighty-five percent of Kansas mineral wealth comes from the extraction of oil and gas from buried rocks although Kansas has few giant fields. Mostly, oil production is from small fields. The average daily crude oil production is below 7.5 barrels per day and has been declining annually since 1956. The national markets for oil and gas have expanded with our national economy each year. The domestic share of the national crude oil market has declined with the increase in imports of foreign crude oil, which is cheaper to produce and sometimes thought to be politically priced as a cold war implement.

Fewer developmental and explorational wells are being drilled each year in Kansas and the nation. This decrease in itself is to be expected since 27 states now have compulsory unitization and generally wider spacing of producing wells. What is alarming is that a decreasing percentage of wells drilled (Kansas and United States) are classified as wildcat (explorational wells). Maintenance of reserves of liquid and gaseous hydrocarbons, in amounts thought to be vital for a sound and healthy industrial economy in Kansas and the nation, is dependent on the finding and developing of additional pools.

Conservative estimates of proved reserves of crude oil and gas, should no more wells be drilled and the presently known reservoirs depleted, give Kansas a 9 to 1 reserve life index ratio for oil and about a 30 to 1 for gas. Reserves are not the same as availability, however, because rate of production determines producing capacity. In an emergency, Kansas producing capacity could be increased by 10 to 15 percent for a short time. Oil reserves in a 9 to 1 ratio probably means a 35-year recovery period because, in depleting a reservoir, the producing rate declines rapidly with age. Future supplies of liquid and gaseous hydrocarbons must come from additional exploration. In Kansas, there are geologically favorable unexplored areas.

Costs of doing business in Kansas have increased in recent years although precise determination of operating cost, or "replacement cost" of depleted product, is difficult. Income generated by the petroleum industry cannot be adequately measured because of the inadequate coverage of standard industrial classification and because much of the income is in the form of delay rentals and royalties. Downward trends of income and wages and salaries from the petroleum industry are noted for the prorated states (including Kansas) since 1957.

Many major explorational oil companies have moved their offices out of Kansas. Study reveals that independent producers have assumed an increasing portion of the state's daily crude oil average production while production by the "majors"

generally has declined. Some causes for withdrawal from Kansas could be: more favorable and higher potential production from other states; more favorable tax structure and operational cost structure elsewhere; a nation-wide reduction and consolidation of domestic staffs and activities complementing an expanded foreign exploration program by the "majors;" and unfavorable national import programs.

Although the national demand for crude oil has increased each year, recently Kansas' share of the domestic market has decreased, a pattern apparent in other prorated states, but not necessarily true in nonprorated states. Seemingly Kansas oil has moved from a seller's market to a buyer's market. Refining capacity gains in Kansas are favorable with the nation's.

The petroleum industry in Kansas is not an expanding industry at the present time. Production of crude oil, natural gas, and liquefied petroleum gases in Kansas should continue at a healthy pace for the next 10 to 15 years but at a slowly declining pace, dependent on the national market. Future development or exploratory work in Kansas will be to a large part done by the independent producer. The incentive for drilling has been restrained by the threat of a cut in posted crude oil prices at the local refineries over the last few years. It would seem imperative for Kansas that an adequate market outlet for the oil produced by the independent producer be protected and that an atmosphere which would be inducive to the expansion of these smaller businesses be created.

As shown by a special report of the possibilities of storage of natural gas in the Kansas River valley in northeastern Kansas,[26] about half of the natural gas produced in Kansas is utilized in Kansas. It would seem that an expanded economy in Kansas would depend upon the intrastate use of mineral resources of the state, such as gas and natural gas liquids. The marriage of the areas of population and adequate water supplies with the natural mineral fuel wealth of Kansas is imperative. If such an association of the elements for industry is not brought about by Kansans in Kansas, rest assured that continued increases in exportation of our mineral wealth will be sought by other political units seeking an expanded industrial economy.

WATER

Water is relatively unique in comparison with the other minerals discussed herein because of its migratory and renewable characteristics. It represents an "economic resource" in every sense of the term and has had a profound effect on the economic development of Kansas.

General Availability [27]

The geographic pattern of water distribution in Kansas is illustrated in Figures 29 and 30. There are no sizable lakes in Kansas; moreover, truly perennial streams are very few in number. Precipitation and surface runoff quantities tend to increase from west to east across the state, and eastern Kansas, consequently, has much more surface water than western Kansas. Although the range in average annual precipitation across the state is from less than 16 inches to over 40 inches,

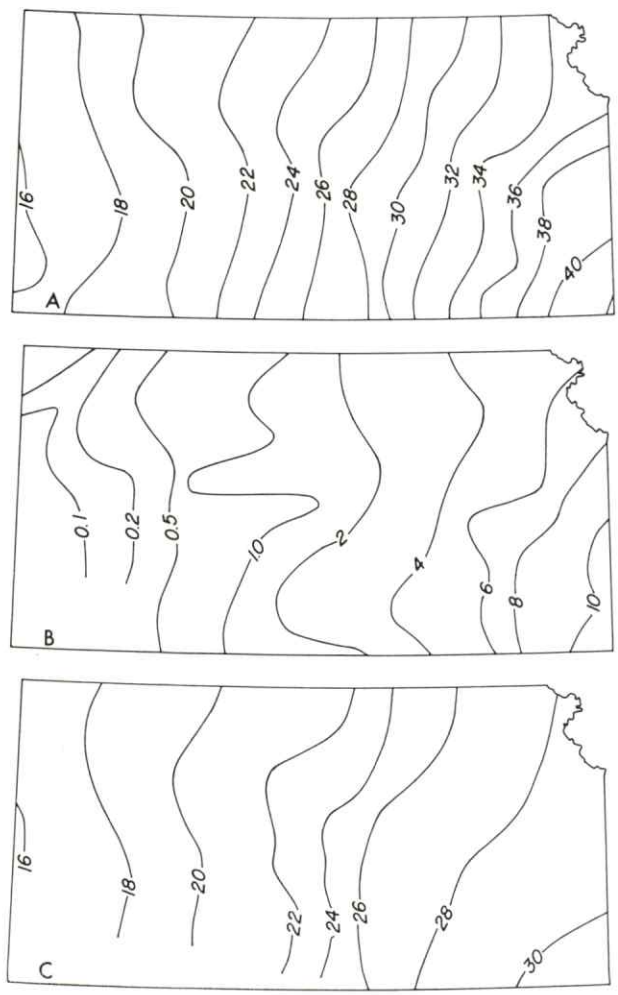

FIG. 29.—Mean annual (A) precipitation, (B) surface runoff, and (C) water loss (precipitation minus runoff) in Kansas. Measured in inches. (Source: Kansas Water Resources Board.)

26. E. D. Goebel and J. M. Jewett, *"Possibilities for Underground Storage of Natural Gas Near the Kansas River Valley,"* Oil and Gas Investigation No. 27, 1962.

27. *Report to the 1961 Kansas Legislature Concerning State Water Policy and Program Needs*, Kansas Water Resources Board (Topeka, Kansas, November, 1960).

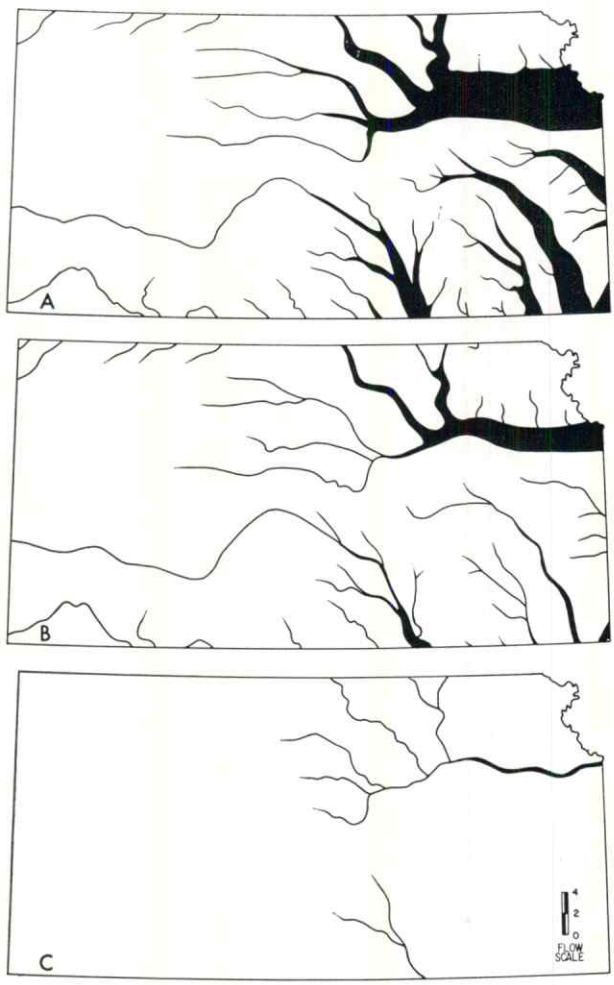

FIG. 30.—Flow in Kansas streams: (A) mean, (B) median (equalled or exceeded 50 percent of the time), and (C) average flow during severe drought conditions. Flow scale in thousands of cubic feet per second. (Source: Kansas Water Resources Board.)

annual rainfall quantities of less than five inches and more than 65 inches have been measured in Kansas. Because of this changeable precipitation pattern, variations in runoff and streamflow at given locations are also extreme from year to year and even from one day or week to the next. If the average conditions illustrated in Figure 30 could be maintained, there would be few problems of too much or too little surface water. Unfortunately, these average conditions rarely occur. On the typical Kansas stream, average flows are exceeded only about 15 percent of the time and for an equal period of time many of the streams in the state are dry. On the other hand, about 75 to 85 percent of the total annual supply in the typical stream occurs about 15 percent of the time. Figure 30 also gives some measure of the time variation of streamflows by showing proportionate magnitudes of runoff under median conditions and severe drought conditions in contrast with the average conditions.

Basic geology, on the other hand, has endowed western Kansas with larger ground-water supplies. Much of western Kansas is underlain by unconsolidated deposits (consisting mostly of sand, gravel, and silt) more than 300 feet thick. These deposits yield large supplies of water for irrigation, industrial, and municipal use. In southwestern Kansas, unconsolidated deposits yield large amounts of fresh water at depths of more than 200 feet. In addition, the alluvial sand and gravel deposits of Kansas stream valleys are permeable and absorb water directly from rainfall and runoff. The alluvial deposits of larger river valleys yield an important part of municipal, industrial, and irrigation water. Much of northcentral and eastern Kansas is underlain by consolidated rocks of Cretaceous, Permian, Pennsylvanian, and Mississippian age. These rocks consist principally of limestone and shale with some sandstone and sandy shale. Locally these older rocks, which yield abundant supplies of water of excellent quality for stock and domestic use, furnish the municipal supplies for many towns. However, in many areas underlain by these rocks, it is difficult to obtain a well-water supply of suitable quality and quantity for domestic use. The storage capacity of these rocks is small in comparison with the thick unconsolidated deposits of western Kansas. The expected yield from wells is shown in Figure 31.

Ground-water levels are subject to fluctuation in response to natural recharge and discharge conditions. Precipitation is the primary source of replenishment of ground-water aquifers. Western Kansas, even though it has the more favorable geologic environment for ground-water storage, has limited opportunity for future recharge of these supplies owing to its low precipitation and high evapo-transpiration (the process of returning water to the atmosphere) rates.

The average annual water loss values shown in Figure 29 consist almost entirely of evapo-transpiration losses. This use consumes about 98 percent of the available precipitation in western Kansas. Despite these water losses, the evapo-transpiration demand is not completely fulfilled. It is estimated that if there were some way of maintaining sufficient soil moisture at all times, the evapo-transpiration use could range from 110 to 145 percent of the average annual precipitation from east to west in Kansas.

Water quality is as important a consideration as quantity for many water users. Generally, the nat-

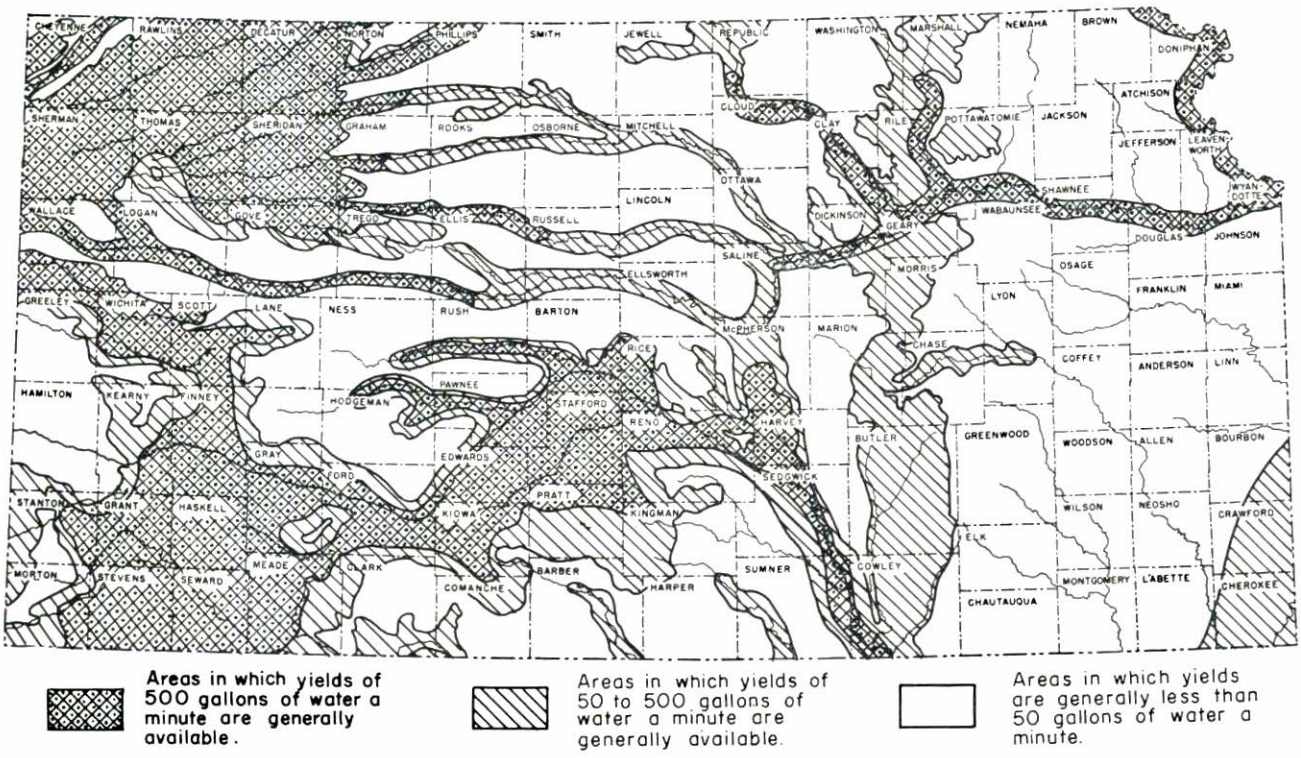

FIG. 31.—Generalized ground-water regions and yield of water wells in Kansas.

ural quality of surface and ground-water supplies in Kansas is good. However, some streams, for example the Walnut River and portions of the Arkansas River, are used only to a limited extent because of undesirable chemical qualities. During low-flow periods, the chloride concentrations in a number of the streams becomes higher than desired. At times both the total dissolved solids content and hardness concentrations of all surface water sources in Kansas are in excess of that desired for many industrial uses. Hence, some treatment is usually necessary for many industrial as well as normal municipal uses. Organic pollution is well controlled in Kansas streams. Except where the water has been obtained or recently released from deep impoundments, the stream waters are subject to seasonal temperature fluctuations. There are many areas where the ground-water supplies, especially in deep formations, are too highly mineralized for use. However, most of the areas, where the higher yields are obtainable (see Figure 2), have excellent quality ground water.

Limitations

The general nature and location of the waters in Kansas pose some limitations for economic development. Brief comment on each of the major divisions of the hydrologic cycle will serve to illustrate some of them.

Annual, seasonal, and even weekly variations in precipitation lead to problems—sometimes localized and sometimes state-wide—of both flood and drought. Agricultural income, a most significant factor in the economy of Kansas, is most responsive to the precipitation pattern. Moreover, during extended drought agriculture must often divert appreciable sums of capital, to obtain supplemental water supplies for domestic and livestock use. In much of the western third of the state, this natural instability in water supply is being minimized by irrigation—primarily from ground water. By contrast, only a small percentage of the agricultural lands in eastern Kansas can be irrigated, owing to the lack of adequate ground water and the erratic flow of most of the surface streams.

The ground-water picture is both bright and dismal. In much of western Kansas, the ample supply, which is conducive to present development, may face a long-term outlook of depletion owing to the lack of an adequate source of recharge.[28] However, use of ground water in Kansas during the past century has not reduced the amount of

28. Kansas Water Resources Board, 1960.

water in storage appreciably. Except in areas of heavy pumpage, the ground-water level today in much of Kansas is about at its average level for the past few decades. In the Wichita well-field area, the amount of ground water held in storage is about 15 million acre feet; the amount of reduction in storage from 1940 to 1962 has been about 90 thousand acre feet, or about 0.6 percent of the water in storage. The water level has recovered from declines suffered during drought. In a few local areas in western Kansas, the pumping of water for irrigation has lowered the water level. For example, in parts of Scott County the water level has been lowered as much as 15 feet since 1940, and in northwestern Grant County the water level has declined 40 feet in 2.7 square miles and 20 feet or more in 173 square miles since 1940 (V. C. Fishel, Chief Engineer, Cooperative U. S. Geol. Survey-Kansas Geol. Survey Ground-water Program, personal communication).

Although its availability to fulfill municipal and industrial uses appears unlimited at present, the ultimate economics of using this water for agriculture will become adverse. In southcentral Kansas and along the Kansas River valley, there appears to be significant opportunity for substantial ground-water development on a sustained management basis. Both agricultural and industrial development of ground-water supplies in these areas can be expected. The lack of sizable ground-water supplies in much of eastern Kansas also has a limiting effect on industrial development to the degree that substantial yields of constant temperature water, highly desirable from a cooling and processing viewpoint, cannot be obtained.

Because approximately 75 percent of the state's population resides in the eastern 40 percent of the state's land area, management and regulation of the relatively abundant, but very erratic, surface supply in eastern Kansas is most important.

Under unregulated conditions, the threat of flood limits agricultural productivity on many tributary streams, inhibits major irrigation investment along the few major stream valleys where access to adequate water supply might otherwise be possible, and poses a state-wide threat to all types of existing floodplain development. Moreover, all investment dependent on the continued availability of water faces periodic hardship.

The obstacles which an erratic, unregulated, surface supply presents to future industrial growth are many indeed. Despite the widespread installation of waste treatment facilities, the amount of residual, organic and inorganic wastes discharged into the streams causes concern during low-flow periods. On practically every stream, the amount of flow needed under present development to maintain desirable quality levels, exceeds the natural, unregulated, low streamflow. This imposes severe limitations on additional development. Some of the major industrial groups, especially the chemical industry, must often anticipate the availability of sufficient receiving capacity in the stream to dilute treated wastes. Many of the industries engaged in the processing of agricultural products have substantial waste loads for which dilution over and above treatment is desired. Alternate schemes for total disposal of wastes (*e. g.*, deep underground disposal) can be sufficiently expensive or impractical as to make prospective industries seek location elsewhere. Still other groups requiring large volumes of process water or cooling water are confronted by the need for special treatment of their water supplies or the problem of high summer temperatures of the streams. Finally, the lack of perennial streams and natural lakes limits the opportunity for water recreation—an increasingly important consideration in industrial plant location.

Most of the surface water problems just cited can be minimized with stream regulation via impounding structures. Advancements are now being made which will alter greatly this natural picture. However, until significant regulation is accomplished, the potential economic value of the surface-water resource available to Kansas cannot be realized.

Economic Significance

The economic importance of adequate water supply and control is hard to measure. Unlike some of the other minerals discussed herein, the economic value of water cannot be readily measured from a value added approach. We do know that problems of water excess and water deficiency have been damaging to the state's economy in the past. In a 1955 report, it was estimated that the average annual loss due to floods in Kansas was nearly $35 million measured in 1951 dollars.[29] Similar annual equivalents of economic loss due to water shortage, such as was experienced in the mid-thirties and mid-fifties, were estimated at $75 million for the 19-year period 1935-54. Such past effects on the then existing economy have served to focus attention on the problems of minimizing such losses. Although this is desirable and needed, an evaluation of the role of water within the frame-

29. *Water in Kansas*, A report to the Kansas State Legislature, as directed by the Kansas State Finance Council (1955).

work of the Kansas economy should emphasize what can be gained by putting the resource to work.

Water's role in the agricultural sector of the Kansas economy should not be omitted. Studies have suggested that each inch of state-wide average rainfall (within the usual range of precipitation experience) is worth about $20 million in cash farm receipts.[30] Even more striking is the suggestion that if evapo-transpiration losses could be reduced 5 percent over the cultivated acreage of western Kansas (about 15,000,000 acres) and 100 percent of the water so saved made available to the crops, over-all crop production values could be increased as much as $60 million.[31] Neither refined weather control nor artificially regulated evapo-transpiration is to be anticipated in the immediate future. Water will, however, play an increasing role in Kansas agriculture via irrigation. It is estimated that irrigated acreage in Kansas, which now approximates 1,000,000 acres, will increase to 2 million acres by the 1975-80 period.[32] Most of this growth will be in the western half of the state through individual farm investment.[33] It is normally assumed that gross crop value per acre must increase about three times to make irrigation pay. This reflects the added cost of machinery, labor, water, and management, all of which accompany irrigation operations. Farm management association reports in the western third of Kansas indicate that gross value of approximately $20 on dry land increases to approximately $60 on irrigated land. The $40 increment in gross crop value indicated above is probably larger elsewhere in the state. On this basis the addition of another million acres of irrigated land during the next 10 to 15 years could be expected to increase gross crop values at least $40 million. This, in turn, will be reflected in added retail trade and other community services. However, much of the true economic value resulting from such irrigation will lie in the stability introduced into the local economy of the communities involved.

Providing water for municipal and industrial consumption is already big business in Kansas. In 1960 there were 445 municipal water supplies in the state. Of these supplies 360 were obtained from wells, 66 from streams, and 19 from both wells and streams. The municipal use of water in 1960 was 197 million gallons per day, of which 115.9 million was ground water and 81.1 million surface water. Industry used 169.9 million gallons per day, of which 110 million was ground water. In 1959, the total water bill (household, commercial, and industrial) exceeded $17 million.[34] This does not account for the water used by industries maintaining their own source of supply, nor for much of the water used solely for cooling purposes. Current water bills, however, do not measure water's contribution to the municipal and industrial economy. The critical question here focuses on a much broader inquiry into the political economy of the state and involves matters of over-all water resources development. As explained earlier, nature's inability to provide adequate sustaining flows in the state's major water arteries acts as a deterrent to economic growth. The more sustained flows necessary to assure adequate quantities and, probably more important in the industrial field, to accommodate the treated wastes of new urban and industrial growth can be obtained by the creation of sizable reservoir impoundments. Preliminary studies based on the assumption that water alone will become the limiting factor (a more realistic assumption is that water is only one of several key factors) have suggested that a political policy of water storage development will help to insure the establishment of a potential for producing incomes of the order of magnitude of several hundred millions of dollars, present value.[35] To realize such benefits, however, numerous financial and related political questions will have to be resolved. Two things do seem most clear. If adequate storage of excess surface waters is not provided for subsequent release and use in times of water deficiency, the potential economic value of the surface-water resource in Kansas cannot be realized. Second, if such storage is to be provided, Kansas must start now to prepare for means of financing and implementing such development.

Water recreation to date has had but a limited impact on the Kansas economy. It is estimated that in addition to the rivers, there are presently available about 150,000 acres of normal water surface area (more in flood period, less in drought years) which is subdivided approximately as follows: 27,000 in federal multi-purpose reservoirs, 6,000 in state fish and game lakes, 18,000 in state

30. *Water in Kansas*, 1955.

31. Water Resources Board, 1960.

32. Water Resources Board, 1960.

33. Limitations of water availability alone will preclude ultimate development of the 14,000,000 acres which are estimated to be potentially irrigable. Moreover, the estimates cited make no allowance for current programs of land retirement, etc.

34. "Municipal Utility Business is Big Business in Kansas," *Kansas Government Journal*, May, 1960, p. 236.

35. Charles Staley, *Municipal and Industrial Water Requirements of the Kansas River Basin*, Center for Research in Business, University of Kansas (Lawrence, Kansas, 1960).

fish and wildlife refuges, 9,000 in city and county lakes, and 90,000 in small private agricultural impoundments. This current status is changing very rapidly. It is conceivable that the total impounded water surface area will double by 1970. Moreover, most of the increase will be in large water areas (excess of 1,000 acres) of the type that are attracting the large visitor-day use activity.

There is no question that Kansans are seeking added water recreation outlets or that they are making appreciable expenditures for such activity elsewhere. The degree to which availability of a number of sizable water areas will induce added economic growth is not easily ascertained; however, an indication that this phase of water use can be economically important is suggested by the following information:

Visitor-day attendance at the seven major reservoirs in Kansas was approximately 1.4 million in 1960. Preliminary computer studies undertaken by the Water Resources Board and the State Highway Commission, in which allowance was made for conflicting "market areas" of projects within and without Kansas, suggest that the 1970 attendance in Kansas will be at least 6 million visitor-days. This estimate makes no allowance for such factors as potential increase in leisure time or improved transportation facilities. Moreover, it assumes no growth in the relative intensity of recreational activity. Data submitted to the Outdoor Recreation Resources Review Commission [36] indicate that the average visitor-day expenditures for visits to such reservoirs is $5.25. Such costs include gas, food, and all other expenditures associated with the visit. If reasonable allowance is added for reusable equipment (depreciation of capital purchases) such as autos, boats, etc., the estimate becomes $9.75. Similar values for state parks, which in the national study had the highest percentage of day use (no lodging expenses), were $4.50 and $8 respectively. Accordingly, annual water-related recreational expenditures for major reservoir usage might well be in the range from $25 to $50 million by 1970, depending on the allowance made for major equipment items.

The retail trade associated with this expenditure will not be confined to the reservoir areas. The ORRRC studies indicate that much of the expenditure originates in the user's home community. Because the studies include such items as food and transportation, and since the recreationist might exercise other options if the opportunity for water recreation were lacking, it does not appear that all such expenditures should be considered as an addition to the gross product. However, this growing recreational picture should offer an added element of stability to the retail community of a rather widespread area.

The exact value that water adds to the economy is difficult if not impossible to measure. Its effect is far too subtle to allow such appraisal, for as the air we breathe it becomes an integral part of every facet of our daily lives. Any appraisal of its future effect on the Kansas economy should not be limited to minimizing the adversity it has caused in the past. Attention must be focused also on how water can be used for new economic growth. Each of the general use areas cited above is capable of generating economic activity approaching, and in some ways far exceeding, the dollar volume previously sustained in flood losses. In total, the economic gains that can be realized from the beneficial uses of water may well represent the most important objectives to be sought in the over-all minerals sector.

Related Considerations

No summary on the relative role of water in the Kansas economy would be complete without indicating some of the basic policies that create a favorable water environment. These include development of an adequate body of knowledge on the subject, maintenance of a favorable regulatory environment, resolution of intergovernmental responsibilities, and establishing a basis for dovetailing water considerations with other resource factors that influence the economy.

Kansas can be proud that the state has developed a vast amount of knowledge about the nature and location of its waters. Historically, Kansas has been a leader in the acquisition of certain basic hydrologic data. During the past several years it has greatly accelerated its efforts in this field, and now the state is in a position to provide prospective industries and other water users a good appraisal of the potential water supply available. The continuing planning program of the Water Resources Board should assure reasonable progress in keeping pace with applied questions of water management and water utilization. However, as use increases, the need for refinement in our knowledge of the physical relations will likewise increase. Much remains to be done in exploring management possibilities in ground water, alternate methods of reservoir operation, the control of natural pollution, and the efficiency of water use both agriculturally and industrially.

36. Marion Clawson, "Private and Public Provision of Outdoor Recreation Opportunities," p. 86, in *Economic Studies of Outdoor Recreation*, ORRRC Study Report 24, Washington, 1962.

The regulatory water climate in Kansas appears to be based on sound principles. The right to use water is a most complex subject. Under unregulated conditions, the question becomes of extreme importance in some states, for during periods of water shortage, competition becomes intense. Investment contingent upon the availability of a continued supply of good-quality water cannot afford the risk of subsequent new developments usurping or impairing present supplies. In recognition of this problem, Kansas laws now provide adequate authority to abate pollution and they dedicate the waters of the state to the public, subject to control and regulation by the state. In implementing the latter general policy, the statutes set forth procedures to be followed in acquiring water rights and for carrying out the state administration of such rights. These state laws pertaining to regulation of water quality and to the kind and amount of water use are important—not only from the standpoint of protecting present users, but also from the assurance they give new investments. Although continuing evolution of these laws is to be expected, the basic pattern now established appears compatible with the hydrologic problems in Kansas.

The migratory nature of water automatically leads to many intergovernmental considerations—intrastate, interstate, and state-federal. Interstate problems are concerned primarily with the relative allocation of water between states. Compacts have been attained with Colorado on the Arkansas River and with Nebraska and Colorado on the Republican River. Kansas and Oklahoma are currently attempting to negotiate a compact covering all streams on the border common to the two states, and negotiations have been initiated with Nebraska concerning waters of the Big Blue River basin. Completion of these two compacts would go a long way toward removing potential legal conflicts of an interstate nature and would clear the route for more firm appraisal of the water that will be available to Kansas in the future.

Local-state and state-federal relationships are not as easily defined. The federal government is the major investor in water resources development in Kansas and the nation. The federal effort is often undertaken in co-operation with local units of government. Prior analysis by the Water Resources Board of the development programs in Kansas indicates that much of the surface-water regulation necessary to alleviate the flood threat in rural tributary areas, and to develop the waters for beneficial use will not be achieved in the continued absence of state participation in certain of these development programs.[37] The Board has submitted recommendations for state participation in these development programs and these recommendations are currently before the Legislative Council. The question posed is most pertinent to the economic considerations outlined above. It seems most doubtful that individual local units can undertake major resource development projects or that the individual local efforts will result in comprehensive integrated development of the resource. If the task is left to the federal government by default, as it were, Kansans will have to recognize that the subsequent management and operation of much of its water resource would be subject to out-state as well as in-state needs. The state is not so endowed that it should relinquish any of its water to management needs elsewhere. Resolution of the intergovernmental development policies appears most desirable from the standpoint of economic development in Kansas.

One final point should be made. The optional uses of water are many. Even within a given category, for example industrial use, the individual water needs vary appreciably. Within the development and regulatory structure of water some broad economic guides are necessary if optimum use of the resource is to be achieved. Water planning could be improved materially if there were firm data to indicate what type of industry is most likely to develop in any selected sub-area of the state. Economic base projections which weigh all resource considerations, population, minerals, water, labor, capital, markets, etc., would give a basis for concentrating on that type of water use pattern which could reasonably be expected to lead to the greatest social and economic benefit to the state.

METALLIC MINERALS

The metallic mineral industry is distinctly different from the industries that produce nonmetallic commodities and liquid and gaseous hydrocarbons. Apart from the obvious fact that the ores yield metals, the industry is characterized by higher unit value of the commodity, extensive milling and separation processes, and much larger capital investment at a fixed location. The product is shipped long distances, and mills may be located close to fluxing materials or fuel and centers of fabrication or metallurgical processing. Reserves in many cases are not unlimited and technological advances play an important role because a mill may

37. Kansas Water Resources Board, 1960.

have to adapt to handle low-grade or disseminated ores after initial production of high-grade ores. In general, exploration techniques must be much more sophisticated than those used for many nonmetallic minerals. Many metallic minerals play an important part in national defense and are classified as *strategic;* accordingly, their production and price is much more responsive to national policy. Since the United States is not self-sufficient in many metallic minerals, these minerals are significant in international relations and are sensitive to import and export duties.

Kansas is not now a large producer of metallic minerals, but it has produced lead and zinc in quantity and once had a flourishing but now floundering metals mining industry.[38] Although it is almost certain that there can be no return to the bonanza days of the past because of exhaustion of known superior mineable ores and because of associated economic factors, the lead-zinc mining industry in Kansas should be reviewed because of its impact on the Kansas economy in the past, and should be evaluated with respect to future economic growth.

Lead and Zinc

The lead and zinc deposits of Kansas occur in what is called the Tri-State mining district, which encompasses an area of about 2,000 square miles in southeastern Kansas, southwestern Missouri, and northeastern Oklahoma (Fig. 32).[39] The lead and zinc ores occur in Mississippian limestone, which has been extensively fractured in places. Depth from the surface to the ore zones in the Kansas section of the district is generally from 150 to 400 feet. The Mississippian rocks are exposed at the surface in the southeastern corner of Cherokee County in extreme southeastern Kansas, but dip northwestward so that ore is found at progressively greater depths toward the west.[40]

The principal ore metals are sphalerite (zinc sulfide), which is commonly brown to black and has a resinous luster, and galena (lead sulfide), a steel-gray metallic mineral, which is found in cube-shaped crystals. Other ore minerals are associated with the lead and zinc; these include iron sulfides, copper-iron sulfides, and cadmium sulfide. Generally, these sulfide minerals are associated with a siliceous material called chert or chat. The ore bodies are irregular in shape but tend to have rather large horizontal dimensions and, for the most part, are restricted to places where the rocks are fractured. The minerals probably were deposited from mineral-bearing solutions that found a favorable environment for deposition in the open spaces of the fractured rocks.

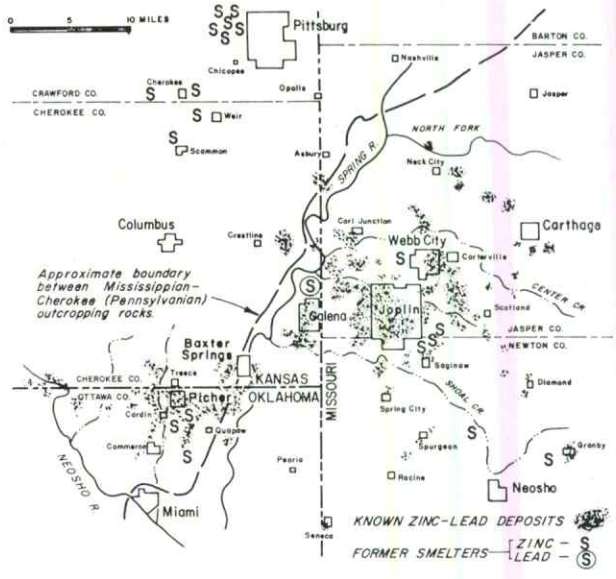

FIG. 32.—Map showing Tri-State Zinc-Lead Mining District in Kansas, Missouri, and Oklahoma. (Source: Kansas Geological Survey files; and A. J. Martin, *Summarized Statistics of Production of Lead and Zinc in the Tri-State (Missouri-Kansas-Oklahoma) Mining District*, United States Bureau of Mines Information Circular 7383, November, 1946.)

Although lead and zinc are the principal products of the Tri-State district, some copper has been produced in the past and the district is an important source of cadmium and germanium, which have been produced as by-products. The ore currently produced from the district averages about 2.0 percent zinc and about 0.6 percent lead; this is a very low-grade ore if compared with 4.7 percent zinc and 2.75 percent lead ore produced in the western United States and 11.2 percent zinc and 12.6 percent lead ore produced in Australia.[41]

Lead is used for manufacture of storage batteries, cable covering, paint pigments, and various alloys. Zinc is widely used for corrosion control through galvanizing, for alloying with copper, for die castings, for pigments and for many other purposes. Cadmium, used widely in low-melting alloys and in pigments, has become an important element in solid-state physics applications. The Tri-State dis-

38. A. J. Martin, *Summarized Statistics of Production of Lead and Zinc in the Tri-State (Missouri-Kansas-Oklahoma) Mining District*, United States Bureau of Mines Information Circular 7383, November 1946, pp. 1-67.

39. Allison Hornbaker, "Zinc and Lead Production in the Kansas Section of the Tri-State Mining District," *Kansas Engineering Society Bulletin*, 1952, pp. 3-5.

40. John M. Jewett and W. H. Schoewe, with chapters by R. M. Dreyer, John C. Frye, R. P. Keroher, E. D. Kinney, Norman Plummer, and John Romary, *Kansas Mineral Resources for Wartime Industries*, Kansas Geological Survey Bulletin 41 Part 3, 1942, pp. 113-117.

41. United States Bureau of Mines, *Minerals Yearbook, 1960*, Vol. I.

trict is a major domestic source of germanium, which has been called a cinderella metal. It is used as a semi-conductor component for electronic devices, especially transistors. Chat, which has been produced in great quantity as waste, has been utilized for railroad ballast, concrete aggregate, and roofing granules.

Ore in the Tri-State district is produced by underground room and pillar method using large scale mechanical equipment. Concentration of the ore is accomplished by crushing and grinding followed by gravity or flotation separation. The lead and zinc concentrates produced by the milling operation are delivered to smelters for ultimate recovery. Until recently much of the lead concentrate has been treated at a smelter in Galena, Kansas; the zinc ore is smelted in Oklahoma, Arkansas, or eastern states.

The "chat mountains" that dominate the Galena-Baxter Springs-Treece area of extreme southeastern Kansas exemplify more than a change in landscape resulting from nine decades of zinc and lead mining in this corner of the state. They are the visible evidence of what was once considered one of the world's richest mining areas.

The exact dates of discoveries of zinc and lead ores in Kansas are vague. B. F. Mudge and G. C. Swallow, in the annual reports of the first and second geological surveys, mentioned evidence of lead mining near Pleasanton, in Linn County, sometime before Kansas became a state (probably in the early 1840's).[42]

The dramatic lead and zinc story of Kansas began in Cherokee County with discovery and development in the 1870's.[43] Lead had been mined and smelted at Joplin in Jasper County in the Missouri part of the Tri-State district prior to 1870, and the mining operations were important to both sides during the Civil War. Immediately following the Civil War, these operations nearly ceased, and it was not until the rediscovery of lead at Joplin in 1871 that the mining fever started anew. Mines were opened in Webb City, Missouri, in 1875, and in 1876 a well digger found rich ore on Short Creek in Cherokee County, Kansas, about 10 miles west of Joplin. As soon as the news spread, companies were formed and serious prospecting got underway.[44] In the spring of 1877, almost pure lead that produced several hundred dollars worth of metal was discovered in Short Creek Valley near Bonanza (the name given to the first Kansas lead mine). In the excitement that followed this discovery, many shafts were sunk and large quantities of ore were found near the surface. Within three months, from 12,000 to 15,000 persons had camped near the site and before the year was over Galena and Empire City, on the south and north sides of Short Creek respectively, not only had been laid out as town sites but had become incorporated cities. The economy of the towns was entirely lead-oriented, but the surrounding agricultural area found a ready market for its produce. From this time on, through the 1880's, 1890's, the 1900's until well into the 1920's, mines and mills in the Galena area multiplied, extending west to Baxter Springs and Treece, and the chat piles grew into 100- and 150-foot high mountains.

Zinc ore, which had been discovered near Galena as early as 1870, was at first considered not so valuable as lead and therefore the development was somewhat delayed. Zinc ore, however, was soon to become the more valuable and in 1873 a small zinc smelter was started at Weir City, where newly-discovered coal deposits were used as fuel; ore was hauled to the smelter by wagon. This was the beginning of the smelting industry in this section of the state, one of the first, as well as one of the most important, manufacturing industries in Kansas history.[45] Proximity to the southeastern Kansas coal fields and the coming of the railroad were decisive factors in this development—in fact, factors that made development possible. Before the 1870's were over, Pittsburg had become a smelter city, and by the 1890's Pittsburg was known as the world's greatest zinc-smelting town, Weir City was a close follower, and the towns of Girard, Scammon, and Galena were not far behind.[46] At this time only Illinois had a comparable zinc smelting industry. It was not until the late 1890's that much outside capital was brought into the development of the Kansas section of the zinc-lead area, perhaps from fear that the deposits would not last long enough to make investments pay. Prices of zinc from the area finally attracted eastern capital, and before 1900 a great influx of capital brought exploitation of the whole district. Much of the extension was speculative and with the development of new mines in Missouri, the area declined

42. B. F. Mudge, *First Annual Report on the Geology of Kansas* (for 1864), 1866, pp. 30-31; G. C. Swallow, *Preliminary Report on the Geological Survey of Kansas*, 1866, pp. 58, 111.

43. Erasmus Haworth, W. R. Crane, A. F. Rogers, *Special Report on Lead and Zinc*, The University Geological Survey of Kansas, Vol. VIII, 1904, pp. 21-33.

44. Irene G. Stone, "The Lead and Zinc Field of Kansas," *Kansas Historical Collections*, Vol. VII, 1901-1902, pp. 243-260.

45. Richard L. Douglas, "A History of Manufactures in the Kansas District," *Kansas Historical Collections*, Vol. XI, 1909-1910, pp. 165-175.

46. *Mineral Resources of Kansas*, anonymous 23-page pamphlet; contains mineral statistical data (credited) for 1890's.

during the period from 1905 to 1915. It was the next 10 years that brought a remarkable increase (Fig. 33). Before the first decade of the 20th

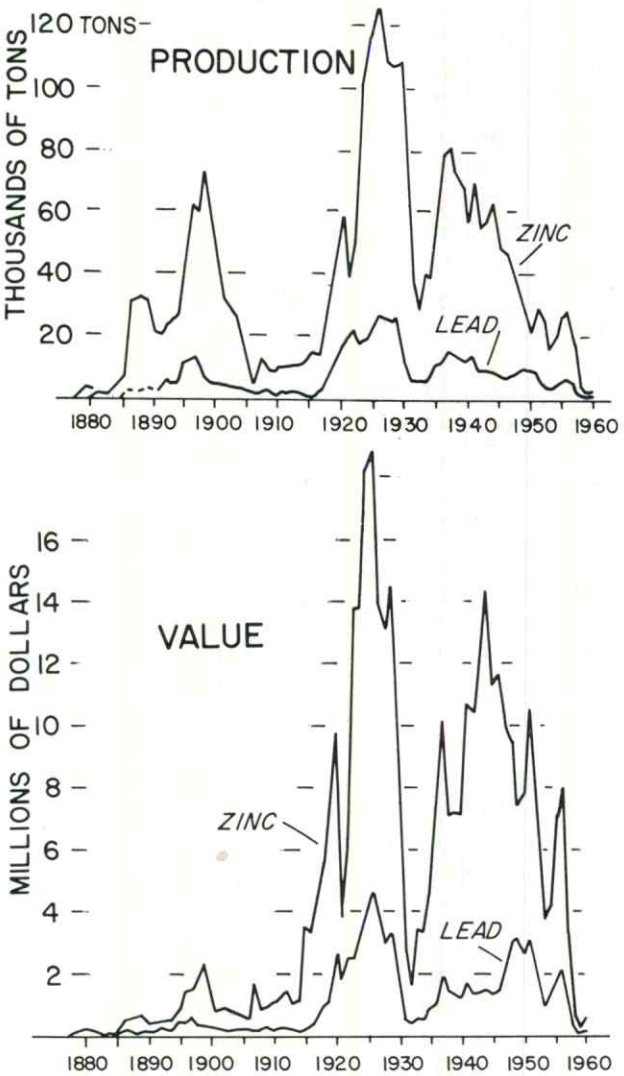

FIG. 33.—Production and value of lead and zinc in Kansas, 1877-1960. (Modified from Walter H. Schoewe, "Geography in Kansas, Part IV, Economic Geography: Mineral Resources," *Transactions of the Kansas Academy of Science*, Vol. 61, No. 4, 1958, pp. 422-423; and Kansas Geological Survey annual reports on the Kansas mineral industry.)

century was completed, all of the Kansas-Oklahoma zinc output was smelted in the area, and the smelters in the two states were producing two-thirds of the country's smelted zinc.

Coincident with the zinc and lead developments around 1900 was the emergence of the nearby gas belt to the west.[47] The attractiveness of the cheap natural gas fuel was a blow to coal—and to the smelting industry of Pittsburg. Beginning in 1896, work was begun on the first gas smelter at Iola, Allen County, and the smelting industry began to move into the gas belt. At first the center was Iola and the nearby towns of Gas City and La Harpe, then Cherryvale in Montgomery County and finally more southern towns, culminating in three large smelters across the Kansas line in Bartlesville, Oklahoma. In 1900 the coal smelters of Pittsburg had practically suspended operation. At this time, small companies were consolidated to cut administrative expenses, and competition increased between stronger and more aggressive companies. Consolidation of Kansas companies around 1900 kept practically the whole smelting activities of the country in the hands of seven large companies, which probably smelted four-fifths of the zinc produced in the United States.

Two other notable developments in the early 1900 period include the erection of the first zinc rolling mill west of the Mississippi River, at the Lanyon Zinc Company at La Harpe; and the equipping of the first smelter west of the Mississippi River for the recovery of sulfuric acid for the United Zinc and Chemical Company at Iola.[48] As early as 1905, a growing difficulty in obtaining natural gas in the northern end of the gas belt began lessening the advantage of natural gas over coal as a smelter fuel in that area. Hence, in 1907 two large smelters were erected at Caney and Deering, Montgomery County, near the Oklahoma line. But even this far south the advantages of natural gas as a fuel were passing, and some attempt was made to reopen old Pittsburg smelters. The outcome of this movement can be projected to the mid 1920's, about the time Kansas production of zinc and lead ores reached a peak, when only two smelters were operating in Kansas, one at Cherryvale and the other at Caney.[49] At this time, unfortunately, much of the locally-mined ore was being sent outside the state for smelting. The Eagle-Picher Smelter at Galena, currently the only primary smelter on Kansas soil, manufactures pigments and sulfuric acid; the Ozark Smelting and Mining Company at Coffeyville, Montgomery County, produces lead and zinc oxide for paint pigment and is closely associated with the zinc and lead industry.[50]

The production of zinc and lead in Kansas reached a peak in 1926—126,307 tons of zinc ore valued at $18,946,050 and 28,463 tons of lead ore valued at $4,554,080 (Fig. 33). Although there-

47. Erasmus Haworth, *Mineral Resources of Kansas* for *1897*, pp. 17-35; *for 1898*, pp. 19-40; *for 1899*, pp. 18-34; *for 1900-1901*, pp. 13-28; *for 1902*, pp. 21-31; *for 1903*, pp. 11-21; The University Geological Survey of Kansas Annual Bulletins, 1897-1903.

48. Douglas, p. 170.

49. Raymond C. Moore and Kenneth K. Landes, *Underground Resources of Kansas*, Kansas Geological Survey Bulletin 13, 1927, pp. 55-60.

50. United States Bureau of Mines, *Minerals Yearbook, 1960*, Area Reports, Vol. III, p. 418.

after the trend moved generally downward, it may be said that the industry survived the depression years in the 1930's as well as any other industry. At the beginning of World War II, the Tri-State district still held a number one position among the country's zinc-producing districts and was the third largest lead-producing district.[51] Kansas was contributing its share to the district's output. Problems of production were becoming apparent, nonetheless, and exhaustion of high-grade ores was reason enough to hope for government subsidies to enable development of lower-grade ores in the 1940's. Technological advances in production and research directed toward possible discovery of new ores also were prompted by the industry's growing difficulties. Nevertheless, the industry began to weaken as reserves of high-grade ore became scarce and even the stimulus of World War II did not halt this decline (Figs. 34 and 35, Table 40). The pumping and control of water have been problems of zinc and lead mining in the Tri-State area. The volume of water that must be pumped in some places is large and the cost is high. Where mines have to close during periods of unfavorable prices, the expense of dewatering a field becomes almost prohibitive. Some operators have attempted to keep going by selective mining, a practice which predicates a serious loss of lower-grade ore reserves in order to save the higher-grade ore.

However, the problems of the lead-zinc industry in Kansas during the period from the beginning of World War II until 1950 were not just a matter of declining reserves, for the industry-wide pattern is similar, as shown for the nation, the Tri-State district, and Kansas in Table 41 and Figures 36 and 37. United States lead production dropped 14 percent in 1946 despite an advance in price to an unprecedented 12.55 cents per pound at the year's end. Among the factors that restricted production were prolonged labor strikes at mines, mills, smelters, and refineries; continued labor shortages; unstable price structure during a period of uncertainty

51. *Kansas Mineral Resources for Wartime Industries*, p. 114.

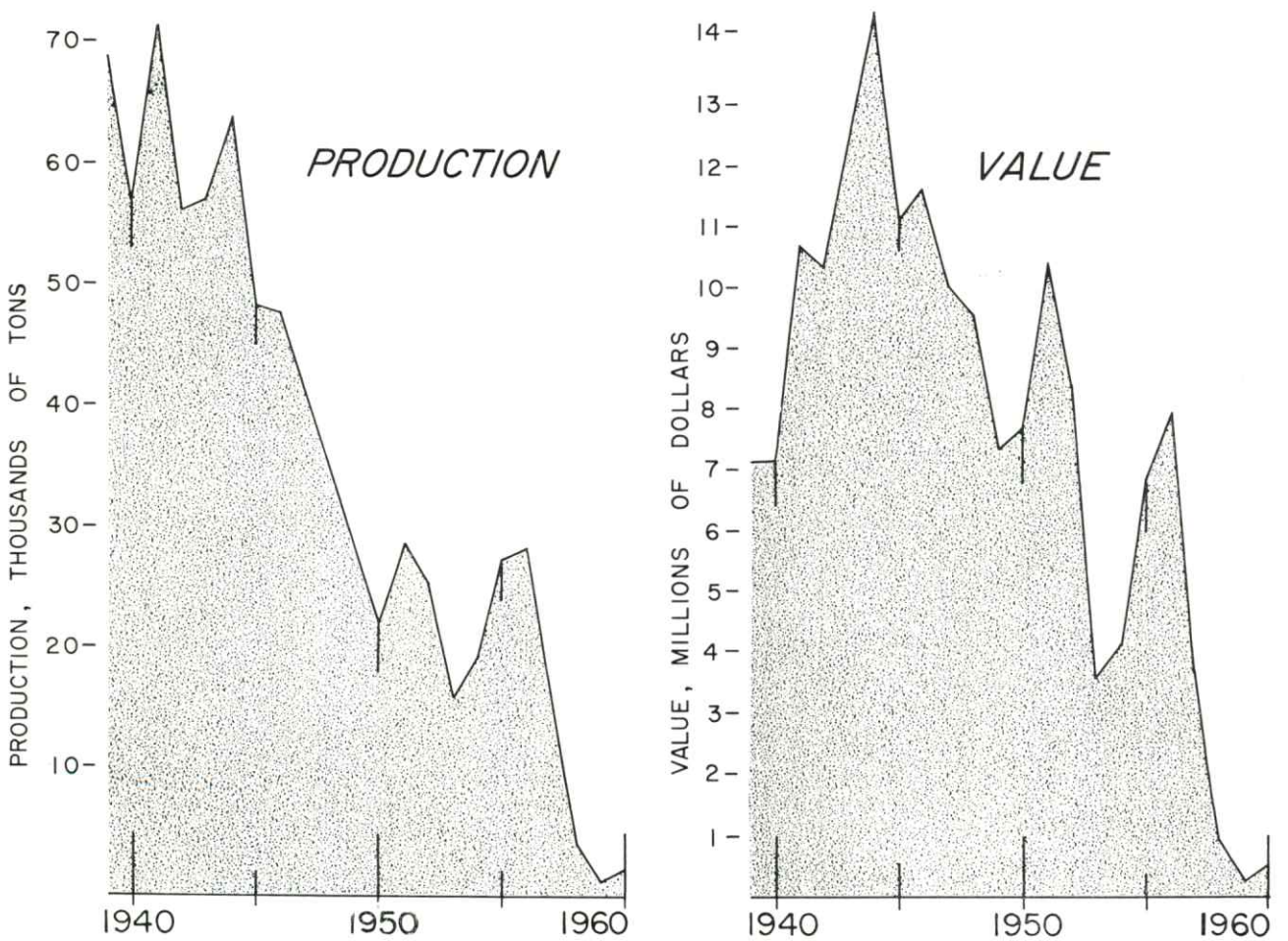

FIG. 34.—Zinc production and value in Kansas, 1939-1960. (Table 40.)

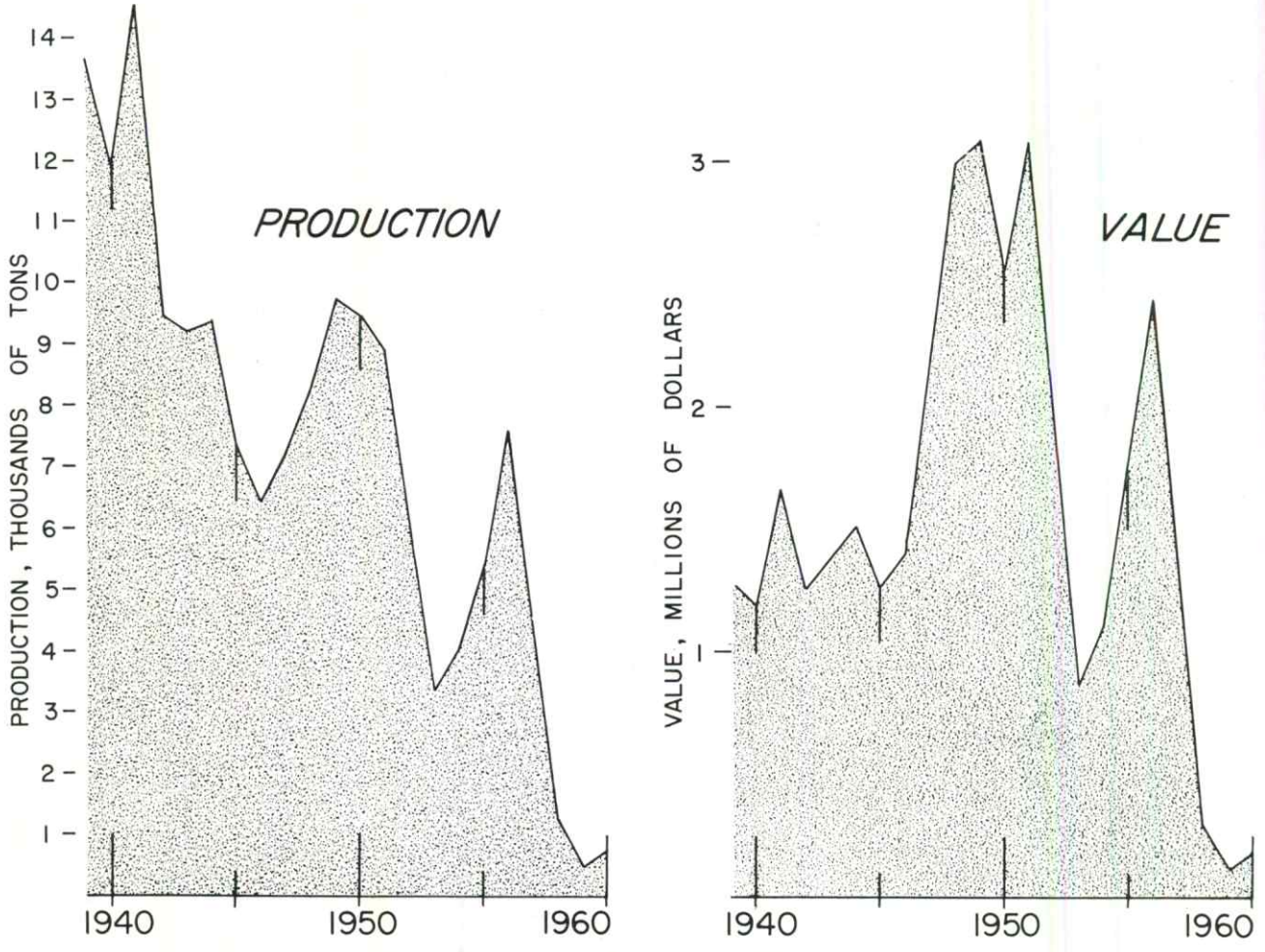

FIG. 35.—Lead production and value in Kansas, 1939-1960. (Table 40.)

regarding extension of the Office of Price Administration; and railroad and coal-mine strikes. Following this period, production of lead and zinc again rose for the nation, to meet consumer demand and requirements of the government for strategic stockpile. Production from Kansas and the Tri-State district continued to decline. After a brief national decline in 1949, production everywhere rose with the outbreak of the war in Korea as consumers recalled the shortages of World War II and paid premium prices (17 cents per pound for lead and 17.5 cents per pound for slab zinc in 1950). Following Korea, production again declined and then rose to a peak in 1955 along with the general business climate. The subsequent history of the industry is one of weak prices, the competition of foreign imports, and government subsidy.

It should be noted that the Tri-State district as a whole presents a more drastic decline for the period than does Kansas. This can be partially explained by the mined-out area in Missouri, which was the first part of the Tri-State to develop a century ago. By 1960 only Kansas and Oklahoma had recorded production.[52] In comparing zinc and lead production in Kansas with neighboring states (Table 42), it will be noted that Missouri far outranks Kansas; this is not because of the Tri-State district but because of the lead-producing area in southeastern Missouri, an area that for more than 50 years has been the number one lead-producing district in the country.[53]

Before World War II, the United States was the world's leading producer and consumer of lead and zinc. But beginning in 1940 and continuing thereafter, the United States has depended upon imports for a goodly portion of its needs (Table 43) and exports have become unimportant (Table 44).

In the 1950's other countries, notedly Australia, Russia, Canada, and Mexico, increased lead and zinc production (Table 45) to the point where

52. *Minerals Yearbook, 1960*, Vol. III, pp. 817-818.
53. *Minerals Yearbook, 1960*, Vol. I, p. 674.

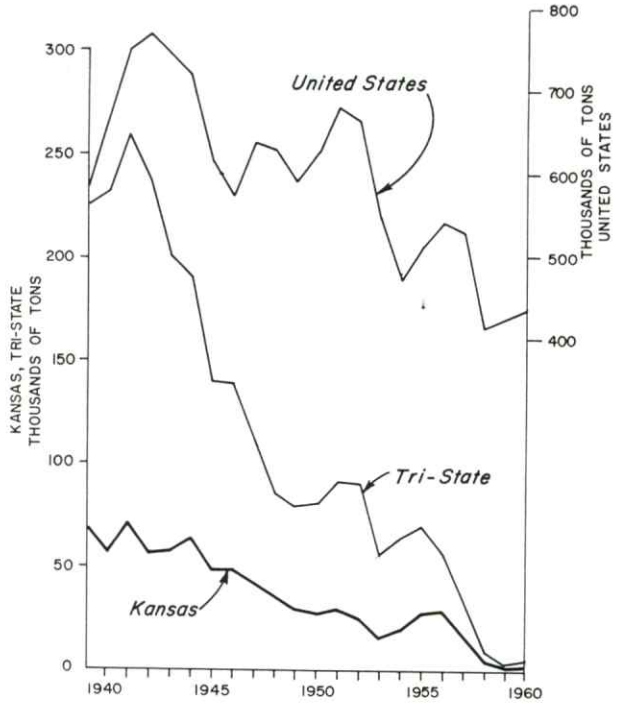

FIG. 36.—Zinc production in the United States, the Tri-State District, and Kansas, 1939-1960. (Table 41.)

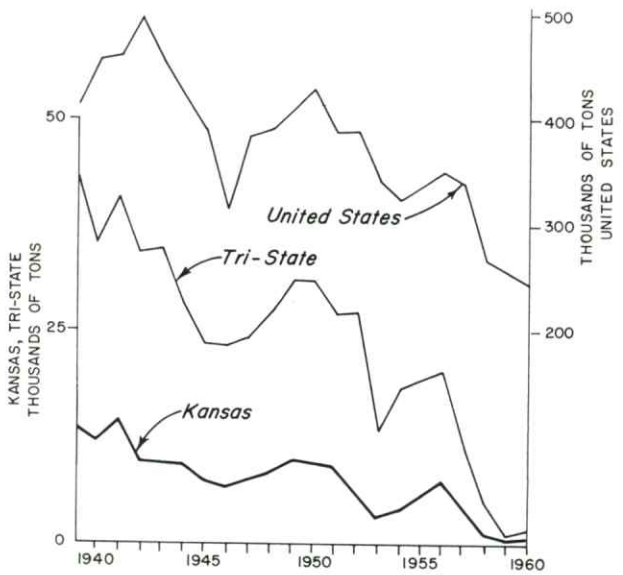

FIG. 37.—Lead production in the United States, the Tri-State District, and Kansas, 1939-1960. (Table 41.)

import quotas and government subsidy became a necessity to protect the domestic industry. In 1957, for example, Australia moved ahead of the United States to first place as a producer of lead, and in 1958 Russia pushed into second place, leaving the United States in third place; these positions were maintained in 1959 and in 1960. In 1958, Canada nudged the United States into second place as a zinc producer; and, although the United States recaptured the first place position in 1959 and has managed to hold it through 1960, the foreign pressures on United States production seem obvious. It can be further noted that European production has surpassed the United States in the production of lead in 1957, 1958, 1959, and 1960 and in zinc in 1958, 1959, and 1960.

Reserves of zinc are about equally divided between the eastern and western hemispheres and about two-thirds of the lead reserves are in the eastern hemisphere.[54] In view of the combination of the large reserves of high-grade ores and low labor cost and efficient plant operation in foreign countries, it is unlikely that the United States will return to self-sufficiency. As it is, about one-third of the United States production of these metals is secondary production from scrap.

Low prices and the competition of foreign imports have served to accelerate the decline of Kansas and Tri-State production already destined by vanishing high-grade reserves.

A bill before Congress (HR 84, introduced January 3, 1961, and reported with an amendment August 12, 1961) is an attempt to stabilize the mining of lead and zinc by small producers on public, Indian, and other lands. As reported, the bill would direct payments to small producers (a small producer is defined as a person or firm who has not produced or sold ore concentrates, the recoverable content of which is more than 3,000 tons of zinc and lead combined, during any 12-month period between January 1, 1956, and the first day of the period for which he seeks payments under the act). As long as the market price for common lead at New York and the market price for prime western zinc at East St. Louis, Illinois, is below 14½ cents a pound, the payment on lead is to be 75 percent of the difference between 14½ cents per pound and the average market price for the month in which the sale occurred; while the payment for zinc is to be 55 percent of the difference between 14½ cents per pound and the average market price for the month in which the sale occurred. The bill, containing numerous stipulations and restrictions, points out that the maximum amount of payments to be paid during the year 1962 should not exceed 4½ million dollars; during 1963, 4½ million dollars; during 1964, 4 million dollars; during 1965, 3½ million dollars. Some of the stipulations are vague and many producers operating on a marginal basis

54. United States Bureau of Mines, *Mineral Facts and Problems*, Bulletin 585, 1960, p. 436, p. 975.

still do not come under the small producer classification and could not benefit from the measure.

Table 46 and Figure 38 show employment and wages for the zinc and lead industry in Kansas,

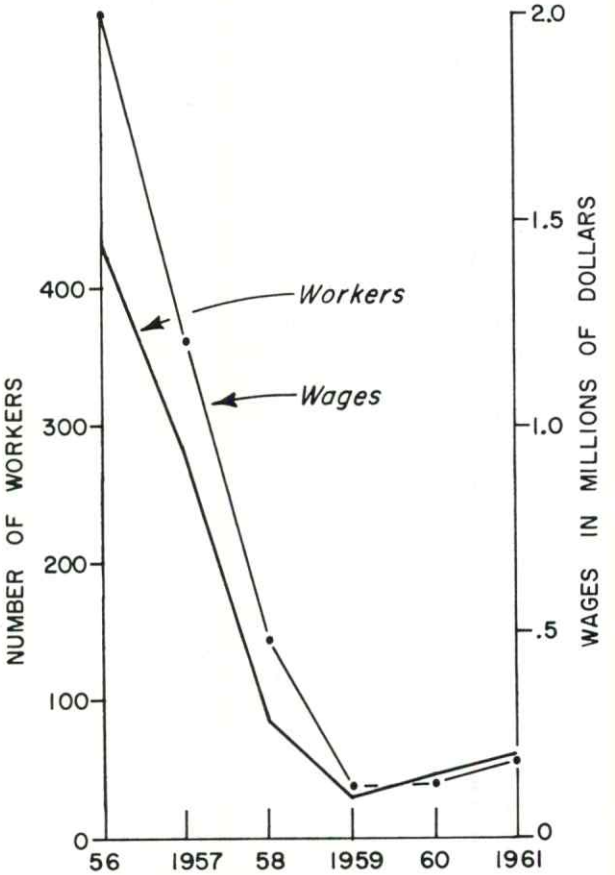

FIG. 38.—Employment and wages in the lead-zinc industry in Kansas, 1956-1961. (Table 45.)

1956 through 1961, and suggest further that the industry is only now hanging on by a thread.

The future of the lead and zinc industry of Kansas is not bright and unless technological advance permits profitable mining of low-grade ore, the industry will vanish. Utilization of by-product cadmium and germanium can continue as chat tailings are reworked, and the chat itself has a market as an aggregate. Geological and geophysical exploration has not, thus far, disclosed new reserves of ore, but a stronger price structure could stimulate this kind of activity because there is no reason to discount the possibility of an important metallic mining industry in Kansas at other places. The very old Precambrian rocks, which everywhere underlie Kansas, are major sources of many different ore minerals throughout the world, and these rocks are within 600 feet of the surface at places in Kansas. Although extensive study of these rocks is now in progress,[55] large-scale geophysical exploration, including state-wide aeromagnetic surveys, will be necessary if new ore deposits are to be discovered.

NONMETALLIC MINERALS

Nonmetallic minerals constitute an increasingly important part of the mineral economy of Kansas. These are the minerals that generally constitute the raw materials for many chemical industries, for many kinds of construction and structural products, and for many of the very ordinary household commodities that one ordinarily takes for granted. Nonmetallic materials are scattered widely throughout Kansas.[56] For the most part, they are formed in place by processes of sedimentation or precipitation from solutions. Distribution of nonmetallic minerals has broad relationship to rock patterns, already illustrated in Figures 1 and 3 of this report; but production of these commodities usually is controlled by other factors. Nonmetallic minerals may be characterized by the following general qualities: (1) Usually, they have low unit value until they have undergone some primary processing. (2) Nonmetallic materials acquire the largest value increment through primary processing or manufacturing. (3) They are abundant in most places and are characterized by large reserves. (4) They are market oriented and their economic value is determined in large part by cost of transportation. (5) Economic activity in the nonmetallic field is usually closely related to the business cycle and population changes. Many of them are used for construction purposes. (6) Their use in many places is dependent upon availability of fuel and water for processing. (7) Use is characterized by close quality control and carefully defined specifications. (8) Marketability, in many cases, is dependent upon brand-name acceptance and consumer appeal.

The matter of reserves needs clarification. Kansas nonmetallic mineral reserves will be reported if they are known. In most cases, however, reserves will be classified as *unlimited, abundant,* and *scarce.* The known reserves of some mineral commodities are so vast and so wide-spread that they can be classified as *unlimited.* Their rate of exploitation is infinitesimally small compared to the known availability. Clay is an example of

55. D. F. Merriam, V. B. Cole, and W. W. Hambleton, "Distribution of Precambrian Basement Rock Types in Kansas," *Bulletin American Association Petroleum Geologists,* Vol. 45, No. 12, 1961, pp. 2018-2024.

56. Walter H. Schoewe, *The Mineral Industry in Kansas in 1960,* Kansas Geological Survey Bulletin 152 Part 3, 1961, pp. 54, 71-85.

such a commodity in Kansas. The availability of fuel and a ready market are virtually the only critical factors in establishing a brick plant in most parts of the state. The reserves are *abundant* if they are large enough to support a mineral industry indefinitely, but knowledge of their availability is limited. Exploitation of these minerals commonly adds to the total known reserves, and reserves may be increased by technological developments. The reserves of some mineral commodities are small (*scarce*), but they are valuable enough to be mined at relatively high expense. Most nonmetallic minerals in Kansas do not fall in this category. We find a seemingly incongruous situation in discussion of reserves. The mineral industry is a wasting industry, and reserves are depleted as the mineral commodity is produced; exploration and technological advance commonly add to reserves so that the reserve picture may remain static for many years.

In this section of the report, an attempt is made to characterize each of the principal nonmetallic mineral commodities in Kansas; to show location, distribution, thickness, quality, and reserves; and to show relation to other economic activity and other related commodities.

Salt

Salt, essentially sodium chloride, is so easily obtained on today's market that it is taken for granted. Reserves are seemingly inexhaustible, for not only do the oceans contain inconceivably large quantities of dissolved salt, but underground deposits throughout the world are sufficiently large to provide man's needs far into the future.[57] The United States alone, despite an annual consumption exceeding 24 million tons, has an almost inexhaustible supply, and Kansas, one of the seven leading salt-producing states, could be the sole supplier of salt for all needs in the United States for hundreds of years.

Salt, in its purer state, is about 39.3 percent sodium and about 60.7 percent chlorine, but it usually contains impurities such as magnesium and calcium sulfate. It is produced from natural salt deposits, from artificial brines formed by injecting fresh water into salt formations, and from natural brines.

In addition to its use in foods, salt has acquired so many thousands of additional uses in modern chemical-industrial-agricultural production that less than 3 pounds out of every 100 pounds of salt produced annually in the United States are for table use. More than 60 percent of the salt produced in the United States is utilized in the chemical industry, principally in chlorine-caustic soda ash production. Large quantities of salt are consumed in the processing of food by meat packing and canning industries, and for livestock use. Increasing amounts of salt are used on roads to melt ice and snow, in the regeneration of water softeners, and in the manufacture of textile dye, soap, pulp and paper, ceramics, rubber, and many other products.

Salt deposits in the United States have both wide geographic and geologic distribution. All the known deep salt deposits in Kansas are of Permian age. These Permian salt deposits occur in layers from a few inches to many feet thick and underlie a vast area in central and southwestern Kansas that extends from immediately west of Wichita and Salina and generally south of the northern tier of Kansas counties southwestward across the Oklahoma and Texas panhandles into New Mexico (Fig. 39). The deposits were formed by precipitation from a large inland sea. Reserves in the Kansas part of the section alone are unlimited and probably exceed 5 trillion tons.[58] Kansas salt beds occur at a range of depths below the surface; salt currently is being mined at a depth of about 650 feet at Hutchinson, about 850 feet at Kanopolis, and about 1,000 feet at Lyons.[59]

The Kansas salt industry began with the promoters and the prospectors, who went to central Kansas during the boom period of the 1880's for coal, oil, gas, or other valuable minerals.[60] Rock salt was found in abundance, but was scarcely recognized as a valuable mineral. The first salt plant was ready for operation near Hutchinson in 1888. Subsequently, rock salt was discovered in wells at Ellsworth, Lyons, Wellington, Great Bend, Kanopolis, Pratt, and other places and after the initial Hutchinson development, expansion and over-expansion came in rapid succession. By the close of 1888, Hutchinson alone had 12 salt factories, and salt works had become active in Anthony, Nickerson, Sterling, Wellington, and Great Bend, all producing salt by the brine-well process. By 1890 Kansas had

57. Bureau of Mines, *Mineral Facts and Problems*, 1960, Bull. 585, pp. 745-765.

58. *Kansas Mineral Resources for Wartime Industries*, pp. 149-153.

59. Robert Taft, "Kansas and The Nation's Salt," *Transactions of the Kansas Academy of Science*, Vol. 49, No. 3, 1946, p. 244.

60. Erasmus Haworth, M. Z. Kirk, "Salt," *Mineral Resources of Kansas*, 1898, The University Geological Survey of Kansas, pp. 67-123; Frank Vincent, "History of Salt Discovery and Production in Kansas, 1887-1915," *Kansas Historical Collections*, Vol. XIV, 1915-1918, pp. 358-378; Richard L. Douglas, "History of Manufactures in Kansas," *Kansas Historical Collections*, Vol. XI, 1909-1910, pp. 175-181; Robert Taft, "Kansas and the Nation's Salt," *Transactions of the Kansas Academy of Science*, Vol. 49, No. 3, 1946, pp. 223-272.

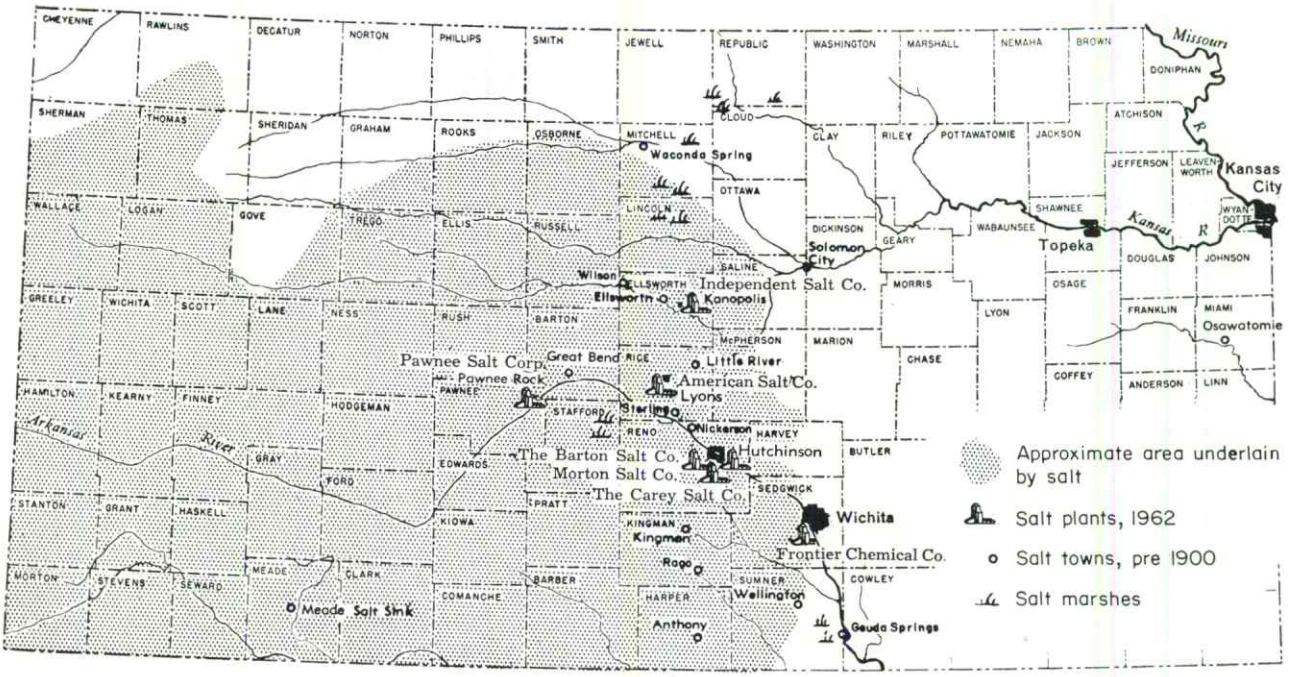

FIG. 39.—Approximate area in Kansas underlain by salt, salt plants, former salt towns, and marshes. (Source: Kansas Geological Survey file data; and Robert Taft, "Kansas and the Nation's Salt," *Transactions of the Kansas Academy of Science,* Vol. 49, No. 3, 1946.)

23 salt plants, and between 1887 and 1892 no fewer than 36 companies had been incorporated to manufacture salt. Kansas had more salt companies than were needed to supply the local market, and shipping costs at that time ruled out competition with salt produced east of the Mississippi River. Hutchinson became the leader of the Kansas salt industry, mainly because of the advantages of water supply, adequate rail transportation, and proximity to a marketing center.

The map shown in Figure 39 includes names and locations of currently operating salt plants and the Kansas area underlain by rock salt. Table 47 shows salt production and value for 10-year periods, from 1860 to 1960, and Figure 40 shows production and value from 1939 to 1960.

The Kansas salt industry by 1939 already had behind it 50 years of highly competitive operation on a narrow profit margin. Even as late as 1923, the price war between Kansas rock salt producers had brought the price of rock salt to an incredible low of 55 cents per ton.[61] Salt produced in Kansas throughout this period, however, was a significant part of the nation's total salt production, having risen on occasion to as much as 10 percent of the total, and the state maintained a rank of 3 or 4 among the salt-producing states. Furthermore, before Kansas became a major salt-producing state, the United States imported more than half as much salt as was produced in the country; within 5 years after salt beds in Kansas were mined, imports of salt dropped to one-seventh of the United States production.[62]

By 1939 and 1940, the Kansas salt industry seemingly had stabilized and had weathered the effects of the depression. Kansas had established an out-of-state market based on favorable rail rates that resulted in a virtual monopoly not only over Kansas but also in southern Nebraska, western Missouri, eastern Colorado, and northern Oklahoma. Furthermore, favorable conditions had been created for competition with other salt-producing areas for markets in Nebraska, Missouri, Colorado, Oklahoma, Iowa, South Dakota, North Dakota, Minnesota, Montana, Wyoming, New Mexico, Texas, and Arkansas. One of the producers at the time noted that 95 percent of his production was shipped out of state.

Production and value for the United States, Kansas, Texas, and Louisiana are shown in Table 48. It is evident that Kansas has not shown the growth rate exhibited especially by Texas and Louisiana. Both Texas and Louisiana have cheap water transportation. Salt produced in Louisiana, for example, can be shipped by barge up the Mississippi River to markets in the Midcontinent area and compete with Kansas salt that is shipped shorter distances

61. Taft, p. 265.

62. Taft, p. 266.

by rail to the same market area. Furthermore, Louisiana salt enjoys an advantage in that it is chemically purer than Kansas salt. Major salt producing areas in the Great Lakes region also have the advantage of water transportation. In the west, Utah and California are establishing marketing areas.

During 1960 Louisiana and Texas each accounted for about 19 percent of the total United States salt output, Michigan and New York each about 16 percent, Ohio 12 percent, and California and Kansas each 5 percent. All other states accounted for the remaining 8 percent.[63] Of the 89 plants operated by 54 companies during 1960 in the United States, 7 plants operated by as many companies were Kansas producers. Thus, Kansas finds itself in a difficult competitive position and other salt producing states are claiming an increasing share of the total market.

On the brighter side, Frontier Chemical Company established a plant near Wichita in the early 1950's in order to obtain salt from brine wells at a location where gas for fuel is readily available. Since its construction, the plant has expanded and its products, including caustic soda, chlorine, and muriatic acid, are sold to the oil industry, chemical industries, and water and sewage treatment plants.[64] Because the oil industry has been centralized in Wichita, this facility enjoys an advantage in a market where caustic soda is used in the preparation of drilling muds and in refining; muriatic acid is used in treating oil-bearing rocks to increase production and in the manufacture of industrial cleaning solutions. It might be pointed out that this is not the first Kansas venture into plants directed toward production of salt brine for industrial chemicals. In 1909 a plant with a capital investment of about one-half million dollars was erected in Hutchinson and began producing soda ash.[65] Purchased by the Solvay Process Company

63. *Minerals Yearbook, 1960,* Vol. 1, p. 935.

64. Glenn H. Miller, Jr., "Mineral and Water Resources," *Economic Development in South Central Kansas,* Part VI, 1959, Center for Research in Business, The University of Kansas, p. 32.

65. Taft, pp. 269-270.

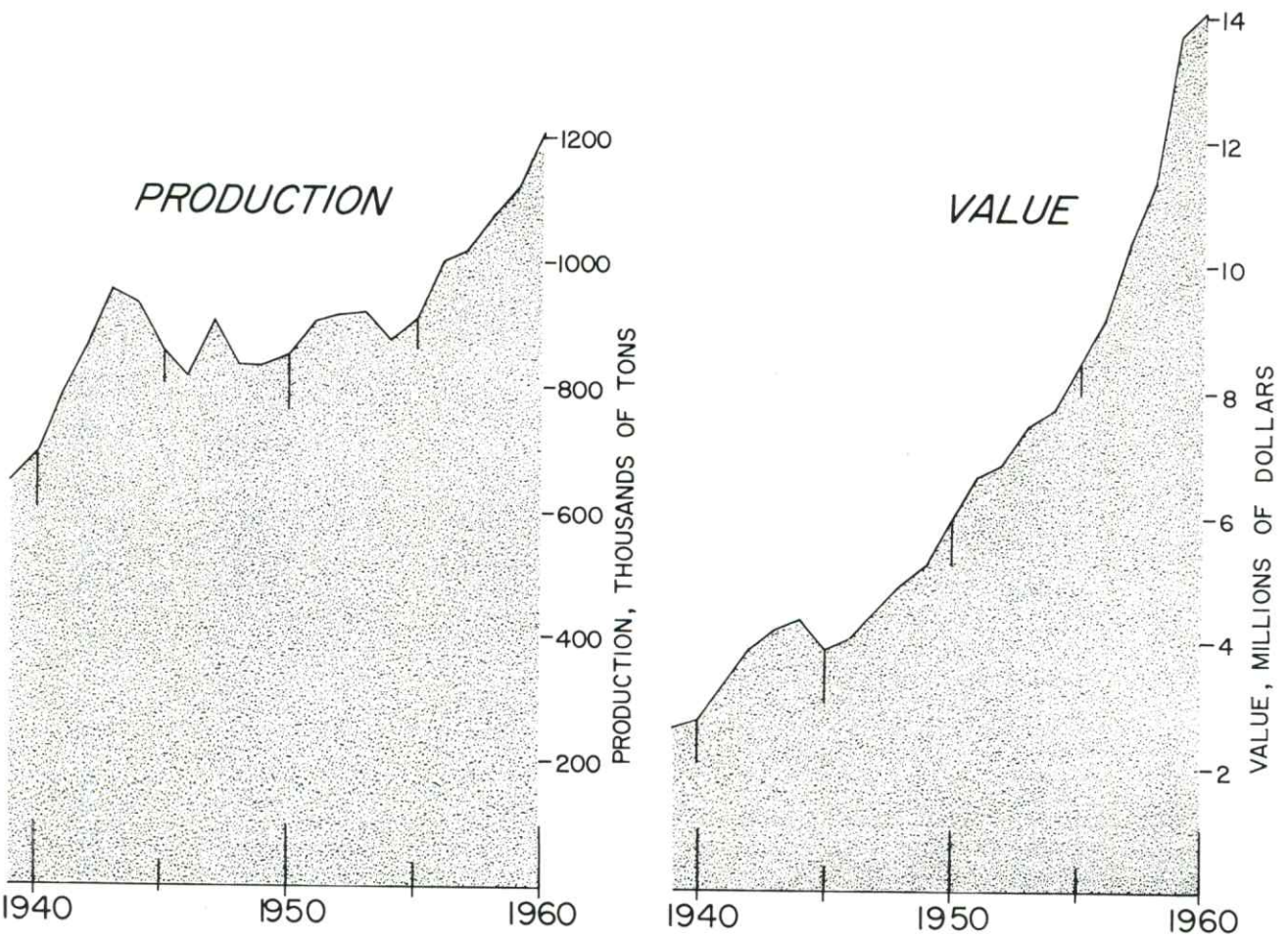

FIG. 40.—Kansas salt production and value, 1939-1960. (Table 48.)

of Syracuse, New York, the organization continued production of soda ash to become one of the largest industrial organizations in Hutchinson by 1916. The plant discontinued operations in 1921, and the equipment was dismantled. In 1960 the Pawnee Rock Company, at Pawnee Rock, began producing salt brine.[66]

Insufficient employment data are available for detailed analysis but partial figures indicate the number of employees in Kansas has not changed drastically in the past two decades (Table 49 and

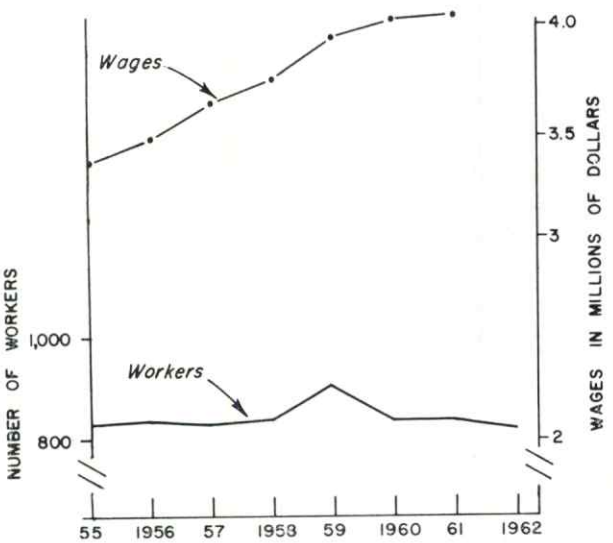

FIG. 41.—Employment and wages in the salt industry in Kansas, 1955-1962. (Table 49.)

Fig. 41). The total wages have risen at a faster rate than the number of employees, reflecting in part wage patterns and dollar inflation, but also an increased use of efficient mining equipment and improved production technique. Table 49 further demonstrates this effect in the capital investment increase shown for 1961.

Certain other principal data relevant to the salt industry reflect the marketing area, the large out-of-state shipment, and the predominantly truck-oriented transportation (Table 49). Some salt is still shipped as far west as California, but seemingly none is shipped farther east than Minnesota and Illinois.

The outlook for the salt industry is good on a nation-wide basis, owing to population increases and expanding chemical, agricultural, and industrial markets. More salt was used in making of chlorine and caustic soda than for any other purpose during 1960, consuming about 67 percent of the salt output.[67] A large amount of salt was used in 1960 for snow and ice removal and road stabilization, a market that should continue to increase. Kansas, as a producer of rock salt and evaporated salt, today has a share of the market for practically all the uses mentioned. On the basis of 1961 replies from Kansas salt companies, the use of Kansas salt by feed dealers, meat packers, and canners has increased. Large amounts of salt also were sold to states, counties, and other political divisions for use on highways and roads. Kansas can look for an expanding market, but a decreased share of that market unless the competitive advantage in transportation enjoyed by other states can be overcome.

The possibility for a new salt-related industry began with a test at the Carey salt mine near Hutchinson, Kansas, to study the feasibility of disposing nuclear wastes in natural salt formations. The work was part of a research effort, sponsored by the Atomic Energy Commission, to find more economical methods of disposing of highly radioactive wastes resulting from processing spent nuclear fuels. In addition, because of low humidity and constant temperature, Kansas salt mines have become an important location for storage of valuable equipment and documents.

Coal

Coal, the most abundant of the world's fossil fuels, is closely linked with industrial development.[68] Used primarily as a source of energy and secondarily as a raw material for the manufacture of a variety of products, coal, in the process of production, distribution, and utilization, influences directly or indirectly almost every phase of community, state, and national well-being. The United States claims about one-third of the earth's reserves, and, in the Midcontinent region, Kansas has a share of these reserves (Fig. 42). What happens in the coal industry definitely gives structure to the total economy, of which local and regional economies are integral parts.

Coal, which consists chiefly of hydrocarbon compounds derived principally from plant accumulations in swamps of the geologic past, may be classified as lignite (brown coal), bituminous (soft coal), or anthracite (hard coal), depending on the stage of the coal-forming process. Most of the coal mined in this country is bituminous. Kansas bituminous coal is a somewhat friable variety having a high to relatively high heat-producing value.

66. Schoewe, pp. 75-76.
67. *Minerals Yearbook, 1960*, Vol. 1, pp. 935-936.
68. United States Bureau of Mines, *Mineral Facts and Problems*, 1960, Bulletin 585, pp. 111-140.

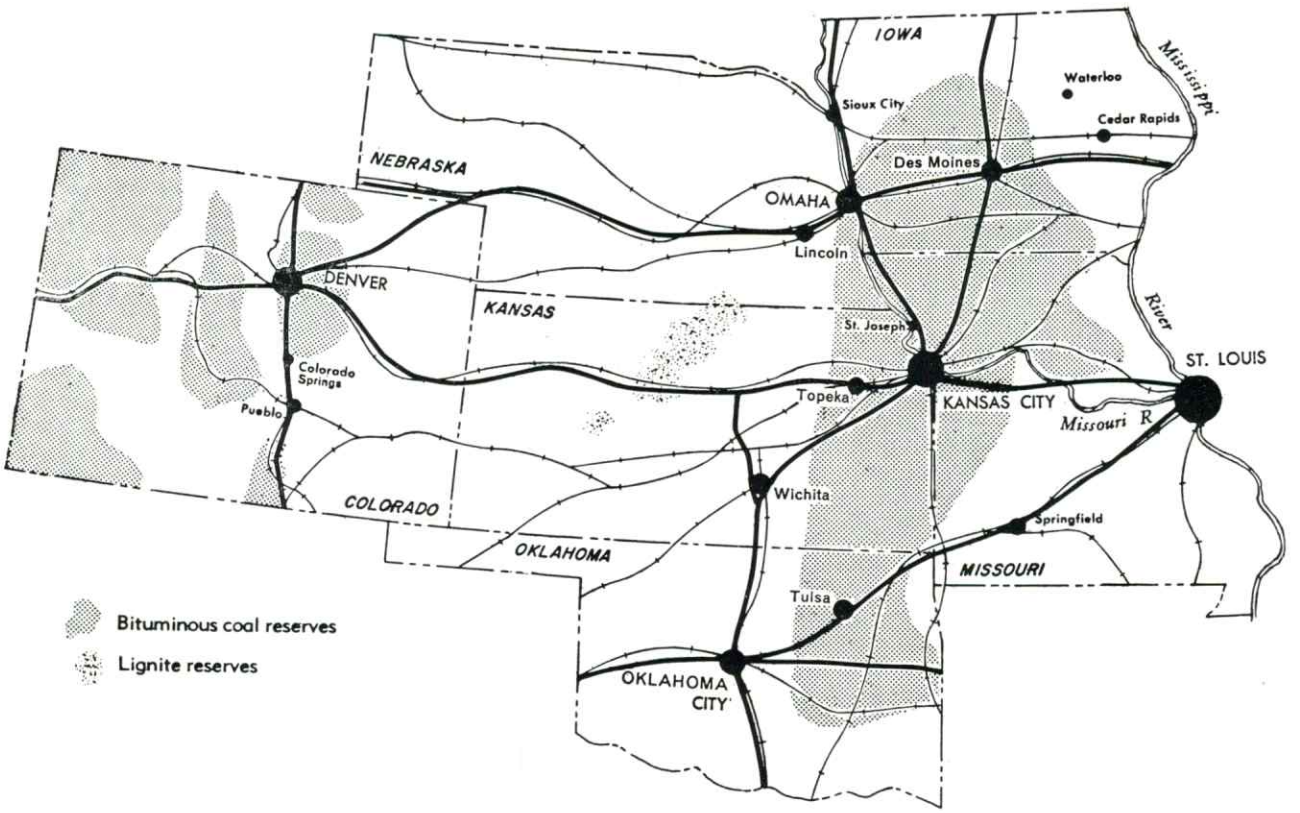

FIG. 42.—Area of coal reserves in Kansas and surrounding states. Major cities, railroads, super highways, and navigable waterways shown. (Sources: *Coal Reserves of the United States—a Progress Report January 1, 1960,* United States Geological Survey Bulletin 1136, pp. 4 and 9; and Kansas Geological Survey publications.)

Most coal produced is burned for heat in power production or is carbonized to produce metallurgical coke. Until recently, or until the change-over from steam locomotives to diesel engines, railroads were by far the heaviest users of Kansas coal.[69] (Kansas coal, while not the best for coking, has in the past been used for this purpose.)

Coal is burned for space heating and to supply hot water and steam for many purposes. One of the most important uses is for generation of electric power. Combustion of coal and control of application for industrial purposes are being intensively studied and developed—so much so that the burning of coal has to a large degree become a science. Pulverized coal can now be moved and handled like a fluid.

Coal chemicals are important by-products of coke production. Residual products from combustion of coal—fly ash, flue dust, coal ash, and cinders, as well as rejects from the preparation at the plant—are possible sources of various chemicals and materials. Fly ash is used primarily in the manufacture of concrete, building stones, and cinder blocks, and in asphalt highway construction. (According to Kansas Geological Survey studies, Kansas coals are potential sources of industrial germanium.[70]) Vanadium, lithium, and uranium can be recovered from coal ash, and during World War II coal ash was a source of aluminum. Washery refuse has been a source of sulfur, and United States companies are now using preparation-plant rejects for the commercial production of lightweight aggregates.

Most of the bituminous coal of Kansas is distributed as relatively thin beds in Pennsylvanian rocks in the eastern one-fourth of the state, although a few coal beds occur in Permian rocks along the western limits of this eastern one-fourth.[71] Lignite deposits, which have been mined in the past but are not commercially mineable in the current economy, occur in Cretaceous rocks in north-central Kansas.[72]

69. Walter H. Schoewe, "The Geography of Kansas, Part IV, Economic Geography: Mineral Resources," *Transactions of the Kansas Academy of Science*, Vol. 61, No. 4, 1958, p. 389.

70. John A. Schleicher, *Germanium in Kansas Coals,* Kansas Geological Survey Bulletin 134 Part 4, 1959, pp. 163-178.

71. G. E. Abernathy, J. M. Jewett, and W. H. Schoewe, *Coal Reserves in Kansas,* 1947, Kansas Geological Survey Bulletin 70 Part 1, pp. 1-20; Walter H. Schoewe, *Coal Resources of the Permian System in Kansas,* 1951, Kansas Geological Survey Bulletin 90 Part 3, pp. 53-68.

72. W. H. Schoewe, *Coal Resources of the Cretaceous System (Dakota Formation) in Central Kansas,* 1951, Kansas Geological Survey Bulletin 96 Part 2, pp. 69-156.

It is the Pennsylvanian-age coals that have been and presently are commercially important to Kansas. More than 40 coal seams have been identified in these rocks, from near the surface to approximately 2,000 feet below the surface. Major coal-containing rock groups in the Pennsylvanian are the Cherokee, Marmaton, Kansas City, Douglas, and Wabaunsee.[73] Principal production currently is from beds in the Cherokee Group of Pennsylvanian rocks in southeastern Kansas, but some coal is mined in the Wabaunsee Group in the Osage-Coffey County area and some in the Marmaton Group in Linn County.[74] (Figure 43 delineates the present coal-producing areas in Kansas and shows location of active coal mines and coal-washing plants.)

Coal production in Kansas dates from the earliest days of settlement. In the 1820's coal for local uses was obtained from surface deposits in the vicinity of Fort Leavenworth, and in the 1850's southeastern Kansas residents dug coal from creek banks for domestic use, blacksmithing, and local manufacturing.[75] As early as 1865, a mine of some commercial importance was opened near Fort Scott, and at least one wagon train of coal from the mine was delivered to Leavenworth that year.[76]

The real development of the Kansas coal industry was contemporaneous with the building of the Kansas railroads, the largest consumers of Kansas coal until relatively recently. Almost as soon as the Missouri River, Fort Scott and Gulf Railway was completed from Kansas City to Baxter Springs in 1870, coal from Fort Scott was being shipped to Kansas City, which, because of geographic location at the confluence of the Missouri and Kansas Rivers, had become the gateway to Kansas settlement and thereafter the uncontested major distributing center for Kansas products—a position the city still holds. This railroad, built specifically to aid industrial development in southeastern Kansas, precipitated further railroad building and the organization of coal mining companies in this section of the state.[77]

Southeastern Kansas thus became the state's major mining-industrial area at a time when most other Kansas areas depended predominantly on agriculture. Near-surface coal deposits were worked at first and methods were slow and tedious. The first recorded use of a steam shovel in the United States was in the vicinity of Pittsburg, Kansas, in 1876 or 1877; three local railway companies provided the capital and the shovel was used to remove overburden from the Weir-Pittsburg coal bed.

Deep mining in southeastern Kansas began about 1874, near Scammon, and thereafter shaft mining was an important aspect of the Kansas coal industry until well into the present century. One of the major early developments elsewhere in eastern Kansas was the opening of a deep mine (700 feet) near Leavenworth in 1870. Mining of more than local significance also soon became evident in the Prescott-Pleasanton district, Linn County, and near Carbondale, Osage County.

By the turn of the century, strip and deep mining, either of a local nature or on a commercial basis, had been recorded for almost every county in the eastern one-third of the state. Four distinct coal fields had developed—the southeast Kansas coal field, mostly in Cherokee and Crawford Counties, with extensions into Bourbon and Labette Counties; the northern Kansas coal field, in Leavenworth and Atchison Counties; the eastern Kansas coal field, in eastern Linn and northern Bourbon Counties; and the east-central Kansas field, principally in Osage and Coffey Counties, with extensions in Franklin and Shawnee Counties.[78]

The southeastern Kansas coal field has constantly remained the state's leading coal-mining district. Deep mining was more important than strip mining until the 1930's, when deep-mined Kansas coal was almost priced off the market by competition from nearby coal-producing states and competition from the liquid and gaseous hydrocarbons. Strip-pit mining staged a comeback about this time, as electric shovels with large-capacity dippers were employed to uncover the coal seams and other improvements in strip-pit mechanization greatly reduced the overhead to make strip-pit mining profitable. Currently all of the coal mined in the area is by strip-pit methods.[79]

Coal production in the northern field, from deep mines in the vicinity of Atchison, Lansing, and Leavenworth for years contributed coal for a regional market; the mine at the State Penitentiary

73. Arthur L. Bowsher and John M. Jewett, *Coal Resources of the Douglas Group in East-Central Kansas*, 1943, Kansas Geological Survey Bulletin 46; Walter H. Schoewe, *Coal Resources of the Kansas City Group, Thayer Bed, in Eastern Kansas*, 1944, KGS Bulletin 52 Part 3; Schoewe, *Coal Resources of the Wabaunsee Group in Eastern Kansas*, 1946, KGS Bulletin 63; Schoewe, *Coal Resources of the Marmaton Group in Eastern Kansas*, 1955, KGS Bulletin 114 Part 2; Schoewe, *Coal Resources of the Cherokee Group in Eastern Kansas: I. Mulky Coal*, 1959, KGS Bulletin 134 Part 5; William W. Hambleton, *Petrographic Study of Southeastern Kansas Coals*, KGS Bulletin 102 Part 1.

74. Schoewe, *The Mineral Industry in Kansas in 1960*, pp. 58-61.

75. Schoewe, "The Geography of Kansas," pp. 367-369.

76. Erasmus Haworth, *Mineral Resources of Kansas for 1897*, 1898, The University of Kansas Geological Survey Annual Bulletin, pp. 36-37.

77. Richard L. Douglas, "History of Manufactures in the Kansas District," *Kansas Historical Collections*, Vol. XI, 1909-1910, p. 103, pp. 108-112.

78. *Kansas Mineral Resources for Wartime Industries*, pp. 78-79.

79. Unpublished data, Kansas Geological Survey files.

at Lansing supplied the coal needs of all state institutions from the 1880's to 1948, when it ceased operation.[80]

In the eastern Kansas coal field, coal has been produced from both surface and deep mines, but at present activity is of little more than local importance. The east-central field has been producing some coal, by stripping methods and deep mining, since the opening of the first mine in 1869. The only deep mines presently active in Kansas are in Osage and Linn Counties.

Permian coal was mined in a few localities in Wabaunsee and Geary Counties during the 1920's and early 1930's.[81] The mining, however, was only of local consequence. Kansas lignite deposits, not reported by the Bureau of Mines among the country's coal reserves because of the thinness of the beds, nonetheless were at one time important in the economy of central Kansas.[82] In the pre-1900 period, when railroad mileage was not great and cheap transportation facilities generally were lacking in the area, locally mined lignite could compete favorably with shipped-in bituminous coal. Lignite was even utilized to some extent by the early railroads. Cloud, Republic, Ellsworth, Mitchell, Russell, Lincoln, and Jewell Counties had mining of some consequence. Current status of lignite is as a stand-by fuel to be used in emergencies, but more especially as a potential source of gasoline and other liquid fuels, and perhaps as a raw material for the manufacture of a special type of wax and other industrial products.

Coal, outranked in value of production in Kansas by nine other mineral commodities—petroleum, natural gas, cement, stone, salt, clay and clay products, sand and gravel, carbon black, and natural gasoline, in 1960 represented only 0.8 percent of the state's total mineral wealth of approximately $500.5 million.[83]

It is obvious that the state's coal producing heyday had its climax at the close of World War I, which also is a convenient date for the beginning of the automotive age and large-scale production of oil and gas, coal's chief competitors. Almost 60 percent of the cumulative total of Kansas coal (as of January 1, 1961) was produced prior to 1920; the 1960 production (876,343 tons) is only 0.3 percent of this cumulative total as contrasted with 1918 production (7,562,000 tons), almost 2.7 percent of the cumulative production.

Figure 44, based on Table 50, shows trends in production and value of Kansas coal, 1939-1960. Except for an upsurge in the early 1940's, identified with the defense economy of World War II,

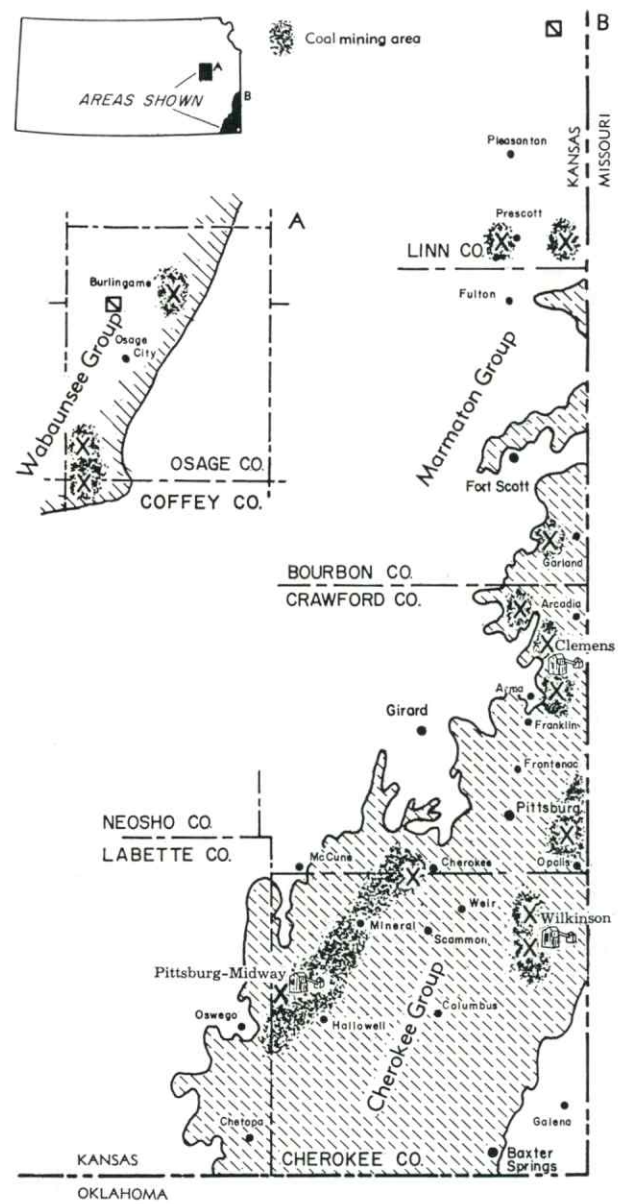

FIG. 43—Present coal-mining areas in Kansas, including location of coal mines and washing plants. (Sources: Kansas Geological Survey Bulletins. Completed inventory reports on Kansas coals are: Bulletin 46: *Coal Resources of the Douglas Group in East-Central Kansas.* Bulletin 52 Part 3: *Coal Resources of the Kansas City Group, Thayer Bed, in Eastern Kansas.* Bulletin 63: *Coal Resources of the Wabaunsee Group in Eastern Kansas.* Bulletin 70 Part 1: *Coal Reserves in Kansas.* Bulletin 90 Part 3: *Coal Resources of the Permian System in Kansas.* Bulletin 96 Part 2: *Coal Resources of the Cretaceous System (Dakota Formation) in Central Kansas.* Bulletin 114 Part 2; *Coal Resources of the Marmaton Group in Eastern Kansas.* Bulletin 134 Part 5: *Coal Resources of the Cherokee Group in Eastern Kansas: I. Mulky Coal.*)

80. Schoewe, "The Geography of Kansas," p. 378.

81. Walter H. Schoewe, *Coal Resources of the Permian System in Kansas*, Kansas Geological Survey Bulletin 90 Part 3, 1961, pp. 61-62.

82. Schoewe, *Coal Resources of the Cretaceous System, (Dakota Formation) in Central Kansas*, Kansas Geological Survey Bulletin 96 Part 2, 1951, pp. 95-97.

83. Schoewe, *The Mineral Industry in Kansas in 1960*, p. 52.

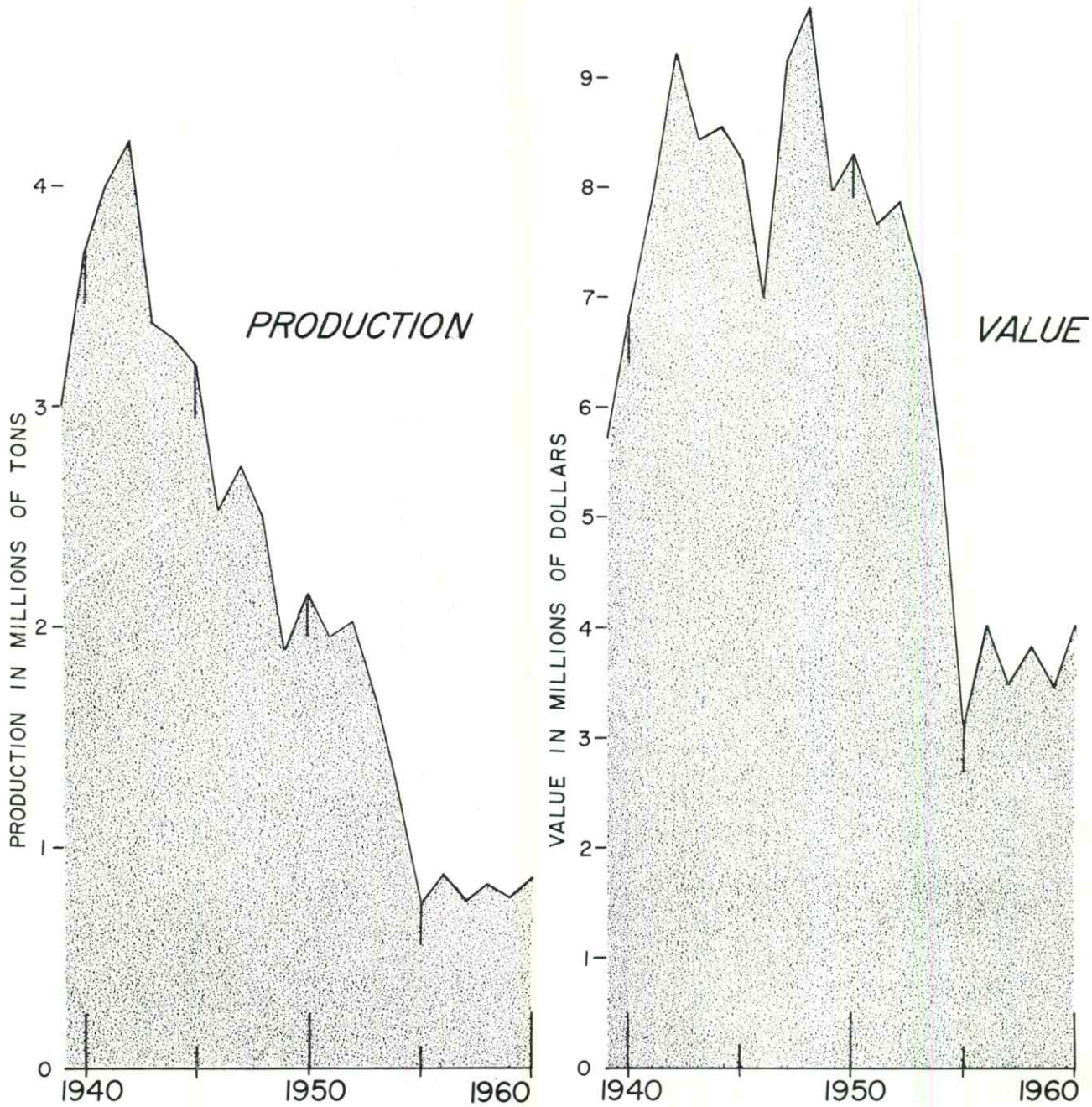

FIG. 44.—Value and production of coal in Kansas, 1939-1960. (Table 50.)

production since 1939 has declined noticeably, but hint of recovery seems evident in the mild fluctuations of the late 1950's up to and including 1960. Stated a little differently, production from 1940 to 1960 had a negative 75 percent change, but from 1955 to 1960, a positive change of about 18.5 percent.

Value of Kansas coal produced during the immediate post-war period in the 1940's diverges noticeably from amount produced—the sharp increase corresponding to the inflationary pattern of rising wages and increasing spendable income and production costs generally prevalent in the post-World War II period. The trend in value of the annual product for the two-decade period, however, conforms to trend in production. A negative 38 percent change in value from 1940 to 1960 is matched against a positive 38 percent from 1955 to 1960.

Decline in Kansas coal production for the two-decade period, generally characteristic of the state's coal industry since the peak production year of

1918, can in the main be attributed to widespread use of liquid hydrocarbons and gas as substitute fuels for coal. The thinness of Kansas coal beds is an additional deterrent in the face of increased operating costs and competition from other fuels. (The thickest Kansas coal bed, the extensively-mined Weir-Pittsburg in the southeastern Kansas coal field, measures 34 to 60 inches; most of the coal beds currently being mined range from 15 to 24 inches in thickness.)[84]

The trend in Kansas coal production, 1939-1960, is comparable with trends in the neighboring states of Colorado, Missouri, Oklahoma, and Iowa (Fig. 45 and Table 51), even though year-to-year pro-

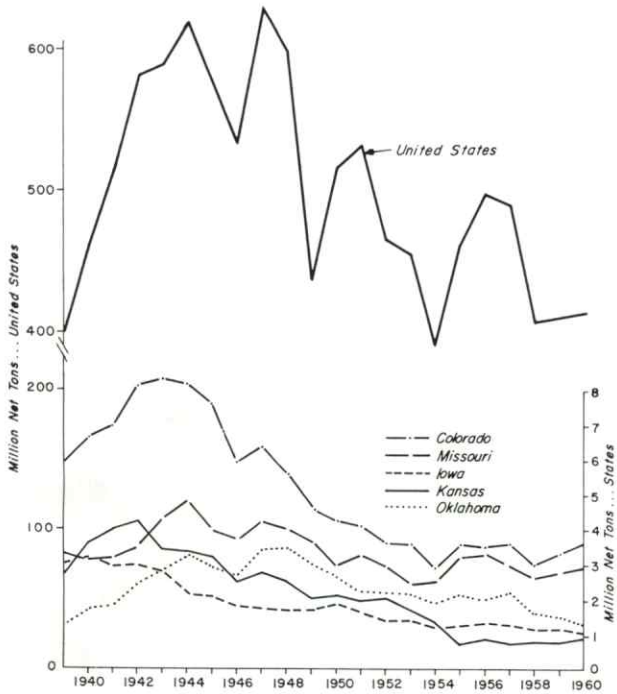

FIG. 45.—Bituminous coal and lignite production, United States, Colorado, Missouri, Iowa, Kansas, and Oklahoma. (Table 51.)

duction for the different states exhibited a variable pattern and Missouri and Oklahoma each had greater production in 1960 than in 1939. Colorado maintained a distinguishable lead throughout the period, but the gap between production in Colorado and in Missouri, the next most productive of the five states, narrowed considerably during the last decade.

Coal production in the United States (Fig. 45), during the 1939-1960 period, at first glance would seem not to be consistent with that for the five-state area. Closer examination reveals that with few exceptions the years of highs and lows in production are essentially the same. The first peak in the 1940's can be attributed to World War II, and the peaks immediately following correspond to post-war reconstruction. The sudden drop in the late 1940's reflects an economic uncertainty and reappraisal. The ups and downs of United States coal production after the Korean War in the 1950's tend to emphasize frustration in the total economy—overexpansion and inflation (a response to stimuli of two decades of wars and government spending), alternated with prosperity (1955-1956), a business recession (1957-1958), and recovery (1958-1959). Steel strikes, especially for prolonged periods in 1956 and 1959, affected coal production adversely, and the bituminous output of 1960 was hobbled by low-level activity in the steel industry.[85]

An interesting observation is that the peak year for coal production in the United States is 1947, as compared with the peak years of 1917 to 1920 for Kansas and adjacent states (Table 52), indicating that utilization of liquid hydrocarbons and gas has not affected coal production nationally to the extent and at the rate that utilization of these substitute fuels has affected coal production in the Midcontinent area. (Table 52 shows total production, maximum annual production, and 1960 production in relation to recoverable coal reserves for the United States and for Colorado, Iowa, Kansas, Missouri, and Oklahoma.)

Total value of produced coal in the United States during the last two decades has averaged more than $2 billion annually, at an average value of $4.82 a ton, despite substantial and continued increases in wages and costs of materials and supplies. Average values per ton of coal produced in the United States and in Colorado, Iowa, Kansas, Missouri, and Oklahoma in 1959 and 1960 are given in Table 53.

Average prices per ton of Kansas-produced coal in 1959 and 1960, $4.67 and $4.73 respectively, are closer to the national averages, $4.77 and $4.69, for these years than are prices of coal produced in the neighboring states of Colorado ($6.39 and $5.85), Iowa ($3.57 and $3.60), Missouri ($4.34 and $4.31), and Oklahoma ($6.74 and $6.79). Further study of Table 53 shows that average value of strip-mined coal is without exception less than average value of coal from underground mines; because of mechanization, costs in strip-mine operations are considerably less than costs in deep-mine operations, and recovery of coal is much

84. G. E. Abernathy, J. M. Jewett, and W. H. Schoewe, *Coal Reserves in Kansas*, 1947, Kansas Geological Survey Bulletin 70 Part 1, p. 6.

85. *Minerals Yearbook, 1959*, Vol. II, p. 39.

greater. This statement becomes clearer by study of Table 54, in which 1960 coal production in the United States and in Colorado, Iowa, Kansas, Missouri, and Oklahoma is analyzed in terms of number of workers and daily output for all mines as contrasted with strip mines. It should be noted that among the states under consideration, Kansas has the highest ratio of strip to deep mines. Figure 46 presents supporting production and employment data for Kansas strip and deep mines.

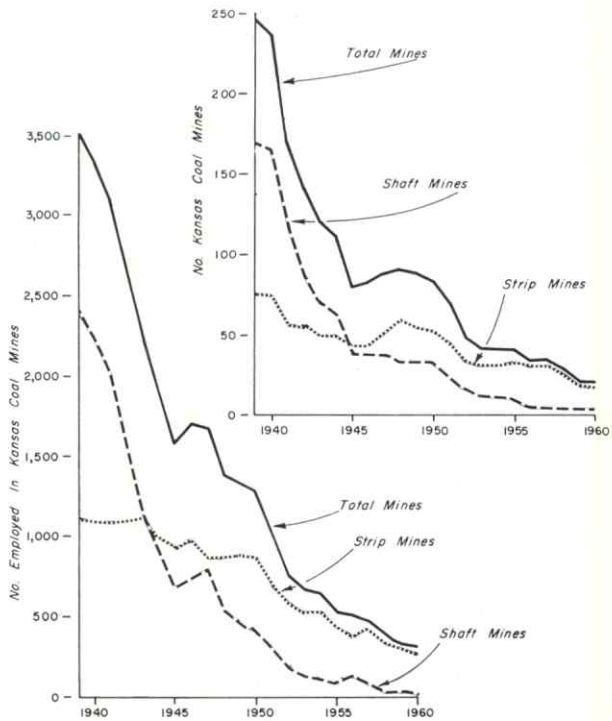

FIG. 46.—Employment in Kansas coal mines and number of mines, 1939-1960. (Table 50.)

Generally speaking, during the last few years the coal industry as a whole has averted spiraling prices and held a substantial percentage of its energy markets because of a phenomenal record of increased productivity and efficiency of operation resulting from mechanization, which also has contributed substantially to drop in employment in the industry. Production climbed from 5 tons per man per day in 1930 to 11 tons in 1958, as mechanical loading increased from 10 percent of underground production to 85 percent, and surface, or strip mining, increased from 4 percent to 28 percent in the same period.[86] Production in Kansas and adjoining states has followed this national trend.

As employment in the coal industry has decreased, wages and salaries have increased from an hourly pay rate of $0.80 for the production and development worker in 1939 to $3.48 in 1958, according to one source. This pay scale represents a climb from one of the lowest pay rates in the mineral industries to the highest. (Figure 47 and Table 55 show trends in wages and salaries in the coal industry from 1956 to 1961.)

Transportation is one of the major factors in the marketing of coal. Eighty percent of all coal leaves mines by railroads, which have from the beginning been the principal means for shipping bituminous coal. Currently freight rates add nearly 70 percent to the cost of coal at mines. This cost factor has in recent years increased use of water and trucks for transporting coal from mines to final destination, or interrupting rail shipments.[87] By the 1930's, trucks had become a particularly important means of transporting coal from mines to final destination, as well as to tipples, railroad sidings, and waterways for further shipment. Trucks are being used increasingly for the short haul, not only because bigger and better trucks have been developed and highways improved, but also because railroad freight rates are not strictly proportional to distance; freight rates for short hauls are higher than for long ones. Another innovation is pipeline transmission of coal and water. (A 108-mile coal pipeline, constructed from a mine in eastern Ohio to a power plant in Cleveland, can deliver 3,600 tons a day.) Technological advancement in long-distance transmission of electric energy also has lessened the coal transportation problem by permitting increased electric generating capacity near or at mine sites. Table 56 shows the status of transportation by rail and water, as opposed to trucking in 1960 in the United States and the five-state area, with emphasis on haulage from strip mines.

Sizing, screening, and mechanical cleaning are an important aspect of preparing coal for market. About 92.7 percent of Kansas produced coal, which has a high percentage of refuse to raw coal, is cleaned and otherwise treated at washing plants located at Hallowell and southeast of Weir, Cherokee County, and near Mulberry, north of Pittsburg, Crawford County. Table 57 shows percentages of total produced coal mechanically cleaned in the United States and in the five-state area of Colorado, Iowa, Kansas, Missouri, and Oklahoma, and serves to stress the competitive disadvantage of the Kansas industry.

In strip mining—and mining in Kansas is 99 percent strip-pit mining—phenomenal growth has

86. *Mineral Facts and Problems*, 1960, p. 119.

87. *Mineral Facts and Problems*, 1960, p. 135.

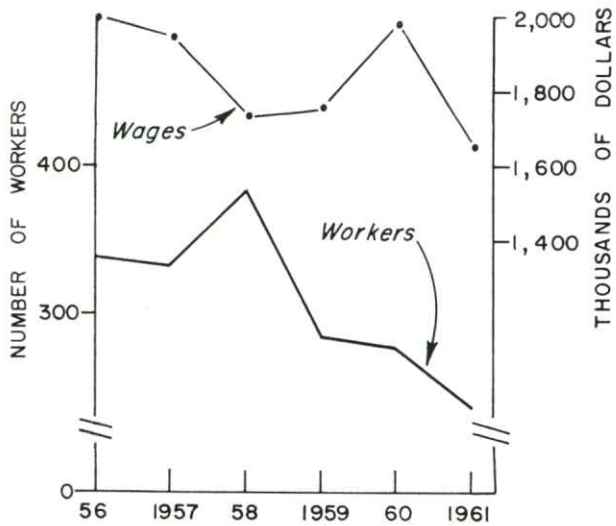

FIG. 47.—Employment and wages in the Kansas coal industry, 1956-1961. (Table 55.)

been made possible by large-capacity electric shovels, trucks, and new explosives such as ammonium nitrate to break overburden. Some of the shovels now in operation in some parts of the country have dippers with 70-cubic yard capacities, and even larger ones are being constructed. One Kansas company now operates a shovel having a dipper capacity of 30 cubic yards, and companies plan to use shovels that will be able to remove 90 cubic yards of earth with one bite. A 90 cubic-yard shovel, by permitting mining of deeper—and thinner—beds of coal, will prolong the life of an operation at one location from an average of 8 years to 24 years. Crawler traction and development of large dragline excavations and carryall scrapers are characteristic of the strip-mining industry. Also, improvements have been made in power drills, in shooting holes in overburden, and in trucks hauling coal from strip pits to tipples and railroad ramps.

In conjunction with stripping operations in the southeastern Kansas coal fields, mine dumps are being reclaimed into attractive and productive landscapes, and many lakes that form between dumps are being developed for fishing and recreational purposes. The State Forestry, Fish and Game Commission is co-operating in many of the projects. The larger shovels will aid in these projects by permitting greater control over placement of the dumps.

Study of Table 58 permits a broad perspective of the classification and productivity of Kansas coal mines in 1960 in relation to those of sister coal-producing states and the United States as a whole. It is rather surprising to note, especially in view of the thinness of Kansas coal beds, that average production per mine in Kansas, 68,329 tons, is higher than average production per mine in the United States, 52,831 tons. It is further surprising that of the sister states, only Missouri had higher productivity, 87,582 tons per mine. That Kansas has a mine in Class 1 (500,000 tons and over) and one in Class 2 (200,000 to 500,000) can only be accounted for by efficiency of operation. Kansas has no intermediate mines (in Classes 3 and 4—50,000 to 200,000), but 3 in Class 5 (10,000 to 50,000) and 8 in Class 6 (less than 10,000). The contrast between Class 1 and 2 and 5 and 6 is striking.

The outlook for the bituminous coal industry is encouraging, in spite of serious drops in production in recent years that have resulted in a marked decline of coal's share in the total energy market. Coal is still the major supplier of industrial energy, largely because of the increased use of coal for steam generation by electric power utilities, a trend that became especially evident about 1953. Technological advances in coal mining, preparation, and combustion equipment design have combined to increase efficiency of power generation to a point where competitive fuels will require a large reduction in prices to compete commercially with coal. For example, in 1920 electric utility plant consumption averaged about 3 pounds of coal per kilowatt hour; new plants now require approximately 0.7 pound of coal per kilowatt hour.[88] According to some estimates, coal requirements in electric utilities alone in the next 15 to 20 years will be close to 500 million tons a year—more than three times the amount of coal now used. As technological research releases new uses for coal, including conversion to liquid and gaseous fuels, the demands on coal are expected to increase further. Based on the steadily increasing gross national product, inherent in a steadily growing population, consumption of coal probably will increase between 75 and 100 percent by 1975. The build-up, however, is expected to be gradual.

Technological developments in the Kansas coal industry point to a certain amount of long-range confidence in this sector. Kansas coal is amenable to liquefaction and hydrogenation, and is therefore a potential source of liquid fuels, as well as a source for the manufacture of a number of products, especially in the category of coal chemicals.

It is likely that the industry, as it now exists, has reached its lowest level of production for some time, but those in the industry have rather contradictory opinions on any major recovery. One major producer is pessimistic about the industry's future.

88. *Mineral Facts and Problems*, 1960, p. 124.

Another major producer believes that the future of the coal industry is so closely tied with electric utilities that productivity and consumption of coal will increase as electrical consumption increases, estimated at about 7 to 8 percent a year. Assuming this, the public utilities of Kansas and adjacent area essentially will be the market for Kansas coal.

In view of the interrelationships of the coal industry with the many aspects of the total economy—including geographic location, transportation facilities and costs, competition from substitute fuels and from other coal-producing areas, population growth, marketing—it is not so simple to predict the future of the Kansas coal industry. Much will depend upon population growth in Kansas cities and especially upon other industries providing other job opportunities, for as technology prevails in the coal industry, employment in this industry will become a negative factor. It would certainly seem that Kansas coals must depend on local and limited regional markets, for even if transportation were no problem, Kansas coal could not expect to compete in a wide market area with thicker coals of other areas. Furthermore, in the long-range view, deep mining will have to be used to recover much of the coal, and, in view of the thinness of Kansas coal beds, the economy would have to change drastically to make such operations profitable. In the immediate future, coal mining activity in Kansas will surely be restricted to stripping operations in southeastern Kansas.

Recognizing that the state and communities within the state are being increasingly pressed with industrial and business planning problems, it is hopeful to say that intelligent planning could possibly create a favorable Kansas industrial climate to which the coal industry would lend major support not only as a supplier of fuel but also as a source of coal products and by-products for use in many manufacturing establishments.

Mineral Commodities of the Construction Industry

The economy of Kansas depends importantly on the abundantly available, but low-unit value mineral commodities of the construction industry—principally stone, sand and gravel, clay, gypsum, and the processed products of these commodities, especially cement and clay products. These commodities therefore should properly be discussed with relation to construction activity even though they have some use unrelated to construction. Because they are generally available in many places and are low priced, profit is based on volume production. Mineral commodities basic to the construction industry must be developed as a local or, at best, a regional enterprise in order to avoid the cost of long-distance transportation. All economic factors considered, construction activity can be expected to be greatest near the centers of population and in areas of major public works.

Figure 48 indicates that the largest sand and gravel and stone producing counties include Kansas City, Wichita, Topeka and Salina, the interstate highway system, and general major construction projects such as reservoirs and dams.

Work on the interstate highway system, initiated July 1, 1956, illustrates large-scale construction activity and utilization of mineral resources. The Kansas share of the interstate system is 801 miles, including 186 miles of the Kansas Turnpike; the impact of the program on construction activity in Kansas has become obvious. Magnitude can in part be measured by appropriations—$114,445,000, approved to April, 1962. (Supported by 90 percent federal and 10 percent state funds, the Kansas part of the system was about half complete as of July 1, 1962.) Raw materials used in the super highway program must meet stringent specifications, certainly a test for the quality of Kansas-produced aggregates. Activities scheduled through 1963, which include about 26½ miles of superior surfacing in eight counties, and about 56½ miles of grading and bridges in six counties (personal communication, Public Relations Office of the Kansas Highway Department, 1962), pointed to increased demand for high-quality construction materials.

The continued program for reservoir construction (Fig. 48) increases the demand for stone, sand and gravel, and other materials for concrete mixtures, fill, and riprap. As reservoirs are completed, water supply is developed. Water supply and improved transportation are factors in population growth and are bound to influence private and public building.

The relationship between the value of construction and the value of nonfuels is demonstrated in Table 59, which shows a comparison of construction contract value and value of nonfuels for Kansas, surrounding states, and the United States for the period 1956 to 1960. Clearly, Missouri and Colorado lead in both construction and production of nonfuels; Oklahoma, Kansas, and Iowa can be grouped together; Nebraska has the smallest share of both construction and nonfuels value. These comparisons are not completely justified, for other circumstances tend to modify the comparison. For example, both Missouri and Colorado lead the

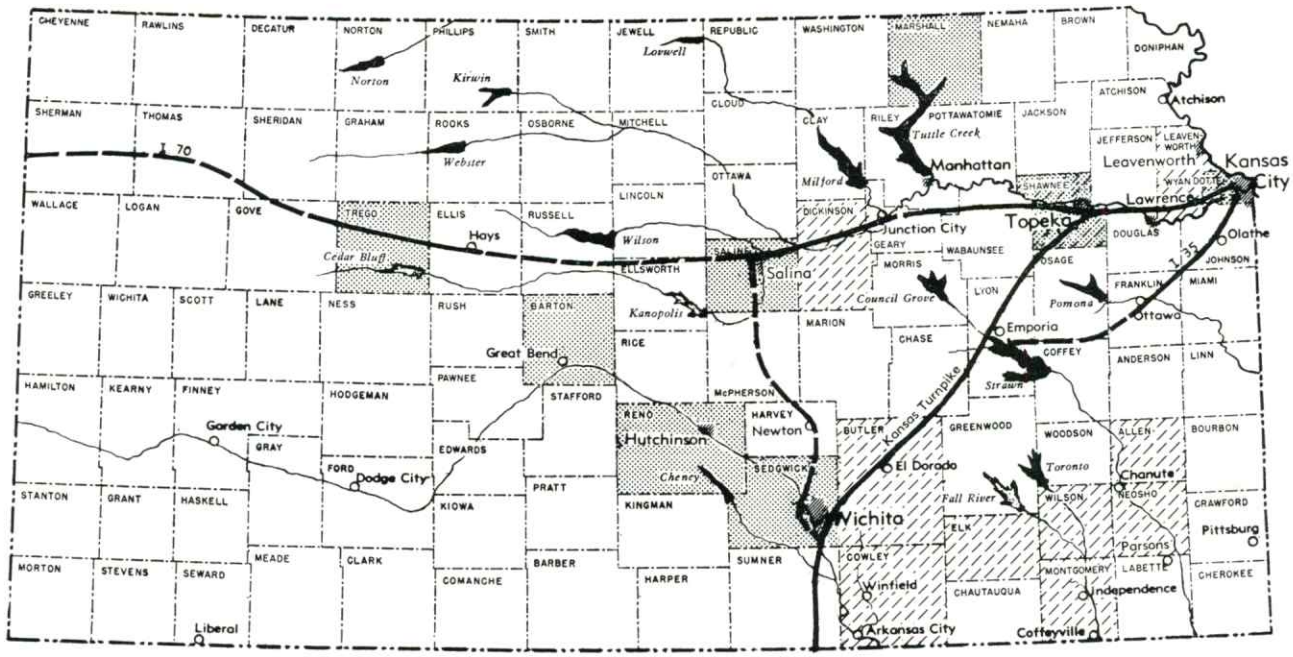

FIG. 48.—Map showing major construction projects (reservoirs and interstate highway system) initiated since the mid 1950's, and counties leading in total stone (diagonal dash pattern) and sand and gravel (dot pattern) production, 1955-1960. (Based on Tables 82 and 83 and information provided by the Kansas Water Resources Board and the Kansas State Highway Department.)

six-state area in the production of metals, which contribute to the total value of nonfuels. Nevertheless, the metals contribution to the total nonfuel picture is relatively small. Iowa introduces a seemingly incongruous element to the relationship between construction and nonfuels because the dollar value of nonfuels for four of the five years exceeds dollar value for Kansas and Oklahoma, but construction activity tends to lag behind these two states. Iowa is a large gypsum-producing state and this commodity has a much larger market area and hence does not tend to reflect local construction activity to as great a degree. Also comparisons are difficult because of the relationship between time of awarding construction contracts, completion of contracts, and period of construction material production.

Major city construction (Table 60) gives an impression of the relatively high level of activity in Missouri and Colorado. The construction industry's part in the economic life of Kansas might have been much smaller had not World War II given Kansas a new lease on economic life by bringing new payrolls to the state. Defense-oriented plants, in fact, gave Kansas another chance to plan for and adjust to growth of manufacturing. New construction became an important part of this growth, and mineral commodities accordingly show a general upward trend throughout the 15-year period from 1945 to 1960. The record of each of the basic mineral commodities and processed commodities including cement and clay products is reviewed in the following sections of the report in an effort to evaluate their performance in future economic development.

CEMENT

Cement, originally and chiefly used in concrete for heavy construction, is an essential mineral commodity in all highly-industrialized areas. The United States currently accounts for approximately one-fifth of the world's cement supply and is the world's largest producer and consumer of cement.[89] Seven of the approximately 180 cement plants in the United States operate in Kansas, favorably located with respect to raw cement materials and fuel.

As commonly used throughout the United States, the term cement is synonymous with portland cement, which currently accounts for 95 percent of all classes of cement produced in the country. Portland cement is the product obtained by pulverizing clinker consisting essentially of calcium aluminum silicates. The clinker is made by combining materials composed chiefly of calcium and aluminum compounds and silica at a temperature of about 2700° F. Different types of raw materials are used in the manufacture of portland cement;

89. *Mineral Facts and Problems*, 1960, pp. 163-175.

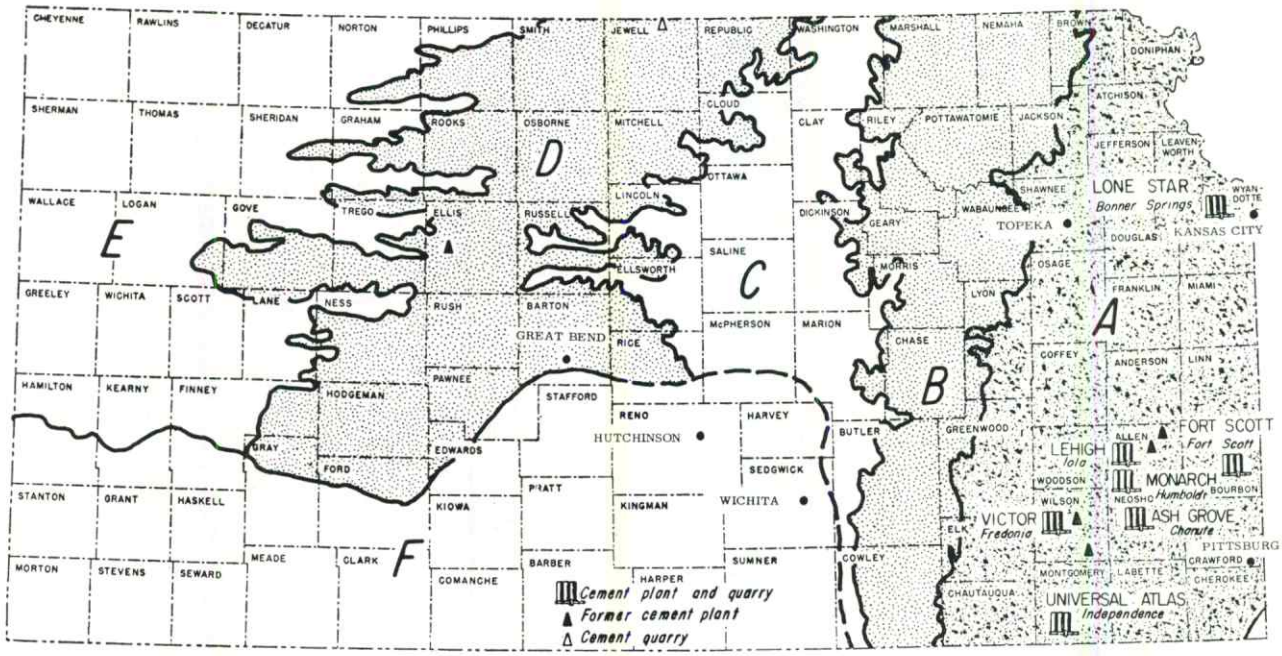

FIG. 49.—Map of Kansas showing areas of cement materials and location of existing and former cement plants. (Sources: Kansas Geological Survey publications, especially R. T. Runnels, *Cement Raw Materials in Kansas*, Bulletin 134 Part 2; and Clinton Warne, *Cement*, Bureau of Business Research, Kansas Industry Series 1.)

generally the principal raw materials are limestone (a source of calcium) and shale (a source of aluminum and silica). At least five types of portland cement are produced to meet a wide range of chemical, mineralogical, and physical specifications and requirements for concrete construction. Six of the seven Kansas cement plants are portland cement plants.

Natural cement differs from portland cement in that it is made by burning naturally occurring rock having the desired chemical composition; one Kansas cement plant is a producer of natural cement. Masonry cement is a mixture of portland or natural cement, finely-ground limestone, and a plasticizer additive; this product is prepared at the seven Kansas cement plants and is utilized as mortar for laying brick or other masonry work.

Reserves of limestone, shale, and other raw materials for cement manufacture theoretically are unlimited and generally available.[90] Distribution of cement raw materials in Kansas is shown in Figure 49 by zones. These zones correspond generally to geologic provinces (Fig. 1).

Zone A contains alternating sequences of limestone and shale and occasional beds of sandstone and coal. Raw material in much of the zone is adequate for almost any size cement plant; the seven operating cement plants in Kansas are wholly within this zone (Fig. 49). Generally lacking in adequate ground-water supply, the zone has many streams that are a source of water. Areas along rivers and creeks are potential sites for cement manufacture, provided other economic factors are favorable. Barge transportation on the Missouri River makes this northeastern part of the zone especially attractive for cement manufacture.

Rocks of Zone B are similar to those of Zone A, except that the shales are thicker, the limestones less pure, and coal beds very thin and sparse. Some of the limestones in Zone B have a prohibitive magnesium content; other beds have the correct proportion of elements for cement raw feed. Raw materials in Zone C do not contain enough calcium carbonate for cement manufacture.

Zone D contains large quantities of chalk and chalky shale sufficient to supply any cement plant for many years. Furthermore, ground water is available in an adequate quantity over most of the zone. Examination of a map showing oil and gas pipelines indicates an available fuel supply; examination of maps showing transportation indicates adequate railway and highway facilities for area distribution, except perhaps in a north-south direction. The big drawback seems to be absence of large towns and manufacturing centers. This drawback is illustrated by the inability of a portland cement plant established at Yocemento, Ellis County, in 1906, to survive, even though the plant

90. Russell T. Runnels, *Cement Raw Materials in Kansas*, Kansas Geological Survey Bulletin 134 Part 3, 1959, pp. 105-124.

product was of good quality. A quarry in Jewell County near the Kansas-Nebraska line, however, has been operated by a portland cement plant at Superior, Nebraska, for many years.

In Zone E, the High Plains section of the state, adequate raw materials are available in a few localities, but the zone does not have the potential of Zones A, B, and D for cement materials. In addition, relatively small markets and long shipping distances are not conducive to cement manufacture.

Zone F, or all of the area southwest of the Arkansas River, does not have any known deposits of cement raw material.

To summarize, almost unlimited deposits of material suitable for manufacture of portland cement are available in the eastern one-third of Kansas and in north-central Kansas. Electric power, water, and transportation are generally available. A fuel supply may or may not be a problem, as costs vary regionally; except for natural gas, fuel costs increase toward the western part of the state.

The history of the Kansas cement industry of the pre-1900's is essentially the history of natural cement, which was first produced commercially in 1868.[91] In that year, a natural cement plant having a capacity of 10 barrels a day and a capital investment of $4,000 was established at Fort Scott, Bourbon County. As the utilization of cement increased in the 1870's and 1880's, principally by the incoming railroads, plant capacity was increased. In 1887, a second plant was built at Fort Scott, and by the middle of the 1890's the two plants could produce 1,400 barrels of cement a day. The Fort Scott Hydraulic Cement Company plant, the outgrowth of this early enterprise, is the oldest cement plant west of the Mississippi River (Fig. 49).

The portland cement industry came to Kansas around 1900, motivated by suitable raw materials, cheap natural gas in the eastern Kansas gas belt, and special freight rates offered by the railroads. The Iola Cement Company (now the Lehigh Portland Cement Company) constructed the first plant, completed in 1899; major inducement was an attractive freight schedule by the Atchison, Topeka and Santa Fe Railway that permitted Kansas cement to be shipped a distance of 2,000 miles to market in California. Encouraged by the success of the first Iola plant, other industrialists began moving into the Kansas gas belt, and between 1899 and 1910 more than 30 cement companies were organized. In the face of obvious overexpansion and a dwindling cheap fuel supply, only about one-

91. Richard L. Douglas, "History of Manufactures in Kansas," *Kansas Historical Collections*, Vol. XI, 1909-1910, pp. 186-192.

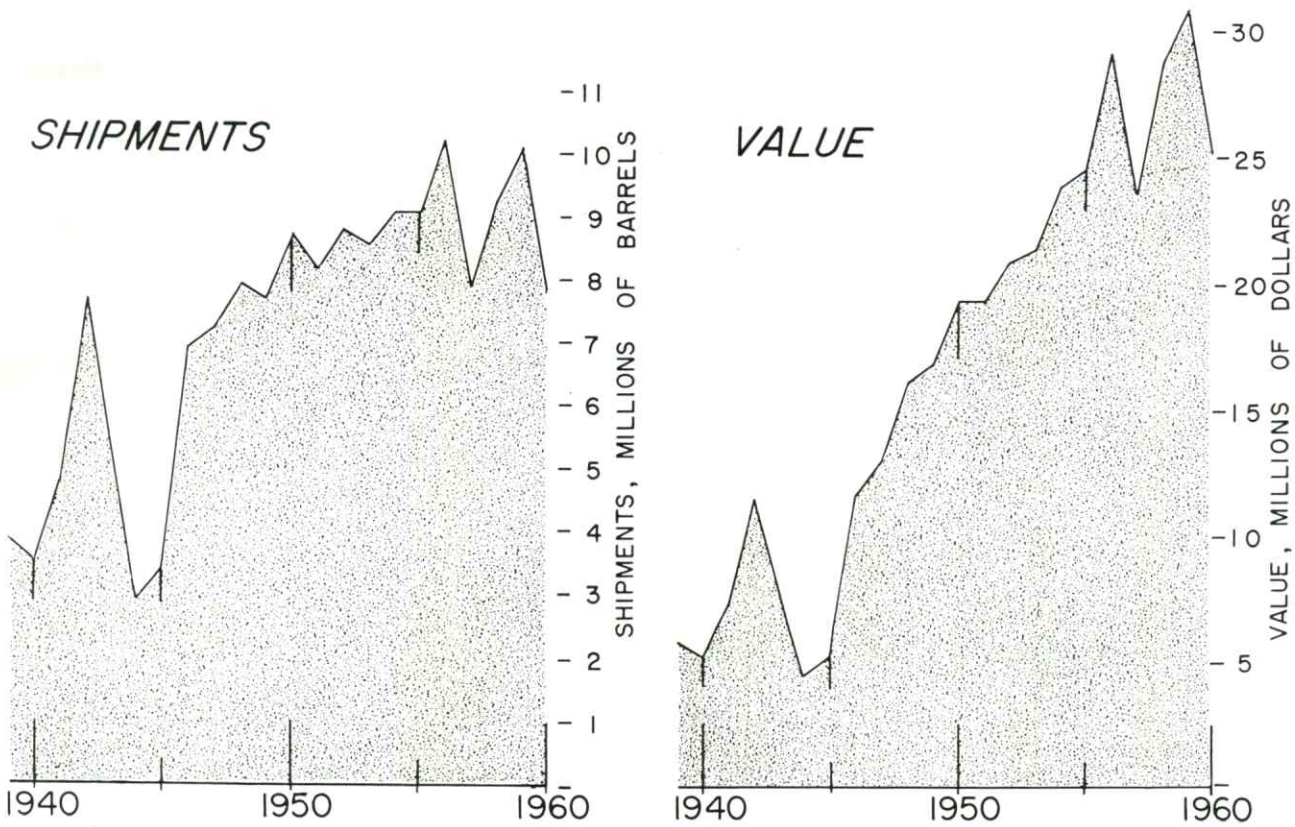

FIG. 50.—Cement shipments and value, Kansas, 1939-1960. (Table 61.)

half of the proposed plants were built; of these 14 reached the production stage.[92]

This early 20th century development included the construction of one plant outside eastern Kansas—the Yocemento plant in Ellis County, west-central Kansas (Fig. 49). The plant operated for some time, but finally ceased production because of unfavorable, associated economic factors.

92. Clinton Warne, "Cement," *Kansas Industry Series No. 1*, School of Business Bureau of Business Research, University of Kansas, December 1955, pp. 1-48.

In the middle of this rapid expansion, marked by speculative ventures, the price of cement dropped below the national average and so remained until about the end of World War I. In addition to overexpansion and disappearance of a cheap fuel supply, freight rates advanced for the Kansas product; simultaneously eastern manufacturers began to capture much of the local Kansas market area. After attempted regional controls and combinations, national organizations bought into the state,

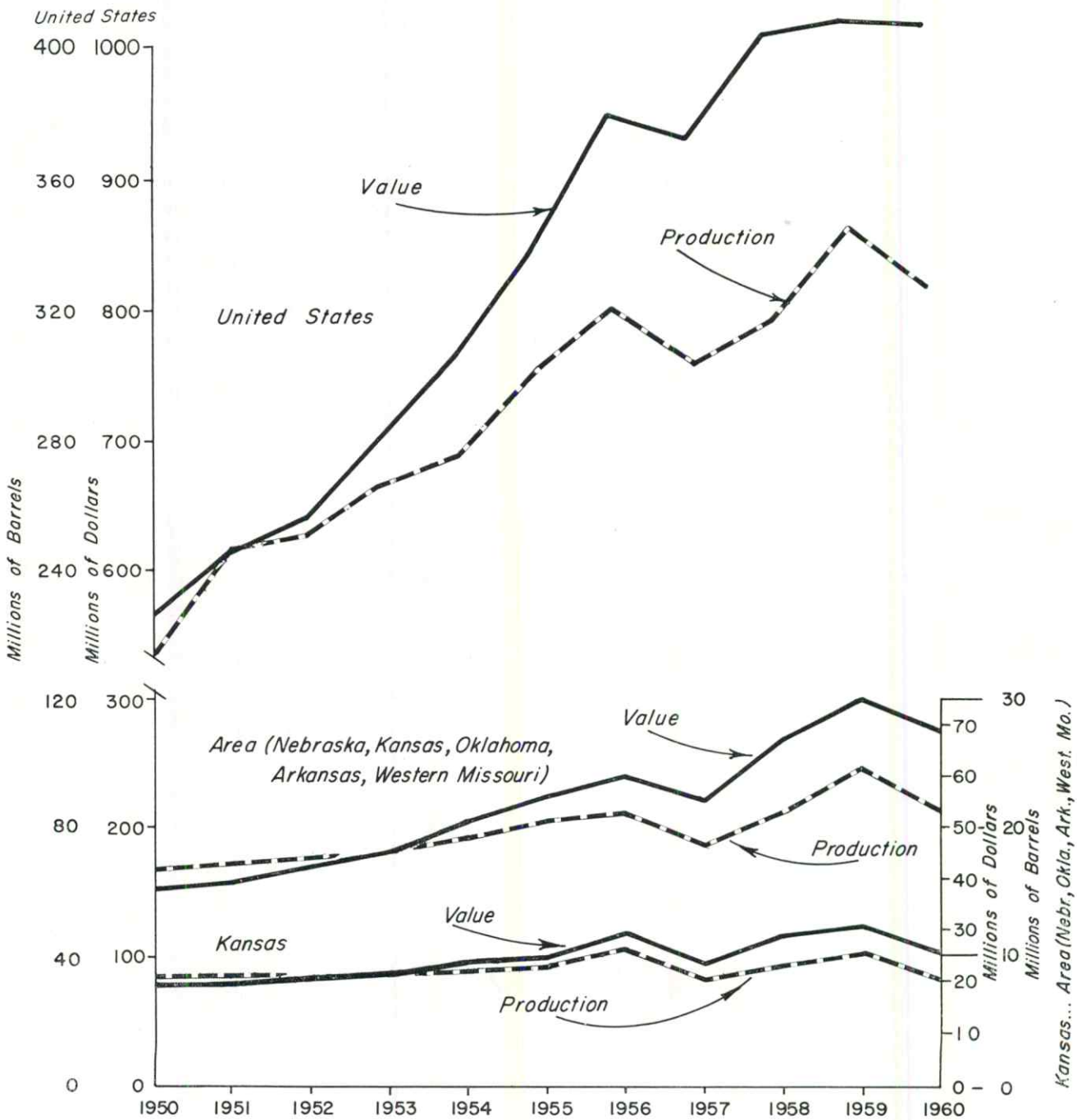

FIG. 51.—Cement production and value of shipments, United States, Kansas, Nebraska, Oklahoma, Arkansas, western Missouri, 1950-1960. (Table 62.)

and by 1920 the industry had been reduced to, but seemingly stabilized at, seven plants and ninth place (formerly third) in rank among the cement-producing states. (These seven cement plants, all established between 1899 and 1908, are located in Figure 49.)

From the early 1900's into the 1960's, Kansas has remained a leading cement-producing state, despite some of the earlier years of struggling. With the exception of oil and gas, cement is Kansas' leading dollar-value mineral commodity.[93] Figure 50 and Table 61 show trends in the Kansas cement industry, 1939 to 1960. Figure 51 and Table 62 show trends in Kansas as compared with sister cement-producing states and the United States, 1950 to 1960.

A brief analysis of these trends reveals general stability and conformity in the cement industry for Kansas, the Midcontinent, and the United States.

Cement production is a gauge of construction activity. The importance of cement in building and maintaining wartime industries is indicated by increases in shipments and value (Fig. 50) early in the 1940's. The sudden drop near the war's end suggests fulfillment of defense-construction contracts, as well as wartime curtailment of non-defense construction and shortage of freight boxcars for shipment. A great increase in cement production in the later half of the 1940's indicates that the Kansas cement industry featured prominently in postwar recovery and adjustment to peacetime industry (Table 61).

Trends in production of cement in Kansas during the 1950's seemed to be in harmony with the total economy; except for the drop in 1951, probably attributable to the Kansas flood which curtailed construction, Kansas production followed the regional and national pattern. The high in the generally prosperous year of 1956, low in the recession year of 1957, and recovery in 1958 and 1959 simply relate to the general economy. The drop in cement production during 1960, however, can be attributed in part to severe weather conditions, which generally retarded construction activity in most categories, and to increasingly keen competition from producers close to water transportation.[94]

Cement production in Kansas increased about 141 percent from 1940 to 1960, but from 1950 to 1960 decreased about 3.8 percent. This compares with a 26 percent increase for the cement-producing area of Kansas, Nebraska, Oklahoma, Arkansas, and western Missouri, 1950 to 1960; and a 41 percent increase for the United States in the 10-year period (Fig. 51 and Table 62).

Other characteristics of the cement industry in Kansas are noted in the employment picture from 1955 to 1961 (Fig. 52 and Table 63). The labor

FIG. 52.—Employment and wages in the Kansas cement industry, 1956-1961. (Table 63.)

force tends to be somewhat constant for the period, the low point in employment, 1958, coming as a delayed reaction to the 1957-1958 recession. The negative 3.2 percent change in employment from 1956 to 1961, plotted against a positive 40 percent change in total wages received by employees in the industry, undoubtedly emphasizes the tendency toward reduced labor force through technological advancement.

The tremendous growth in use of concrete in the United States during the last decade has paralleled development of new types and uses of concrete, technological advances resulting in better cement products at lower costs, and the tendency toward a dispersed, diversified market. For example, the number of local ready-mix concrete suppliers and cement-block industries has increased markedly since World War II and at the beginning of the 1960's new applications of concrete block in concrete masonry have been evident. These products are being marketed for city paving, residential construction, and industrial construction where the advantage of uniform mixing, proportioning, and good timing eliminate the need for on-the-job mixing of different materials necessary for good concrete. Prestressed concrete constructional units, such as large beams for bridges, are being utilized to an increased extent. Precast cement products, soil cement for secondary road paving, and lightweight concrete in thin-shell roofs are only some of the additional uses of cement. An influencing factor is that cement prices have not advanced as much

93. *The Mineral Industry in Kansas in 1960*, p. 52.
94. *Minerals Yearbook, 1960*, p. 303.

as have prices for other building materials—three times for cement since 1930 as compared with five times for other building materials; this brings promise for even greater expansion in the cement industry. Cement products will feature in increased residential and public construction, and in the huge highway programs throughout the country. The approximately 4 percent increase a year in gross national product can only bring much greater industrial construction, and cement may well be the key product.[95]

The Kansas cement industry to date is in healthy condition, despite a decrease in output from 1959 to 1960. Kansas is the principal market area for Kansas-produced cement, but the product is also shipped to Missouri, Arkansas, Illinois, Minnesota, Nebraska, South Dakota, Texas, Wyoming, and even several foreign countries. According to incomplete returns on industrial questionnaires, the in-state and out-of-state market is about equal, and percent shipped by railway ranges from 65 to 84 percent as compared to 16 to 35 percent by truck.

During the next few years, interstate and state highway construction will consume large amounts of Kansas cement. Where feasible, in eastern Kansas, concrete is being used for the highway itself, but in all parts of the state, bridges, culverts, and all other structures are being constructed of concrete.

New cement plants have not developed concurrently with the new markets because of the large initial capital investment necessary and the strongly competitive nature of the nonmetallic industry. Recent developments in cement-manufacture equipment possibly could reduce the initial cost and stimulate new business ventures that have good chance for success, if they are soundly studied beforehand and are well managed.

R. T. Runnels, Assistant Superintendent of the Monarch Cement Company, Humboldt, stressed (personal communication) these aspects:

> Market areas have diminished since World War II in the midcontinent area. Increases in population and industry directly influence sales. New uses and expanded demand for known uses have kept the demand for cement at a level with other facets of our economy. On a national basis the trend is now for secondary supply locations spotted geographically. Water transportation in the East has speeded the location of distributing stations there. Truck transportation is making a serious move to compete with railroading, although at a higher cost. The percentage of truck versus rail shipments in our area has not stabilized at the present time.

Since World War II the trend has been toward larger companies and very few new independent plants, and the merger of existing small cement companies with large cement companies or other soundly-financed companies in allied fields.

Kansas in the next decade or two can at least look to continued activity in an increasingly competitive cement industry. Dispersement of the industry is doubtful in the immediate future, but as more effective transportation is provided on superduty highways, trucking of bulk cement may become a reality. New uses for improved products undoubtedly will increase the production factor, but as technology develops, the labor force in the industry itself is not expected to keep pace. This disadvantage may be offset to some extent by the increased need for technically trained personnel and by development of associated industries.

Clay and Clay Products

Clay and shale, among the most abundant of earth substances, have been utilized by man for at least 10,000 years. Tangible evidences are the relatively indestructible baked clay products that have been unearthed in the ruins of past civilizations, evidences that commonly provide the only durable record between the ancient past and the present. For example, fired clays and pottery pieces from the Nile Valley relate to an Egyptian clay industry dating back to 3,000 B. C. Bricks covered with colored glazes and inscribed baked clay tablets found in the ruins of cities in the Euphrates Valley tell of the civilizations of ancient Babylon and Assyria.

From this far past down to the 20th century, rule-of-the-thumb practices have prevailed in the ceramics industry, and it is only recently that clay technology has been applied to the study of clay and shale raw materials to evaluate them for a variety of precise industrial uses. That clay and shale, under the scrutiny of modern technology, are emerging in new perspective as available and desirable raw materials to support a diversified ceramics industry is one of the hopeful signs in today's minerals industry. The segment of the ceramics industry that seems particularly destined to grow, encouraged by the acceptance and endorsement of clay products by the mushrooming construction industry, is the manufacture of structural clay products.

Kansas is one of the states that is well along in scientific evaluation of its abundant clays and shales and in laboratory research to determine precise adaptabilities of various deposits for specific uses.

Clay is an earthy aggregate of fine-grained minerals and colloidal substances. It is useful primarily because of its plasticity and burning properties; that is, the ability of clay, when wet, to be shaped into desired forms that can then be made permanent

95. *Mineral Facts and Problems*, 1960, p. 174.

when baked at high temperatures. *Shale,* a hardened compacted clay, is also suitable for the manufacture of many types of ceramic ware—ceramic ware being defined as any product made by the high-temperature firing process.

Clays and shales are of many types and have been variously classified.[96] Kaolin, named *china clay* to designate usage, is one of the highest-grade clays. *Ball clay,* which because of unusual high plasticity can be readily rolled into balls, is essentially kaolinite having a high silica-to-alumina ratio; ball clay is white burning and is suitable for use in whiteware manufacture and as a bonding and suspending agent. *Fire clay* includes all refractory clays exclusive of kaolins and ball clays; high in alumina content and exhibiting a range in plasticity, fire clay has a relatively high firing temperature and is suitable for the manufacture of a variety of refractory products, including light-colored brick. *Bentonite* is a special type of clay that has among its uses, depending upon whether it is swelling (high in sodium) or nonswelling (high in calcium), application as a drilling mud or as an industrial bleaching and filtering material. *Fuller's earth* resembles the nonswelling variety of bentonite and is variously used as a cleaning substance or an absorbent in sweeping compounds. *Miscellaneous clay* is, for statistical purposes, any clay not included in the above-mentioned clay types. Most of these clays or their variations are found in Kansas. Commercial production includes mostly fire clay and miscellaneous clay. In some areas, as in southeastern Kansas, clays occur under beds of coal; these clays are designated as *underclay,* and many of them are suitable ceramic raw material. Classified according to use, clays may be called stoneware, paving brick, sewer-pipe, slip (used in glazes), pottery, retort, filler, earthenware, terra-cotta, bleaching, bonding, and foundry clays.

Kansas clay in some form has been used by all peoples known to inhabit the Kansas area. Well-made pottery pieces have been found in burial pits of Indians thought to have frequented the plains before Columbus discovered America; early explorers mentioned the mud huts of Indian tribes they encountered in the Kansas territory; Kansas history records the use of hand-molded building brick fired in crude, temporarily constructed kilns in many eastern Kansas communities in the early days of settlement in the state; and finally we have the evidence of the 20th century clay products industry that includes manufacture of building brick, vitrified paving brick, pottery, sewer pipe and drain tile, wall and roofing and floor tile, burned clay for railroad ballast, and lightweight concrete aggregate for use in making concrete block or in poured concrete.

The Kansas clay industry of the last century is summarized below and shown in Table 64.

1860-1889—Many small brick plants. One in almost every eastern Kansas town at some time during this period . . . . An era of settlement and building . . . . Municipal improvements, stimulated by westward movement of railroads, characteristic of 1880's.

1887—First vitrified paving bricks made in Kansas at Atchison.

1890-1929—Centralization of brick and tile industry in eastern Kansas gas belt. . . . Gas-fired vitrified paving brick of superior quality; marketed widely out of state.

1890's—Decline of brick manufacture, which had begun in the wake of the drought of the late 1880's, continued until after the panic of 1893. Thereafter, growth of industry was steady and the trend noticeably toward fewer brickyards. . . . About 500 million brick produced in 1890 decade.

1896—First gas-burned brick made at Coffeyville—the initial development in concentration of the brickmaking industry in the gas belt.

Early 1900's—Most brick and tile plants in the gas belt completed within 3 or 4 years after 1900. . . . Industry revolutionized. Clay products: Vitrified brick for street paving, sidewalks, and building; pressed brick, common brick; burned clay for railroad ballast; ornamental earthenware and pottery; sewer pipe, drain tile, and roofing tile.

1901—Plant opened at Pittsburg to manufacture sewer pipe, drain tile, and similar hollow products; plant has become one of country's largest of type.

1903—Roofing tile plant established at Coffeyville.

1906—A peak year in number of bricks produced—about 400 million.

1920's—Vitrified and common building brick reached peak in production value—from little more than $5.00 per 1,000 brick in early 1900's to about $12.00 per 1,000 in mid 1920's. . . . Concrete, which for the previous decade and a half was being developed for construction and paving, was gaining as a competitor.

1930-1939—Period of slump, consistent with depression economy. . . . Also, increased use of concrete for paving, building block, and other structural products had seriously narrowed market outlet for brick. . . . Further, red brick for building was losing its fashion appeal.

Late 1930's—State Geological Survey began intensified study of Kansas clays during latter part of decade.

1940-1960—Clay research and revival of Kansas ceramics industry. . . . Several brick and tile plants established in central Kansas between 1945 and 1956. Result of State Geological Survey investigations that determined the excellence of certain cen-

96. Norman Plummer and John F. Romary, *Kansas Clay, Dakota Formation,* Kansas Geological Survey Bulletin 67, 1947, pp. 10-34.

tral Kansas clays for manufacture of ceramic products, especially light-colored brick. (In the building trade, the fashion had shifted from red to buff brick.) . . . State Geological Survey research also led to establishment of a lightweight concrete aggregate plant at Ottawa, Franklin County, in 1951. The bloated shale product manufactured at the plant has been so popular in the construction industry that a subsidiary plant was opened at Marquette, McPherson County, in 1961 to help meet demands.

1960—Outlook good for Kansas ceramics industry. . . . About 350,000 brick produced daily in Kansas plants (10,000 brick will build an average-sized brick house). About 400 cubic feet of lightweight aggregate produced daily; operation of Marquette plant will double output.

Growth of the industry has been influenced by need for products, availability of fuel supply, competition of substitute materials, technological change, building fads, and general business activity. It is understandable that pioneers in the early days of statehood, faced with inadequate supplies of building timber and lack of transportation facilities, should turn to clay as a source of much-needed building material. It is further understandable that many small brick plants should appear near communities at an early stage of development. It is natural that the clay industry should be shaped and influenced by the semi-industrial development of southeastern Kansas in the late 1890's and early 1900's, stimulated by the availability of cheap gas fuel in the eastern Kansas gas belt and encouraged by promoters, railroad officials, and businessmen of the gas-belt cities.[97] The consolidation and centralization that came about in the period has carried into the present.

The character of the industry, which was noticeably top-heavy with vitrified paving brick until into the 1920's, shifted emphasis and drifted into a slump in the depression years of the 1930's. Not only was the total economy in trouble at this time, but concrete had practically displaced brick as a paving material. The use of concrete for construction generally had established its supremacy, and red bricks from eastern Kansas brick plants were faced with a greatly narrowed market accentuated by the lessening appeal of red brick for building.[98] The use of concrete block definitely was on the increase, and many economists predicted that the clay industry would not recover from this slump.

Thanks to clay research, especially the intensified studies of the Kansas Geological Survey, the clay industry got a new lease on life. Specifically, central Kansas emerged in post World War II as a center of the clay industry, specializing in the manufacture of buff and other light-colored brick, at the time much in demand by the public and much in favor by builders and architects.

In the early 1950's, the manufacture of expanded shale aggregate was added to the Kansas clay products industries, and the building of a new lightweight aggregate plant in central Kansas in 1961 is an endorsement of the acceptance of this product by the construction industry. Up to the 1960's, the clay industry exhibited stability, as top-quality Kansas brick maintained a healthy market in Kansas and surrounding territory and the demand for Kansas lightweight concrete aggregate was being felt in a fairly wide market area.

Kansas has widespread deposits—almost unlimited reserves—of clays and other ceramic raw materials. The deposits range in geologic age from the Pennsylvanian shales of the eastern one-fourth of the state to the Pleistocene loesses that cover much of the northern one-half of the state (Fig. 53). Included are extensive deposits of the high-grade fire clays of the Dakota Formation of Cretaceous age in central and north-central Kansas.[99] Silts and clays of Permian age are among the potential ceramic materials, but their range of usefulness does not equal that of the Cretaceous and Pennsylvanian clays and shales or of the Pleistocene silts and loesses.[100]

The Dakota Formation fire clays tend to be the most suitable for manufacture of high-quality light-buff brick and tile, and currently these clays are the source of raw material for three major Kansas brick and tile plants at Concordia, Kanopolis, and Hoisington. Many of the Dakota Formation clays are deemed refractory enough to be used in the manufacture of kiln furniture and other structural ceramic products that must withstand extremely high temperatures. The present need is to extend the study of these clays to include deeper deposits; for this, test drilling equipment is necessary to determine their ceramic quality and their extent.

The Pennsylvanian shales are the basis of the structural clay industry as started in the pre-1900's. These shales have a firing range that permits manufacture of red bricks almost exclusively. The underclays in the coal-producing area of southeastern Kansas are an exception; the brick plant at Weir utilizes underclay in the manufacture of a variety

97. Douglas, pp. 96-99, 203-206.

98 Edward V. Kruger, "The Outlook for Kansas Clay Products Industries," *Industrial Research Series*, No. 1, Bureau of Business Research-Kansas Geological Survey, 1940, pp. 7-42.

99. Plummer and Romary, p. 201.

100. John C. Frye, Norman Plummer, Russell T. Runnels, and William B. Hladik, *Ceramic Utilization of Northern Kansas Pleistocene Loesses and Fossil Soils*, Kansas Geological Survey Bulletin 82 Part 3, 1949, pp. 80-123.

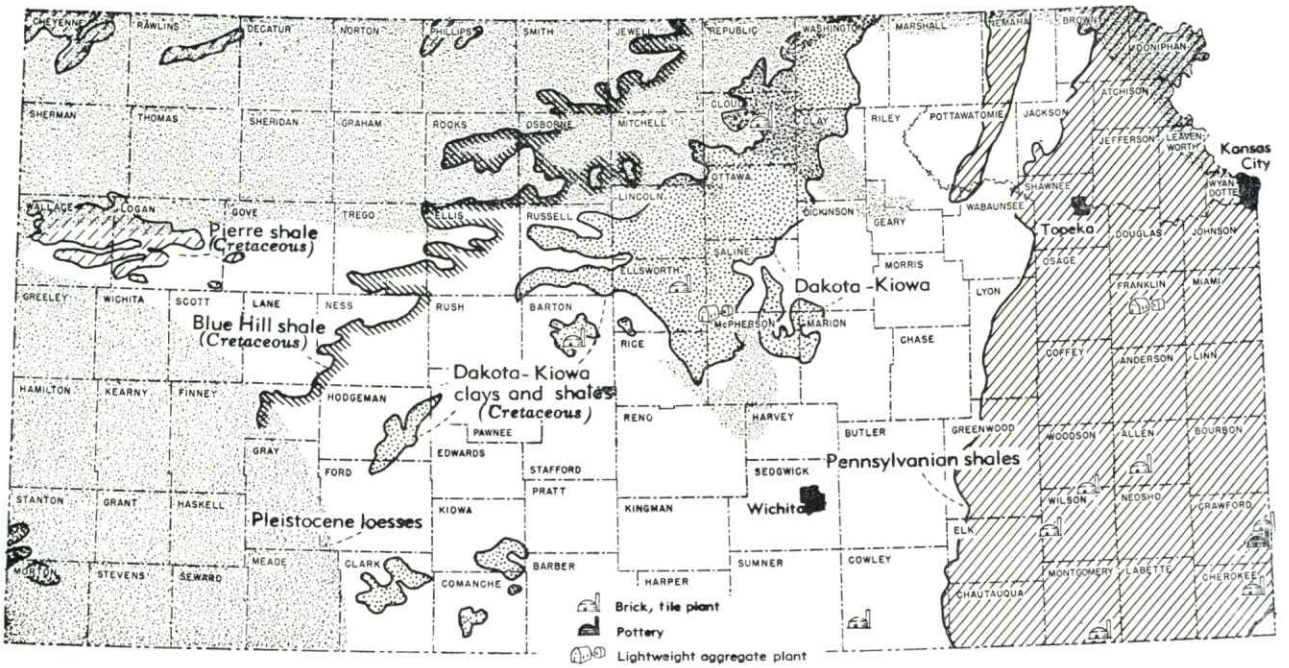

FIG. 53.—Map showing location of raw materials for clay products in Kansas. (Sources: Kansas Geological Survey publications, especially Bulletin 67: *Kansas Clay, Dakota Formation;* Bulletin 91: *The Manufacture of Lightweight Aggregate From Kansas Clays and Shales;* and Bulletin 82 Part 3: *Ceramic Utilization of Northern Kansas Pleistocene Loesses and Fossil Soils.*)

of buff and other light-colored bricks. Pennsylvanian shales have been and are still extensively used in the manufacture of building brick of different shapes; tile, including drainage and sewer tile; and more recently lightweight concrete aggregate.[101] Lightweight shale aggregate, variously called expanded shale aggregate and haydite, is now an established mineral commodity in growing demand for construction where lightweight, strength, and durability are desirable. Even though a plant near Kansas City is no longer in operation, this is no reflection on the market for the product. Buildex, Incorporated, the plant at Ottawa, has found an increasing market for the plant's product throughout the 1950's, and in 1960 established another plant at Marquette, McPherson County, to supply the demand in central Kansas and the adjacent areas to the north and west. This plant is utilizing Kiowa (Cretaceous) shale as a raw material (Fig. 53). A branch of the Missouri-Pacific Railroad serves the plant and natural gas is available as a fuel. The output of the plant is expected to double the quantity of lightweight aggregate marketed annually from Kansas.

The lightweight aggregate product is marketed for manufacture of concrete building blocks and to an increasing extent for poured concrete in bridge decks, roof decks of public structures, intermediate floor decks in tall buildings, and in some other places where lower weight is an advantage. By reducing the dead weight of concrete mixtures, less structural steel is needed in bridges and similar superstructures; this in turn means a dollar saving to the construction industry.

An established use of Pennsylvanian shales is in the manufacture of portland cement, and a Nebraska plant is utilizing the Cretaceous chalky shales of central Kansas for cement manufacture. Some of the state's ceramic raw materials have been found suitable for use in the manufacture of rock wool and similar insulating materials.

Silt, clay, and shales of most geologic ages are suitable for use in railroad ballast, concrete aggregate, and road metal. Pleistocene loesses and silts, which constitute the most widespread ceramic raw material in Kansas, not only are a source of material for manufacture of brick and tile but also of both light and heavy ceramic aggregate. The accelerated superhighway and other road-building programs, the tendency toward portable plants, and the general nonavailability of rock aggregates that meet the stringent specifications of super construction projects suggest that heavy ceramic aggregates possibly could provide the much-needed material.

101. Norman Plummer and W. B. Hladik, *The Manufacture of Lightweight Concrete Aggregate from Kansas Clays and Shales,* Kansas Geological Survey Bulletin 91, 1951, pp. 1-100.

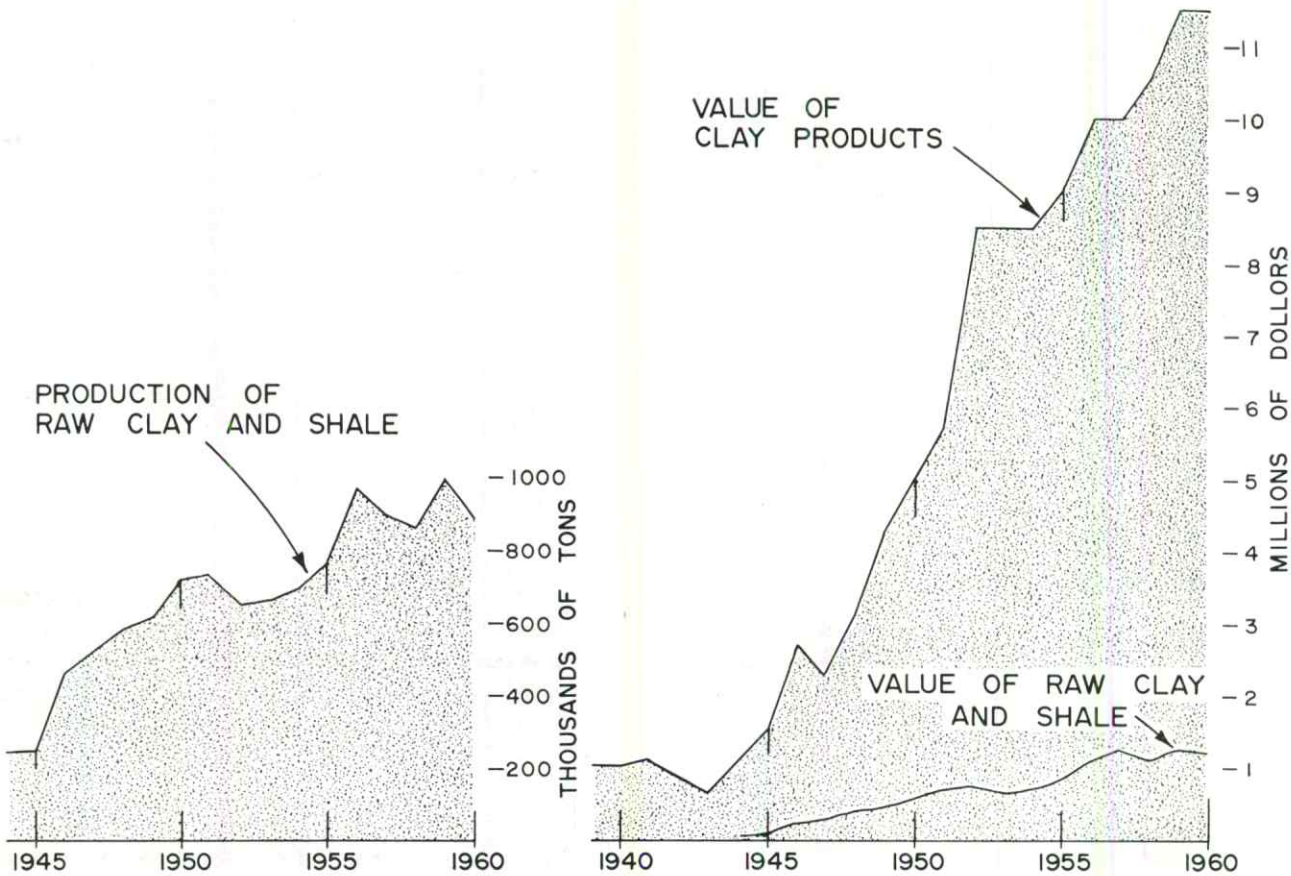

FIG. 54.—Production of clay and shale and value of clay products in Kansas, 1939-1960. (Table 65.)

Because clay and clay products are so closely related at the production level, economic analysis is more meaningful if they are discussed together. Accordingly, production and value of raw clay and shale and clay products from 1939 to 1960 are shown in Table 65 and Figure 54. It is important to remember, however, that a part of clay and shale production is used in the manufacture of cement. These data stress the postwar development of the clay products industry in Kansas. The first of the central Kansas brick plants, Cloud Ceramics, was established at Concordia in 1946. A year later, a plant was established at Great Bend and the value of clay products nearly doubled from the late 1940's through 1952. Lightweight aggregate plants at Ottawa and near Kansas City were established in 1951 and 1952 and a plant for the manufacture of wall and floor tile was opened near Arkansas City, boosting production and value. The industry steadied for a few years, and with the establishment of a plant at Hoisington in 1955 and another plant at Kanopolis in 1956, the rise continued until about 1959. Established ceramic plants of eastern Kansas shared in the general industry prosperity during the growth period. However, because red brick had lost appeal as a building material, most of these plants turned to special types of brick and tile production. The sewer clay pipe manufactured at Pittsburg, for example, now has an established market and the plant at Buffalo specializes in the manufacture of a brick used in chemical industries. During this growth period, clay products were in great demand to support construction of all kinds and Kansas producers were well situated to supply this demand with good products. Nevertheless, the industry has become very competitive and transportation costs have placed Kansas producers at a disadvantage except for very local markets or specialty products.

Employment and wages for the structural clay products industry are shown in Table 66 and Figure 55. Except for a decline during the recession in 1957, the industry has shown relative stability. Perhaps the more significant information is to be found in the decline in the number of units reporting; consolidation of plants has been in progress and one might expect that the decline in the number of workers in 1961 is a reflection of efforts in the direction of more efficient operation.

Comparison of data for clay products in Kansas and neighboring states (Table 67) shows trends in the individual states and does not necessarily have relevance to the Kansas industry. Both Missouri and Colorado, for example, produce mostly refractory clays, which are not competitive with Kansas clays, produced mainly for the manufacture of brick (Table 67). These two states do have a lightweight aggregate industry but there seems to be no conflict in the marketing of products. Iowa could possibly be a competitor for the Kansas product but Nebraska and Oklahoma at present are not competitors. It might be pointed out that most of the clay produced in Kansas is miscellaneous clay, whereas most of the clay in Missouri is high-grade fire clay for refractories.

Table 68 shows the number of bricks produced in Kansas from 1948 through 1961. General business and construction activity are reflected in these data. Perhaps a more meaningful index of activity is to be seen in the record of bricks produced but not sold, shown also in Table 68. For the period January 1, 1960, to March 1, 1962, Kansas brickyards had on hand 33,003,000 bricks or 12.7 percent of production for the period, whereas the nation's brickyards held 3.5 percent of production. Although producers usually retain brick in the yard for rapid delivery to customers, it is evident that Kansas producers have a large surplus despite reduced production since 1959 and that the industry faces increasingly strong competition for markets.

The cost of transportation has become a major factor in the competition for clay-product markets. To date, most of the bricks from most plants are shipped by rail, but there is a growing tendency to ship by truck, especially in eastern Kansas areas. W. S. Dickey Clay Company of Pittsburg, for example, indicates that rail shipment of their product is practically nonexistent because of cost and delivery inconvenience. The company has six transports of its own but uses mostly contract truck carriers. Twenty-five years ago, the plant shipped almost entirely by rail, but today many customers do not even have rail sidings.

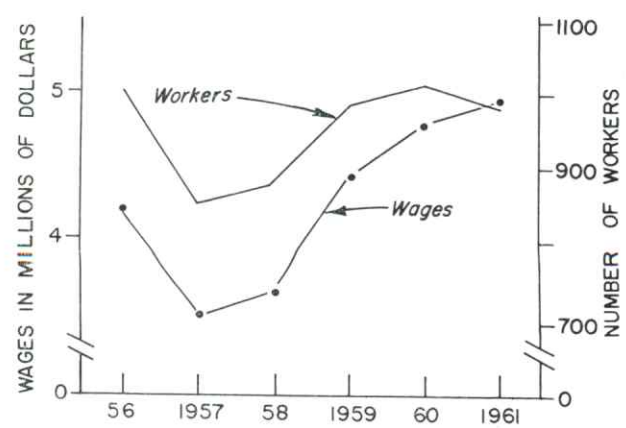

FIG. 55.—Employment and wages in Kansas structural clay products industries, 1956-1961. (Table 66.)

The market area for structural clay products seemingly includes Kansas, Nebraska, Missouri, northern Oklahoma, northwestern Arkansas, and to a certain extent, parts of Iowa, South Dakota, Minnesota, and Wisconsin. Colored brick from Kansas has a relatively wide market area in the Midcontinent region and some of the brick is shipped to far parts of the country and even into Canada. The brick is of high quality and has been widely accepted by architects and builders, who have publicly recommended it. Through a program of intensive research carried out co-operatively by producers and the Kansas Geological Survey, the industry has been able to adapt to changing needs. It is a curious fact, however, that although Kansas has a first-rank quality product clay industry, brick is not widely used within the state, especially for home construction. Kansas would do well to promote its own industry and find solutions for the shortage of brick masons.

There is a growing demand for more and better refractory materials. At present, Kansas is not in a position to compete with Missouri in manufacture of this commodity because Missouri has extensive deposits of high-grade refractory clay. However, central Kansas clays can be developed for excellent refractory products if demand is great enough. The manufacture of heavy concrete aggregate from the loesses of northern Kansas holds promise. It has become increasingly difficult to meet highway specifications for aggregate in many areas and the clay industry may be able to enter this field. The product could be produced at portable operations near construction.

Kansas, then, faces a highly competitive market in clay products that stems largely from transportation costs. Aggressive product research, and product promotion within the state are necessary for continued growth of the industry.

GYPSUM

Gypsum is a seemingly ageless mineral commodity. It can be traced through thousands of years from specialized uses in ancient Chinese art, Assyrian sculpture, Egyptian design, and Roman architecture to almost universal use as plasters and prefabricated plaster products in modern construction.[102] The utilization of gypsum products in the

102. *Mineral Facts and Problems*, 1960, p. 367.

construction industry has in fact become so firmly established that gypsum consumption rises and falls with the expansion or curtailment of construction. Hence, production in the United States in 1960 — almost 10 million tons of crude gypsum valued at almost $36 million and approximately 8.6 million tons of calcined gypsum valued at $121 million—declined slightly from production in 1959.

Large deposits of gypsum occur in various parts of the country, including Kansas. Since 1900 annual production in the United States has increased about fourfold. The United States accounts for about one-fourth of the world's output and most of the gypsum produced in this country is used in this country, but imported crude gypsum, mainly from Nova Scotia, supplies some of the coastal areas. The gypsum production is controlled principally by three major companies—the United States Gypsum Company of Chicago, National Gypsum Company of Buffalo, New York, and Bestwall Gypsum Company of Ardmore, Pennsylvania. Mine and plant operations—69 mines and 61 calcining plants—are located in approximately 30 states. In Kansas, mine and plant facilities are located at Blue Rapids in Marshall County and near Medicine Lodge in Barber County, and are operated by National Gypsum Company and Bestwall Gypsum Company respectively. Both Kansas plants produce specialized top quality gypsum plasters and plaster products, and the plants are in fact located in Kansas only because Kansas gypsum can be manufactured into superior products.

Gypsum is hydrous calcium sulfate, or calcium sulfate containing water. The same chemical compound without water is anhydrite. Both gypsum and anhydrite are found in Kansas, commonly in associated deposits. Three varieties of gypsum, all found in Kansas, are recognized: *selinite*, a transparent, coarsely crystalline, cleavable, generally colorless form; *satin spar*, a fibrous form that may be white or pink and that has a silky luster; and *rock gypsum*, a compact, granular, colorless-to-white or light-gray variety. Rock gypsum is the commercially produced gypsum in Kansas. Alabaster, the material used by the ancients in sculpturing, is a very fine-grained type of massive gypsum; alabaster has not been found in Kansas. *Gypsite*, or *gypsum dirt*, is a soft, earthy, impure deposit containing a large amount of gypsum. Gypsite deposits are found in Kansas; in the past they have been exploited as sources of commercial gypsum but presently are not being mined.

Raw, or *crude, gypsum* has a wide variety of uses but the chief use is as a retarder in portland cement; the presence of gypsum in cement retards setting long enough to enable the concrete to be poured into forms. Raw gypsum may be used as a soil conditioner or land plaster, as a mild abrasive in toothpaste and powder, as a filter in paint and paper, as a base in insecticides. *Calcined gypsum*, or *plaster of paris*, is gypsum that has been heated until most of its contained water has been driven off; when water is restored, the material can be set into any desired shape. Gypsum that has been completely calcined is known as *dead-burned gypsum*. Keene's cement is a special type of dead-burned gypsum to which the property of quick setting has been restored by the addition of salts. Because the quality of Kansas gypsum is superior, the Kansas plants manufacture somewhat specialized products in the form of plaster of paris and its fabrications. These include gypsum wall plasters, Keene's cement, and prefabricated wallboard. Among other specialty products are orthopedic and dental plaster, industrial and molding plaster.[103]

Gypsum has rather widespread occurrence in Kansas rocks, but all known workable deposits occur in Permian rocks, in the vicinity of Blue Rapids, Marshall County, in a north-south belt across east-central Kansas, and in an area west of Medicine Lodge in Barber County and in adjoining parts of Comanche and Kiowa Counties (Fig. 56). The bedded deposits are chemical precipitates from a large inland sea. In the Blue Rapids area, a massive bed of superior quality gypsum that averages 8 to 9 feet in thickness is being mined by the underground method. Gypsum is calcined and manufactured into specialty gypsum plaster products in a plant at the mine location. In the Medicine Lodge area, superior quality gypsum is being produced from a massive gypsum-anhydrite bed having a maximum thickness of 30 feet in an underground mine south of Sun City. Gypsum is crushed at the mine and transported by rail 20 miles to a plant at Medicine Lodge, where calcining takes place and specialized gypsum plasters and plaster products are manufactured.

Potential commercial gypsum occurs in subsurface Permian rocks throughout the central Kansas area, indicated on the map in Figure 56. In several places in central Kansas, as indicated on the map, gypsite, the earthy variety of gypsum, has been produced.

It is an established fact that Kansas has large deposits of gypsum that could support new gypsum

103. Robert O. Kulstad, Paul Fairchild, and Duncan McGregor, *Gypsum in Kansas*, Kansas Geological Survey Bulletin 113, 1956, pp. 1-110.

plants or expansion of existing facilities. Natural gas as a fuel currently is available throughout the area. It is further known that trends in the building industry indicate that plaster products are replacing other building materials, especially wood. Balanced against these advantages is the fact that Kansas gypsum deposits are relatively remote from centers of population, which means that transportation costs to distant markets would make it almost impossible for the Kansas product to compete with gypsum products of other areas if the Kansas product were not of high quality. Despite available materials, then, many economic factors are drawbacks, and to permit or encourage expansion, adjustments must be made in transportation, labor, and population concentration.

The history of the Kansas gypsum industry demonstrates a probable course of events when a superior raw material is discovered and is developed without complete cognizance of other economic factors. The industry doesn't die, but many of its over-extended parts do, or are absorbed until the operations are centralized or stabilized to the demands of the market area.

The Kansas gypsum industry had a romantic beginning. One of the earliest settlers in the vicinity of Blue Rapids in 1858 accidentally calcined some gypsum at his campfire, and out of the burned product he made a plaster to chink the cracks of his cabin.[104] Many houses in the new town of Blue Rapids in the following year were similarly plastered, and the commissioners of the town, realizing the advantages of the local gypsum beds, reserved a strip 100 rods long and 320 feet wide along the river where the gypsum deposit was known. But it was not until after the Civil War that the first gypsum plaster was manufactured in Kansas. The industry began at Blue Rapids in 1872 when the Coon Brothers of Elmira, Ohio, came to Blue Rapids and began to manufacture plaster of paris in a five-barrel kettle. The business was enlarged in 1875 and was valued at $10,000. The plant operated until 1887 and a few years later was destroyed by floods. This plant was never rebuilt, but before it closed its doors another plant was built by H. G. and F. W. Fowler, who organized the Blue Rapids Plaster Company. This company operated until it was purchased by the United States Plaster Company of Toledo, Ohio, in 1900. At about the same time two other mills, the Kansas Cement Plaster Company and the Great Western Plaster Company, were established at Blue Rapids.

104. G. P. Grimsley and E. H. S. Bailey, *Special Report on Gypsum and Gypsum Cement Plasters*, The University Geological Survey of Kansas, Vol. V, 1899, p. 51.

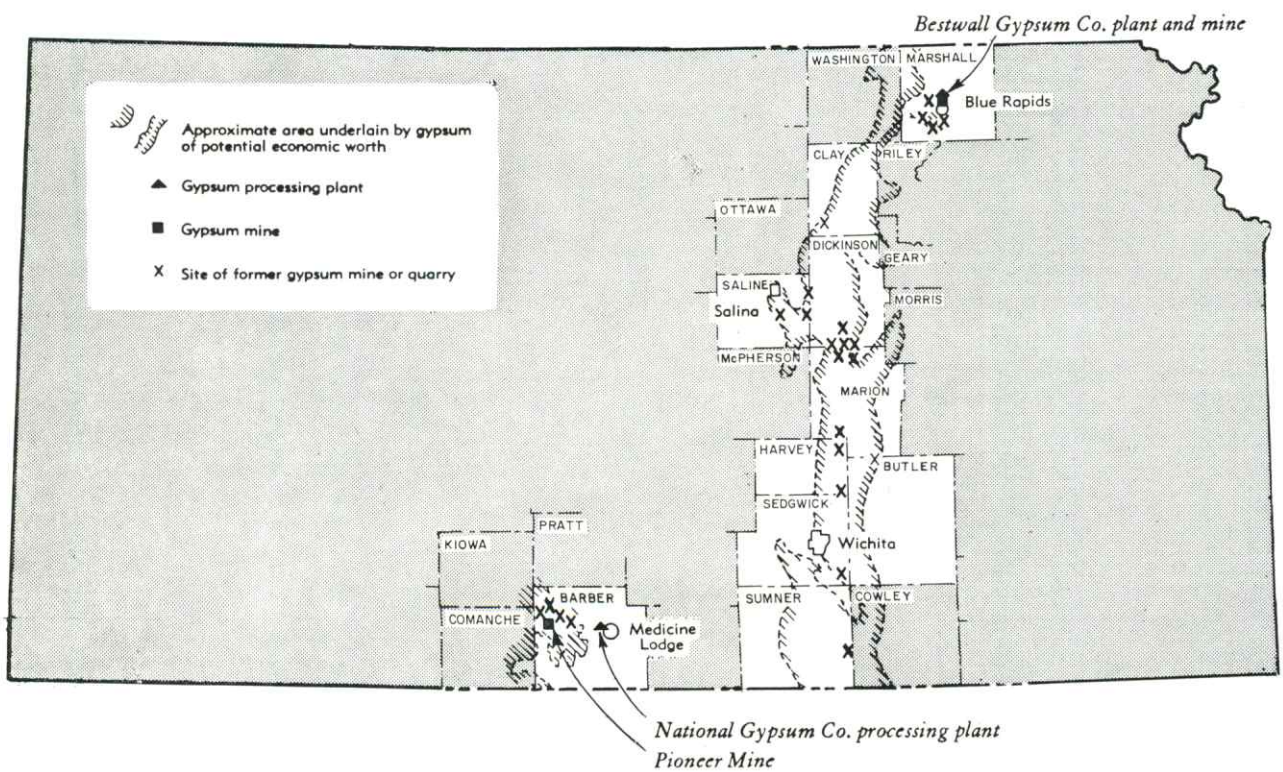

Fig. 56.—Map showing location of gypsum deposits, plants, and mines in Kansas. (Source: Kansas Geological Survey Bulletin 113: *Gypsum in Kansas.*)

Elsewhere in the state other gypsum deposits were attracting attention. In the 1870's gypsum dirt had been discovered in Saline County, and in 1889 a company of Salina men formed the Acme Cement Plaster Company. Soon other mills in the central area were established, most of them utilizing gypsite as a raw material. By 1900 plants had been built and were operating in this central area—at Dillon, Dickinson County; Rhodes and Burns, Marion County; Longford, Clay County; and Mulvane, Sedgwick County. Farther south, perhaps the most important development of the period was the building of the Medicine Lodge plant in Barber County in 1889. An article by Professor Robert Hay on the Barber County gypsum deposits appeared in *Harper's Magazine* in 1888 and was read by some English capitalists who made a trip to Barber County to see if the Barber County deposits were as pure as described. Deciding they were, they built their plant and began producing Best Brothers Keene's Cement, a superior product that became famous and commanded a market area that reached as far east as New York despite high costs of transportation.

Mills continued to increase through the early 1890's and by the middle of the decade Kansas was the number one gypsum-producing state, a rank held only temporarily, unfortunately. Gypsum plaster from Kansas was utilized in the World's Fair buildings in Chicago in 1893, and in 1904 a facade of gypsum plaster was the front entrance to the Kansas exhibit at the St. Louis Exposition. The year 1895 was the industry's banner year, 72,000 tons valued at approximately $370,000 (Table 69).

Then the market area began shifting as Texas deposits, developed by one of the owners of a Kansas plant, moved into the field.[105] The Kansas mills had been finding a market in the western states and as far east as Ohio, even though freight rates were high. In 1897, for example, common rates from Kansas to St. Louis were $3.00 a ton, to Chicago $4.00 a ton, or more than the manufacturers of the same class of product in New York paid for freight to either Chicago or St. Louis. It was the quality of the Kansas gypsum that enabled such favorable competition.

About 1900 or shortly afterward gypsum began to experience the movement toward centralization. The first was American Cement Plaster Company, organized at Lawrence in 1898; the company opened a mill at Mulvane, Sedgwick County, in 1899, and already had a large plant at Quanah, Texas. The Lawrence company then acquired two other companies with three mills in Kansas and started large mills at Grand Rapids, Michigan. Other consolidation and mergers followed until two combinations—the American Cement Plaster Company and the United States Gypsum Company—had completed centralization of management so that it was possible to raise the price of gypsum from $4.30 a ton to $5.00 a ton. The Medicine Lodge plant remained the single competitor of the two companies.

Several other factors entered the picture about this time. The gypsite deposits of central Kansas were becoming depleted and activity in the building trade was not great enough to demand great quantities of gypsum plasters.

Improvements and methods of handling raw gypsum and in calcining gypsum were a corollary of centralization. From 1928 to the present, Kansas has had only two operating gypsum plants—The National Gypsum Company plant at Medicine Lodge (until 1938 the Best Bros. Keene Cement Company) and the Bestwall Gypsum Company plant at Blue Rapids (formed by the Certain-teed Products Corp. in 1956, and originally, 1896, the Great Western Plaster Company—American Cement and Plaster Company, then the Beaver Products Co.). These plants are thoroughly modernized. The Medicine Lodge plant was remodeled in 1951 and the Blue Rapids plant rebuilt in 1960, following the destruction of the previous plant by fire. Both plants produce superior quality gypsum products and both are optimistic about future production and consumption.

The present status of the Kansas gypsum industry cannot be illustrated by statistics of production, concealed since the late 1920's. With deference to the state's two operating plants, it can be said that the manufacture of superior quality gypsum plasters and plaster boards is one of Kansas' million-dollar industries. A peak behind the production curtain shows a somewhat favorable trend in recent years (Table 69). For example, crude and calcined gypsum form a parallel pattern, reacting logically to exterior pressures in the economy. The value for the calcined product is particularly impressive; it emphasizes the superiority of Kansas gypsum. Predictions by those in the industry who believe in continued demand for the Kansas product and look to capacity production within the next 20 years are probably well founded.

The combined values of gypsum, natural cement (which incidentally suffered a major setback in 1960), volcanic ash, and diatomaceous marl (Table

105. Douglas, pp. 181-186.

70) portray the importance of gypsum and at the same time call attention to the limited utilization of certain other mineral resources.

The employment-wage pattern of the gypsum industry is concealed by the concrete industry (Table 71); nonetheless, the income contributions of these interrelated industries are seen to be of some magnitude. No further comment will be made except to point out that the low-unit high employment-wage ratio of 1956 and 1957 can be attributed to a different method of computation for these years.

Comparisons of economic activity in the gypsum industry in Kansas, the United States, and surrounding states are impossible because data are concealed to avoid disclosing the competitive positions of the few producing companies. In 1960, Oklahoma reported production from 5 mines, and Iowa reported production of 1,283,000 short tons from 5 mines with a value of $5,428,000. Iowa is the third largest producer in the United States (following Michigan and California) with an estimated production value at least five times that of Kansas.

Sand and Gravel

Sand and gravel are low-unit value mineral materials familiar to almost everyone. In broad definition, sand consists of loose, unconsolidated rocks having particle size between that of silt (under 0.0029 inches in diameter) and pebbles (under 0.25 inches in diameter). Gravel is coarser and is made up of rocks having particle size ranging up to about 3½ inches in diameter. Both sand and gravel have resulted from natural disintegration of rocks and both may be composed of materials in which a single mineral predominates or in which there is a mixture of many minerals, depending upon the composition of the original rocks. Kansas sands and gravels, for the most part, are composed of such hard, resistant minerals as quartz.

The sand and gravel industry fits no well-defined category of organization, as producers of sand and gravel range from large corporations operating highly-complicated processing plants to one-man, stream-bank operations characterized by little or no processing. Production facilities may be large stationary plants or small portable operations. At least 4,000 active commercial plants are scattered throughout the nation—more than 120 in Kansas—and practically every county in every state is a potential producer, if not a producer, of sand and gravel.[106]

106. *Mineral Facts and Problems*, 1960, p. 701; Schoewe, *The Mineral Industry in Kansas in 1960*, p. 77.

Sand and gravel attained industrial prominence in the United States at the beginning of the 20th century, at which time their use was stimulated by the introduction of portland cement and steel-reinforced concrete in the construction industry. Used principally as fine and coarse aggregate in concrete for construction of buildings, bridges, dams, highways, and similar structures, sand and gravel are products of a mineral industry that in the United States has the largest output of the nonfuel mineral industries and a dollar value that is among the highest.

Greatest tonnage and value of Kansas-produced sand and gravel are derived from structural sand and gravel, classed as *paving sand and gravel*, used in all forms of road and pavement construction; and *building sand*, used in engineering and architectural structures, and in mortar and plaster (Table 82). Some material is used as traction and filter sand, some as railroad ballast, and some as grinding, polishing, and molding sand. In addition, some Kansas River sand is used in fiberglass manufacture, and potential glass sand is found in the corner area of Kiowa, Barber, and Comanche Counties.[107]

Sand and gravel deposits have widespread occurrence in Kansas (Fig. 57), and about two-thirds of the state's counties currently are producers. Derived from rocks of many geologic ages, deposits include well-sorted homogeneous flint gravels of southeastern Kansas; heterogeneous, poorly-sorted glacial gravels of northeastern Kansas; uniformly-sized dune sands in central and southwestern Kansas, mostly south of Arkansas River; highly-variable upland gravels of the High Plains area in western Kansas; and abundant river sands and gravels found almost anywhere along the major stream courses of the state. Most sands and gravels currently being produced are dredged from floodplain and river deposits; hence, production is concentrated along the river systems.

Sand pumps are standard equipment in obtaining material from the river beds; other equipment commonly is at hand for use in screening, washing, or otherwise preparing the material, to increase its sales value. (Prepared material has from 60 to 100 percent greater value than the unprepared.) In areas of dry pits, power shovels, bulldozers, and other heavy earth-moving equipment also are necessary.

The utilization of sand and gravel undoubtedly featured in the early development of Kansas com-

107. Earl K. Nixon, Russell T. Runnels, and Robert O. Kulstad, *The Cheyenne Sandstone of Barber, Comanche, and Kiowa Counties, Kansas, as Raw Material for Glass Manufacture*, Kansas Geological Survey Bull. 86 Part 3, 1950, pp. 41-84.

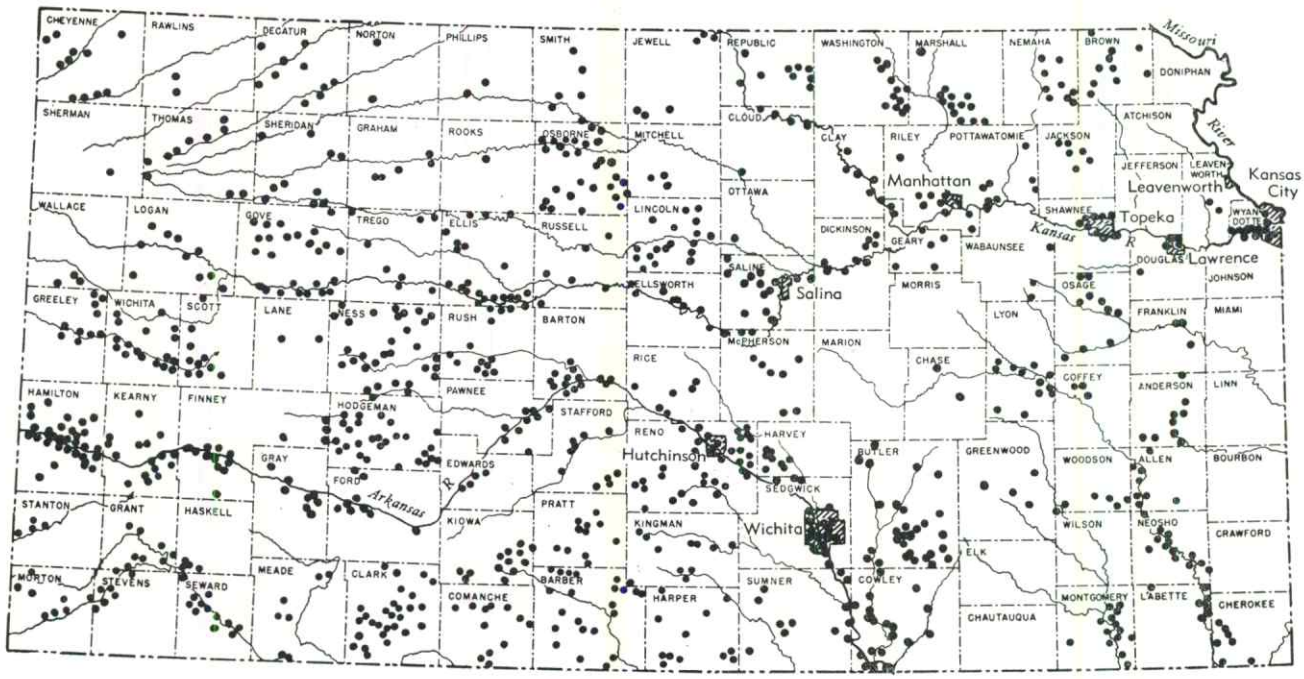

FIG. 57.—Map showing Kansas sand and gravel pits. (Source: Unpublished data, Kansas Geological Survey.)

munities, but statistical information is lacking.[108] Recorded production of sand and gravel began in 1905, about the time the portland cement industry was getting a good start in the state. The production reported for the year, slightly more than 70,000 tons, had a value of about $21,500. Production increased about 4½ times the next year and by the beginning of World War I exceeded 1 million tons a year and had an annual value of more than $300,000.

Production of sand and gravel decreased through the World War I years, but from 1920 to 1930 annual production advanced from approximately 1,275,000 tons valued at about $906,000 to more than 3,230,000 tons valued at about $1,650,000. Throughout the depression years of the 1930's production was consistently under 3 million tons annually valued, for the most part, under $1 million. Table 72 shows production and value for selected years up to 1940.

At the present time sand and gravel rank 7th among the mineral commodities of Kansas. During 1960 the output was about 9.7 million tons, valued at 6.8 million dollars (Table 73). As shown in Figure 57, sand and gravel operations are not confined to any one area, although concentration is along streams, and production tends to be close to population centers.

Figure 58 and Table 73 show trends in sand and gravel production for the 1939-1960 period, during which time production totaled more than 150 million tons valued at approximately $95 million. Sand and gravel production was generally upward during the period, and production and value seem to have advanced at a more comparable rate than have production and value for many of the other commodities of the construction industry. This perhaps emphasizes the low-unit value of sand and gravel and gives credence to the need for automation to increase productivity. The demand for sand and gravel in the early 1940's points to the utilization of these materials in wartime defense construction. The lull near the war's end, when defense construction contracts had been completed and domestic construction was still at a minimum, was followed by demand for the product in postwar construction.

The slight setback in 1947, contrary to the national trend, can be attributed to local relaxation in construction. Local weather conditions, specifically one of the worst floods in Kansas history, hindered construction and lowered the demand for sand and gravel in 1951; hence the major drop in the product for that year. Production of sand and gravel in the United States in 1951 has surpassed all previous records (Table 74), and production was steady for the five-state area of Colorado, Kansas, Missouri, Nebraska, and Oklahoma. The pattern of production thereafter in the 1950's in Kansas tended to correspond to that of the general economy, as indicated by the peak in 1956

108. Schoewe, "The Geography of Kansas," p. 441.

and the low in 1957. The decline in 1960 was caused mostly by decline in building activity. It will be noted that for the United States, 1960 was the only down year in the 1950-1960 period. On a nationwide basis, this decline in 1960 can be attributed to a decline in total expenditures for private building.[109]

On a percent basis, production of sand and gravel in Kansas increased about 328 percent from 1940 to 1960 but, almost paradoxical to the intermediate climb in the 1950's, decreased about 0.7 percent from 1950 to 1960. For the five-state area, the increase from 1950 to 1960 was approximately 90 percent, and for the United States approximately 91 percent.

Table 75 shows number of workers (covered and estimated) and wages for a given number of units in the sand and gravel industry, 1956 through 1961. The trend as shown seems to be consistent with production trends and value.

The Kansas sand and gravel industry, despite its seeming simplicity and assured permanence, has its share of problems in attempting to satisfy the needs of a complex construction industry. Deposits of sand and gravel are widespread, yes, but contrary to popular opinion not all deposits in Kansas, as elsewhere, are useable; some deposits do not meet the rigid specifications of modern construction, some cannot be worked because of zoning restrictions, and some are inaccessible. Adequate deposits are available in much of western Kansas (in the more sparsely populated section of the state), but in eastern Kansas sand is limited mainly to riverbed deposits. These sources in eastern Kansas are further restricted in that good sand deposits are relatively scarce along certain river systems in southeastern Kansas that have their source east of the Flint Hills. Also, hill gravel in eastern Kansas is not, for the most part, suitable for use in concrete aggregate, which is the big use for sand and gravel. These restrictions give the edge to competitive sources of aggregate.

The outlook for sand and gravel production in Kansas and in the country as a whole is excellent. With the prospect of population growth and major construction projects, most obvious of which presently in the superhighway programs generated by the Federal Highway Act of 1956, it is not unrealistic to predict production of a billion tons of sand and gravel annually in the country by 1970.[110]

109. *Minerals Yearbook, 1960,* Vol. I, p. 949.

110. *Minerals Facts and Problems,* 1960, p. 713.

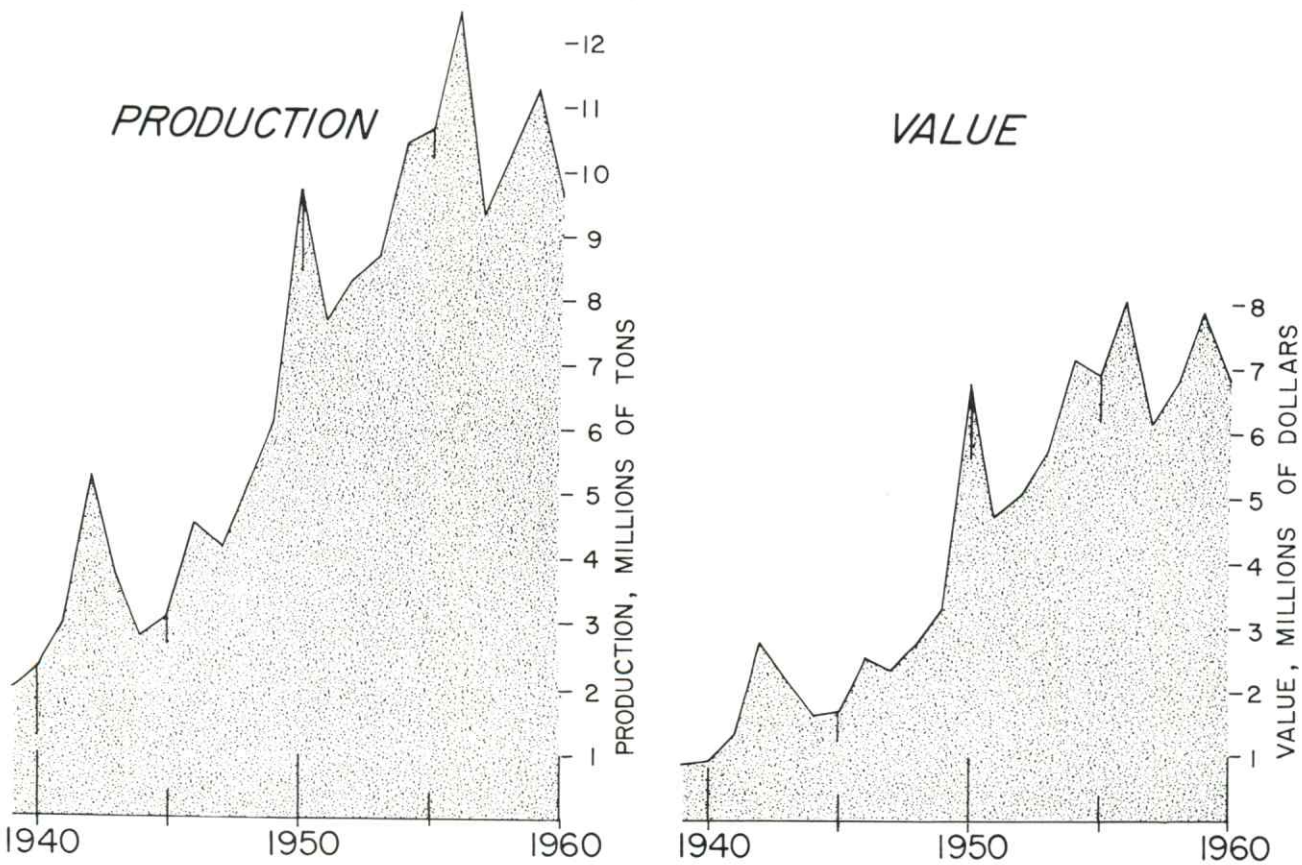

FIG. 58.—Kansas sand and gravel production and value, 1939-1960. (Table 73.)

Presumably Kansas will have its share. The industry, however, will be faced with such problems as holding unit values and profits at a low margin because of competition from other materials, including aggregate produced by contractors. Research is increasingly more necessary to meet stringent specifications, and Kansas sand and gravel producers can be expected to follow the national trend in placing greater emphasis on automation.

Stone

Stone is the commercial term for all natural rock materials that are quarried or mined for constructional or industrial uses. Construction stone, or rock materials used in the construction trade (directly without calcining or chemical processing), embraces both *dimension stone* and *crushed* and *broken stone.*

Dimension stone is natural rock quarried to obtain blocks or slabs that meet specifications as to size and shape; included in the classification are several types of building stone, from rough-hewn blocks to cut stone of precise size and shape, and flagging stone.[111] The major use of dimension stone is as block to form exterior walls of buildings, but the stone has various other architectural uses and in slab form is used as veneer on walls, as sidewalks, curbing, and even paving block. In the past, dimension stone has been used extensively for bridges, retaining walls, and similar structures.

Crushed and broken stone is used mainly as concrete aggregate, road metal, railroad ballast, road dressing, and highway base. Riprap, included in the crushed-stone category, consists mostly of quarry blocks of irregular shapes and sizes and is utilized for rough construction, such as breakwaters, jetties, piers, and fills; quarry wastes, or broken blocks that are rejects of dimension-stone quarries, are the principal source of riprap. Stone fragmented to various sizes for special purposes—fluxes, refractories, agricultural lime, roofing granules, and cement—is included in the crushed and broken stone category.

Stone is still one of the most important raw materials of the building and construction trades, but with the advent of steel and concrete, use in the form of dimension stone has greatly decreased. Crushed and broken stone, on the other hand, have become a major mineral commodity in 20th-century industrial pursuits. Large amounts of crushed and broken stone are required in many types of construction projects, the most prominent of which are in evidence in the accelerated nation-wide highway program.

The rock formations of Kansas provide an abundance of stone, principally limestone and sandstone, suitable for use in both the dimension stone and the crushed and broken stone segments of the stone industry. Pennsylvanian and Permian rocks, which are exposed in the eastern one-third of the state (Fig. 59), are the most extensively utilized because of the quality of the rock and because of the greater concentration of population and industry in this part of the state. Rocks in the Cretaceous area of north-central and west-central Kansas are a source of a variety of rock products; the rocks range from chalk, a white-to-buff, relatively pure limestone, to brown, iron-stained sandstone. In the High Plains area of western Kansas, Ogallala (Tertiary) sandstone and "mortar beds" are among the principal rocks exploited in the construction industry.

Permian limestones in the Flint Hills region (Fig. 59) are the source of the most popular commercial building stones of Kansas. They include the buff-to-tan Fort Riley Limestone, quarried extensively in many localities in the past and currently quarried near Silverdale, Cowley County, and in the vicinity of Junction City, Geary County; the "Onaga" (Funston) Limestone, similar in texture to the Fort Riley and quarried in Pottawatomie County; and the buff-to-white Cottonwood Limestone, quarried primarily in Chase County.

In north-central Kansas, the brown-streaked, tan "Fencepost Limestone" bed of the Greenhorn (Cretaceous) rock formation has been utilized extensively not only for buildings, bridges, and other structures but also for fenceposts. "Fencepost Limestone" presently is being quarried to provide building stone for public buildings and houses in the north-central Kansas region. The light-brown to dark-brown Dakota sandstone, the easternmost Cretaceous unit shown in Figure 59, is used locally, to some extent, as building stone and has been used extensively as foundation stone. Farther west, the Fort Hays member of the Niobrara chalk in the past has been quarried rather extensively for local building, but because of its softness it is not as weather-resistant as some of the other building stones.

Pennsylvanian limestones and some sandstones have been extensively quarried as building stone and many still are utilized locally, but the only reported current commercial production is the Bandera sandstone, Bourbon County.

111. Hubert E. Risser, *Kansas Building Stone,* Kansas Geological Survey Bulletin 142 Part 2, 1960, pp. 53-122.

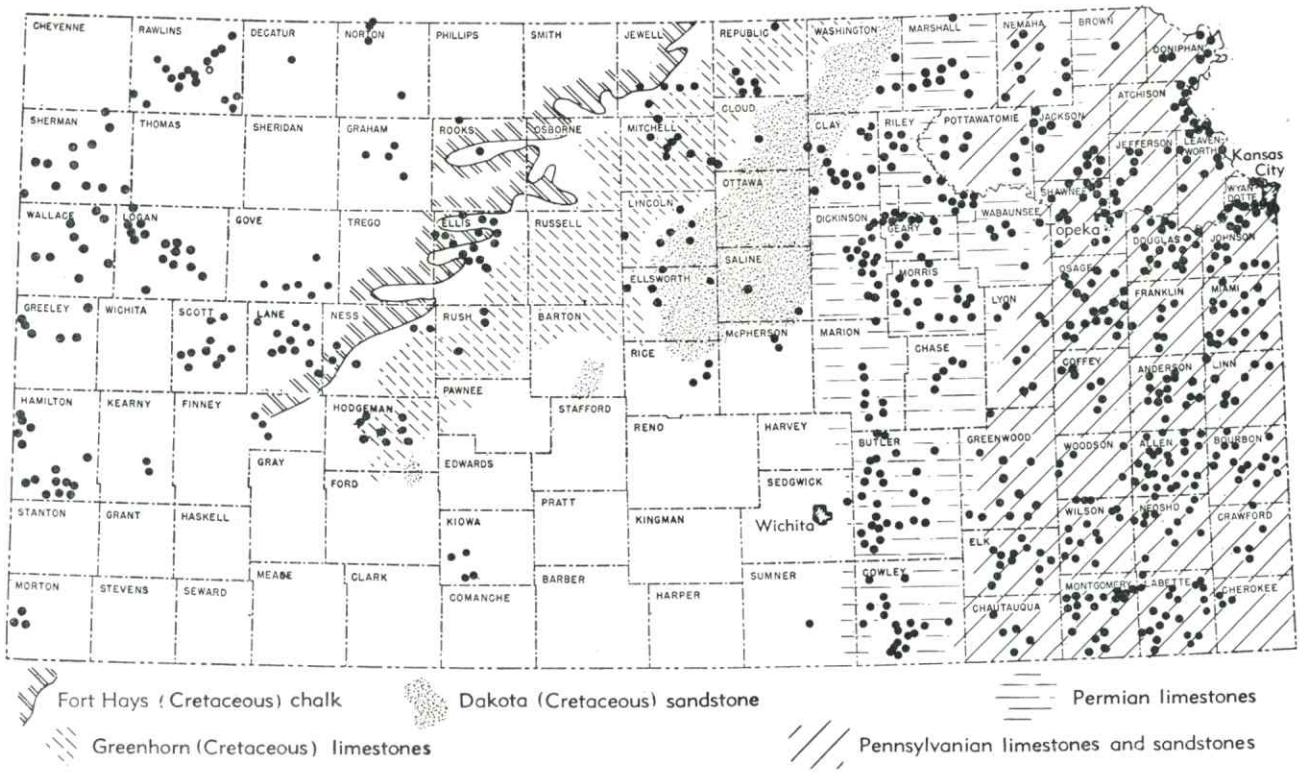

FIG. 59—Map showing distribution of materials for the stone industry in Kansas and approximate location of stone quarries (dots). (Sources: Kansas Geological Survey unpublished data, miscellaneous publications, and Bulletin 142 Part 2: *Kansas Building Stone.*)

The same rock units, generally speaking, that supply the building-stone trade are the source of crushed and broken stone for the other major segment of the construction-stone industry.[112] All of the leading producing counties are in the eastern part of the state. Pennsylvanian limestones are more used than the Permian for reasons of composition and quality, accessibility, and nearness to industrial market centers.

As in sand and gravel production, some active operations are noted in the far west away from population centers but near concentrated construction activity. Absence of quarries at places where major construction is in progress may be a reflection on the quality of some of the rocks of the area; many of them do not meet specifications for use as concrete aggregate. The massive, soft chalk of west-central Kansas, for example, is not suitable for aggregate or road metal or in any direct construction in which hardness, toughness, and resistance to abrasion or to the elements is a requirement. Chalk is, however, a very pure limestone, much of it more than 95 percent calcium carbonate, and is excellent for use as whiting, filler, and many applications in the chemicals industry.[113] Chalk and chalky shales of the area also are suitable raw materials for use in the manufacture of cement—should other economic factors make it feasible for a plant to locate in the area.

In southeastern Kansas, the chat piles that are the waste products of years of zinc and lead mining are the source of concrete aggregate, railroad ballast, and road metal. Of the 375,000 tons of chat produced in 1961, about 161,000 tons were used for railroad ballast.

Kansas has almost unlimited reserves of stone for many uses, but much of the rock must be up-graded or processed in some way, if it is to meet rigid requirements of crushed stone for many construction purposes, including superhighways.

Kansas-produced stone has been one of the state's most useful building materials for business buildings, schools, churches, institutions, bridges, foundations, retaining walls, and sidewalks during the last century. In today's economy many building materials are vying with and superseding stone, but in the days of the first settlements up to and beyond 1900, quarrying stone for building block

112. Robert O. Kulstad and Earl K. Nixon, *Kansas Pits and Quarries,* Kansas Geological Survey Bulletin 90 Part 1, 1951, p. 8.

113. Russell T. Runnels and Ira Dubins, *Chemical and Petrographic Studies of the Fort Hays Chalk in Kansas,* Kansas Geological Survey Bulletin 82 Part 1, 1949, pp. 26-32.

was almost invariably one of the enterprises of practically every community.[114] It was building stone and not crushed stone that was important, and because of the nature of the industry—local with little thought to tonnage and value and therefore no reliable records of production—figures do not reveal its magnitude. Average annual reported value of all stone produced between 1887 and 1918 is about $550,000, and no recorded tonnages are available. Table 76 gives value of stone for selected years before 1918 and production and value for selected years from 1918 to 1940.

Crushed stone, like sand and gravel, did not become a really important mineral commodity until after 1900—until the manufacture of portland cement furthered the need for aggregate in concrete. It was not in fact until after World War I, when hard-surfaced roads became a corollary of the automotive age and other construction began to demand crushed rock, that the change-over from building to crushed stone took place on any noticeable scale.

The story of the Kansas stone industry until well into the present century is almost exclusively the history of the building stone industry. In the territorial period and early days of statehood, many Kansas buildings were constructed of local rocks simply because rock was the most accessible and generally therefore the cheapest building material. Native timber beyond stream valleys and especially on the prairie in the central and more western area was scarce, and a feasible, noncostly means of transporting lumber was lacking.

The reconstruction and homesteading period after the Civil War featured local stone prominently as a building material in Kansas. Statements on type, quality, and quantity of rock available for building purposes in counties and communities were included in almost every description of the assets of land open for settlements. By 1880, according to some accounts, it was possible to tell what kinds of rock cropped out in the various areas by looking at the buildings.

From 1880 to 1900 the economy went through a boom period in which many industrial enterprises were established and the railroad industry stabilized, despite years of drought, panic, business failures, and loss of Kansas population. Although lumber could now be transported rather cheaply by the railroads, the demand for fireproof building materials had persisted, strengthened by the burning of many business sections as the coal-burning locomotives set fires along railroad routes. Masonry construction for public buildings predominated, and stone and brick were choice building materials. Business blocks of stone, stone churches, stone schoolhouses, stone courthouses, and other stone buildings emerged as familiar landmarks in Kansas towns throughout this period of major building activity, which ended about 1909 or 1910. Since then, except for a time in the 1920's and in the late 1930's and early 1940's (when stone was used to a considerable extent in public works projects), increased costs have hampered the building-stone industry.[115]

As the building stone industry diminished, the crushed stone industry gained. After World War I crushed stone had an established place in the construction industry and now is the chief reason that stone is one of Kansas' most valuable mineral commodities—next after oil, gas, and cement. In 1960, stone production amounted to more than 12 million tons, valued at almost $15.5 million. Of the 105 Kansas counties, 45 reported production, concentration of which remained near centers of population and areas of major construction.[116]

Looking back two decades (Fig. 60 and Table 77), what the defense economy of World War II did for many other segments of Kansas industry, including the construction and building trades as a whole, it did not do for stone production. From 1939 to 1944, stone production declined, mainly because concrete was employed less extensively in the temporary wartime structures, highway construction except for military roads was practically suspended, and building stone was not a strategic product for defense.

The climb in value and production in the recovery years of 1945 to 1950 followed the pattern noted generally in cement and other construction materials. The slight drop in Kansas production in 1951 was contrary to the national trend because of weather effects on local construction. For the 1950 decade generally, stone production in Kansas and the five-state region seemingly responded to trends in the total economy more than did the United States as a whole (Table 78). Stone production for the United States, unlike the Midcontinent region, neither exhibited a decline in the bad business year of 1957 nor succumbed to the general decline in construction activity in 1960. It is perhaps a little surprising to observe that the stone industry managed an uninterrupted climb in the United States throughout the decade including 1960—this in spite of a 4 percent drop in volume of construction in

114. Haworth, *Mineral Resources of Kansas, 1897*, pp. 70-76.

115. *Kansas Mineral Resources for Wartime Industries*, pp. 159-168.

116. Schoewe, *The Mineral Industry in Kansas in 1960*, pp. 80-82.

1960; increased demand for crushed stone in road building and concrete construction was responsible for the gain.[117]

Stone production in Kansas increased 317 percent from 1940 to 1960, and about 54.9 percent from 1950 to 1960. Increase for the United States from 1950 to 1960 was 147 percent, and the five-state area of Colorado, Kansas, Missouri, Nebraska, and Oklahoma showed a 132 percent increase.

The employment record of the stone industry in the last few years, 1956-1961 (Tables 79, 80, and 81) seems to point out no drastic deviation from normal development. For example, units reporting in 1961 are about double units reporting in 1956 and total workers covered and estimated in the industry for 1961 are about double those for 1956. The total wages in 1961, however, are about 2½ times the total wages for 1956, which would seem to be normal progression for this inflationary period. In employment, as in production, the year 1957 shows a decline, followed by better times in 1958 and 1959 but with a slight setback in 1960, which continued downward through 1961. This again can be accredited to the slackening in certain sectors of the building industry, which had not yet regained momentum in 1961.

In utilization, especially as aggregate material, stone, sand, and gravel have an interrelationship. It seems therefore desirable to evaluate these materials as a unit as well as separately (Tables 82 and 83). It should be noted that stone produced for aggregate is part of concrete, road metal, and screenings. The combined tonnage of building sand and gravel and paving sand and gravel is equal to or somewhat greater than the tonnage of crushed stone for all purposes. Whether sand and gravel or rock aggregate is used for a specific project or whether some other material is used—such as lightweight ceramic aggregate, or chat, or even such materials as vermiculite or perlite, shipped in from out of state—depends upon many factors, including availability and specifications. The conflict between growth of population centers and encroachment on mineral deposits adds to the problems of production and utilization.

It is a little more difficult to determine what percentage of crushed stone is used for building purposes and for road and highway purposes than it is to make this determination for sand and gravel (Tables 82 and 83). In the production breakdown, no distinction for rock aggregate is given other than rock used as concrete, road metal, and screenings. For sand and gravel, on the other hand, the breakdown provides this information by designating tonnages used for building sand and gravel as opposed to tonnages used for paving sand and gravel. This is further broken down into commercial and noncommercial production of building sand and gravel and paving sand and gravel. We note, for example, that during the 1955-1960 period (Table 82), commercial and noncommercial paving sand and gravel seemed of greater importance than building sand and gravel. Even if building activity should maintain a high level for the next few years, it is unlikely that production of building sand can keep pace with paving sand and gravel, owing to increased highway construction.

Production of riprap has increased, mainly because of increased demand for this type of material by local, state, and federal projects for dam construction. Most of the riprap was produced in northeastern Kansas in Doniphan and Atchison Counties for dike construction along the Missouri River. Agricultural limestone usually is produced as a by-product of crushed stone plants, although it may be a primary product.

Building stone, despite relegation to a lesser role in the total stone industry, is still an important Kansas mineral commodity (Table 83). Kansas produces both building limestone and building sandstone, but it is as a producer of limestone that Kansas competes with other states in the Midcontinent area. In 1960 Kansas ranked fifth in value of building limestone produced and within the last two decades has ranked as high as second. Table 84 indicates production and value of limestone for the United States and for Indiana, Texas, Minnesota, Wisconsin, Kansas, and Missouri for selected years, 1940 to 1960.

The outlook for the Kansas building stone industry, as for the building stone industry generally, is however, only fair. Building stone will continue to be used in large dignified structures, but major expansion of the industry is unlikely. For example, one Kansas building stone producer, who currently transports 75 percent of his product by truck out of state (primarily in Nebraska and Oklahoma but also in several other Midcontinent states), has stated that cost of transportation and high wages of stone masons are two major reasons for lessened demand.

Should popularity of rustic architecture gain momentum, use of native and local stone, of which reserves are large, may be in greater demand. There seems to be some reawakening among architects and builders, who have a great deal to do with forming public opinion, in recognizing the advan-

117. United States Bureau of Mines, *Minerals Yearbooks*, 1942-1945. *Minerals Yearbook*, Vol. I, 1960, pp. 1023-1053.

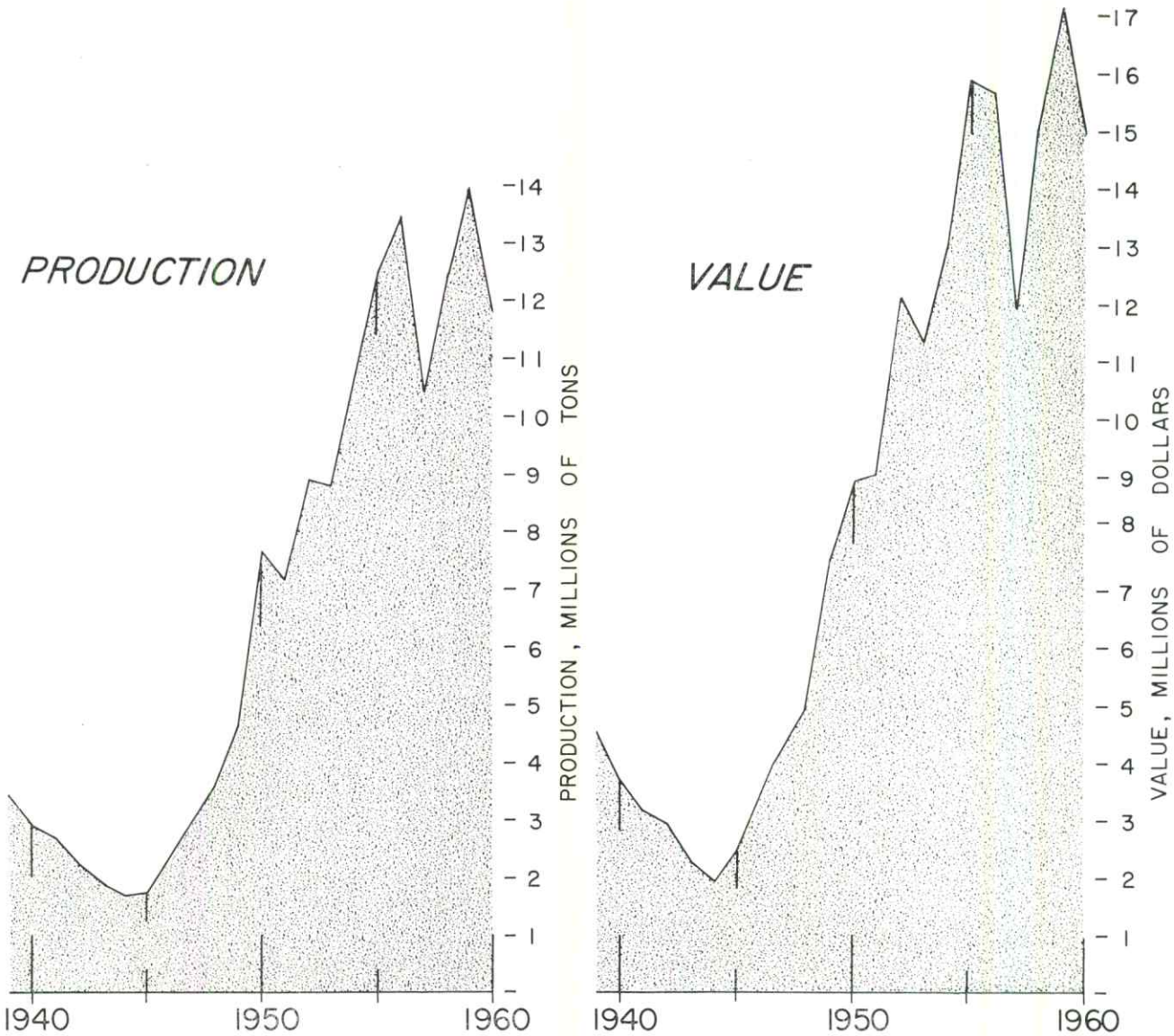

FIG. 60.—Value and production of stone in Kansas, 1939-1960. (Table 77.)

tageous properties of stone—durability, strength, color, density, and architectural adaptability. Major needs to keep the industry alive are improvements in efficiency of machines and methods of quarrying, utilization of wastes, and finding ways to meet competition from alternate materials. Price of bricks and bricklaying has increased to an extent that some veneer is now competitive with brick facing in some areas, but a major hurdle is still finding stone masons at a wage rate that is competitive.

The outlook for the crushed and broken stone industry is brighter. Unless there is a major change that cannot now be predicted, the bulk of crushed stone produced will continue to go directly into construction projects, with significant amounts into cement manufacture and for chemical and metallurgical purposes. Reserves of stone are being depleted at high rates, but adequate sources of supply remain, although at a progressively greater distance from consumption centers. Quality control is bound to be more of a problem as rigid requirements call for many different specifications for crushed stone for construction purposes.

Miscellaneous Materials

A number of mineral materials occur in Kansas that have produced in the past, or are presently produced in small quantity, or have potential for future development. Production data usually are not made available for these commodities so that the competitive position of producers will not be revealed. The locations of some of these materials are shown in Figures 61 and 62; Table 70 shows

combined production values and Figure 62 value and production for volcanic ash.

FIG. 61.—Location of miscellaneous industrial minerals in Kansas. (Miscellaneous publications and unpublished data, Kansas Geological Survey.)

VOLCANIC ASH

Millions of tons of volcanic ash—a white powdery substance composed of small pieces, or shards, of glass formed during the eruption of volcanoes—arrived in Kansas during the last hundreds of thousands of years, transported by wind from unknown numbers of volcanic explosions to the west or southwest. The deposits are rather widely scattered throughout central and western Kansas.[118] This imported resource attracted little attention until the beginning of the 20th century. During World War I some of the ash deposits became the basis of an abrasive industry that elevated Kansas to the number one rank as a volcanic ash producing state. Kansas maintained this rank for almost 30 years, but in the mid-1940's the industry almost completed its exit on a clue from technology that introduced other materials as abrasives (Fig. 62).

The industry has not completely died—two deposits, one in Norton County and one in Lincoln County are being exploited commercially, and other deposits are being utilized locally to an undetermined extent in road construction or for other purposes. Production and consumption are, however, relatively insignificant, and an estimated 20 million tons in deposits in at least 39 Kansas counties have remained industrially idle. Figure 62, based on Table 85, shows production and value of Kansas volcanic ash from 1916 to 1946 and for a few years in the 1950's, excluding the years in which only two commercial operations make concealment of data necessary.

118. J. S. Carey, J. C. Frye, Norman Plummer, and Ada Swineford, *Kansas Volcanic Ash Resources*, Kansas Geological Survey Bull. 96 Part 1, 1952, pp. 1-68.

Recent research[119] in the laboratories of the Kansas Geological Survey indicates that volcanic ash has marked potential as an industrial material. It can be expanded or "popped" into small glass spheres by blowing it through a flame at a temperature of about 2,700° F.; in this form it is characterized by low bulk density, excellent thermal and acoustical properties, large surface area, and chemical inertness. It can be used for filtering purposes, can be formed into insulating panels with inorganic binders, and has possibilities for use in plaster mixtures, cellular concrete, and structural products. In addition, volcanic ash can be used in concrete aggregate, as a ceramic material, and as a filler or extender.

LIME

One of the earliest mineral commodities to enter the Kansas building trade was lime—produced from limestone by calcining, or by heating the limestone to temperatures of 2,000 to 2,500° F. to drive off carbon dioxide. The direct product from this calcining is calcium oxide, commercially known as quicklime. The second product is developed by the measured addition of water to quicklime to produce calcium hydroxide, known commercially as hydrated lime. Both have many industrial applications.

In the early days of Kansas, especially up to the time that the industry of natural cement was established in Kansas, lime was produced locally in lime

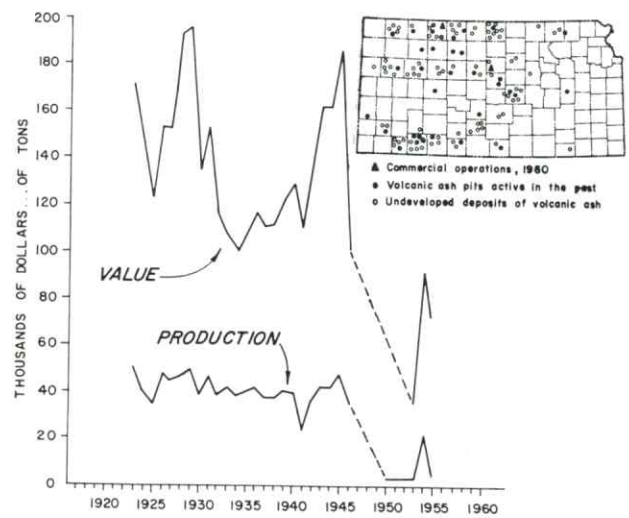

FIG. 62.—Value and production of volcanic ash in Kansas, 1916-1946, and a few years in the 1950's. Figures are not available for years between 1946 and 1950 and since 1955. (Based on Table 85 and on Kansas Geological Survey publications, especially Bulletin 14: *Volcanic Ash Resources of Kansas* and Bulletin 96 Part 1: *Kansas Volcanic Ash.*)

119. Maynard P. Bauleke, *What's New in Volcanic Ash for Industry?*, Kansas Geological Survey Bull. 157 Part 3, 1962, pp. 1-19.

kilns in eastern Kansas for use as mortar and plastering material in the building trade. The product, however, then entered a period of obscurity in the industrial field of Kansas and it was not until relatively recently that attention has been redirected at the high calcium Kansas limestones suitable for manufacture of lime. Several areas in Kansas have been delineated, on basis of analytical studies by the Kansas Geological Survey,[120] as areas of high-calcium limestone deposits suitable for mining (Fig. 61). In 1960, Midwest Lime Company, Incorporated, completed construction of a lime plant near the Loring Quarries southeast of Bonner Springs, a northeastern Kansas area having limestone deposits of known calcium carbonate content exceeding 95 percent. In addition to the raw material, transportation and fuel are available near this Kansas City industrial area. The lime plant, essentially a vertical kiln, was in operation during 1961 and produced 15,494 tons of quicklime valued at $192,900. This product was sold to the Kansas City municipal waterworks for water purification and softener.

Most quicklime and hydrated lime produced today enter into chemical and industrial applications. Some is utilized in construction, in mortar and plaster, as well as in soil stabilization and as soil conditioner. The lime industry definitely has further potential in extending and developing other uses in categories of construction, agriculture, and chemical, industrial, metallurgical, and refactory manufacturing. This potential should become definitive through technical, economic, and statistical data, analyzed with the intent of solving problems encountered in quarrying, calcining, hydrating, storing, handling, and transporting.

Glass Sand

An industrial application of sand for the manufacture of glass, mostly window glass but also colored bottle glass and fruit jar glass, developed in the gas belt area between 1902 and 1906. During this period, 16 glass factories were built in Kansas, most of them in four towns in Montgomery County—Independence, Cherryvale, Coffeyville, and Caney. Chanute in Neosho County and Neodesha in Wilson County also had glass factories. (The first bottle glass factory west of Mississippi River was opened at Paola, Miami County, in 1887; a window glass factory was being constructed at Fort Scott the same year.)

Attraction of cheap natural gas and dwindling supply of natural gas in Indiana, in which the glass industry had centered, were the main attractions for Kansas. The Kansas glass industry in 1905 had a capital investment of a half million dollars, and production valued at about $1 million. This, however, was the best year for the glass industry. The industry had an inadequate market in the sparsely settled areas to south and west. Transportation costs added to value of the Kansas product did not allow competition with Indiana-made glass. Furthermore, the industry faced a dwindling fuel supply and certain deficiences in the raw material for manufacture of a quality glass. Kansas now has only one glass factory, at Caney. Products manufactured include bottle glass and glass for light fixtures; raw material for the product, unfortunately, is not obtained from Kansas.

This is not to say that Kansas could not again develop a glass industry. It probably could, other economic factors being favorable; we have determined through research the excellence of certain sands in parts of Kansas that are suitable for this purpose.[121]

Diatomaceous Marl

Diatomaceous marl, a mass of the remains of tiny one-celled plantlike creatures called diatoms and calcium carbonate, in recent years has been added to the list of Kansas industrial mineral resources. The deposits were discovered in 1931 in the northeastern corner of Wallace County and adjacent parts of Sherman and Logan Counties. Since 1953, a plant at Edson, Sherman County, has been processing diatomaceous marl from a pit in northeastern Wallace County into paint filler and similar products.[122] The marl also has many other economic possibilities. Because of the chemical inertness of the hydrated opaline silica of the microscopic diatoms and because of the unique structure of the plants, diatomaceous marl is extremely valuable as a filtering substance, for insulation, as absorbent filler, as polishing material, and for many other industrial uses. Reserves are not known.

Rock Wool Materials

Rock wool—a fluffy, usually white insulating material composed of minute fibers of glass—has been produced at several locations in Kansas in the late 1930's and early 1940's. The material, made by fusing a mixture of limestone and shale and then pouring the liquid rock into a blast of air or steam, was

120. William Ives and Russell T. Runnels, *Lime Raw Materials in the Kansas City Area*, Kansas Geological Survey Bull. 142 Part 3, 1960.

121. E. K. Nixon, Russell T. Runnels, and R. O. Kulstad, *The Cheyenne Sandstone of Barber, Comanche, and Kiowa Counties, Kansas, as Raw Material for Glass Manufacture*, Kansas Geological Survey Bull. 86 Part 3, 1950.

122. Maxim K. Elias, *The Geology of Wallace County*, Kansas Geological Survey Bull. 18, 1931, pp. 214-221.

used primarily in the insulation of buildings but also had other applications where there was need for a fire-, water-, vermin-proof material having low thermal conductivity. Pennsylvanian limestones and shales were the raw material utilized in this venture, but tests made in the laboratories of the Kansas Geological Survey [123] indicated that throughout the state enormous raw materials suitable for rock wool manufacture are available.

The rock wool manufactured in the Kansas plants was of excellent quality. Because of economic factors, the plants did not survive the war years of the 1940's. Many other materials have now entered the market and it is doubtful that rock wool industry in Kansas will revive.

123. Norman Plummer, *Rock Wool Resources of Kansas*, Kansas Geological Survey Mineral Resources Circular 5, 1937.

Asphalt Rock

Asphalt rock, or rock containing partly oxidized residue of petroleum, is found at several locations in eastern Kansas where crude oil at some time has seeped to the surface. Both limestone and sandstone asphalt rock deposits are known to occur in the Bourbon-Linn-Miami County area, and in the 1930's and early 1940's deposits were worked at various times to obtain asphalt to use in road surfacing. A plant located at Pleasanton processed asphaltic sandstone into a high grade asphalt to market in several states as a paving material. No asphalt deposits currently are being worked, but it is estimated that between 20 million and 25 million tons are present in Linn County alone.[124]

124. John M. Jewett, *Asphalt Rock in Eastern Kansas*, Kansas Geological Survey Bull. 29, 1940.

Chapter IV

PROSPECTS FOR KANSAS MINERAL RESOURCES

SUMMARY AND CONCLUSIONS

This study of the mineral industry and water sector of Kansas economy reveals a prospect that is both gloomy and bright. It is gloomy in that unadorned data show declines in the component parts of the mineral industry as measured in terms of value, employment, and wages and salaries. It is bright in that some of these declines may be of short duration and trends are responsive to changes in policy. Moreover, economic growth in the mineral industry sector can be stimulated by bold planning and wise decision. Given first, then, are the rather gloomy facts of decline or slow growth in terms of value, employment, and wages and salaries. In the following parts of the summary, economic activity is reviewed in somewhat more detail and conclusions regarding stimulation of the mineral industry economy are presented.

Kansas, at present, exhibits a mature mineral industry with inherent features of stability or slow decline. These characteristics are shared with the mineral industry of Oklahoma and Missouri. The neighboring states of Colorado, Nebraska, and to a certain extent Iowa, exhibit a youthful mineral industry. These three states show a high growth rate, but the base for growth is low and the potential for an expanded mineral industry may be less favorable than in Kansas. For example, Nebraska and Colorado became important producers of crude oil only within the last ten years, and thus show high initial growth rates.

Value of Production

Kansas has maintained its share of the nation's total value of mineral production, but there is evidence of general decline in fuels production that probably cannot be reversed except for short periods unless there is a major change in federal fuels policy, and a declining rate of growth in nonfuels that probably will continue unless there is reversal of present population trends and strong economic growth in other sectors of the economy. Total value of Kansas mineral production in 1961 was more than $512,000,000.

Employment

Kansas has done better than the nation in employment in the mineral industry, but has shown an over-all decrease of 1.2 percent since 1950 and a much greater decrease since the period of peak employment in 1956. Greatest losses have occurred in the area of metal and bituminous coal mining. On the whole, Kansas has not done as well as its neighboring states in offering opportunity for employment in the mineral industry; only Missouri exhibits a lower growth rate. However, significant growth is to be seen in the category described as mining and quarrying, that part of the mineral industry concerned primarily with production of construction materials. Because so many external variables affect the total mineral industry in Kansas, projections through 1975 are difficult, and decisions at a national, state, and local level could change industry patterns very quickly. A total projection of employment in the mineral industry in Kansas to 1975, based on relatively unchanged conditions, presents a discouraging picture. Table 86 shows employment projections for total mining employment in Kansas, the United States, and Kansas' neighboring states for 1965, 1970, and 1975. These estimates are based on index numbers on straight-line semilog projections. They are influenced by judgment regarding gains and losses in various segments of the mineral industry. According to these projections, mineral industry employment could decline from 3,600 (high projection) to 3,200 (low projection) by 1975 unless other factors stimulate this segment of the economy.

Wages and Salaries

Kansas has done better than the nation in generating wages and salaries in the mineral industries, except in the nonfuels category. Wages and salaries in nonfuels are closely allied with population changes and concomitant construction and consumer goods demand.

Commodity Summary

Liquid and Gaseous Hydrocarbons

Let us turn now to an examination of the economic factors influencing commodity production. Production of crude oil from Kansas has been declining during the past few years, whereas production of natural gas liquids and natural gas has increased. Most Kansas oil production is from small fields and the average daily crude production is

below 7.5 barrels and has declined annually since 1956. Fewer developmental and explorational wells are being drilled in Kansas each year, especially by major companies who find that the cost of doing business in Kansas has increased, and who find more favorable and higher potential production in other states. These companies also have sought a more favorable tax structure and lower operational costs. Although the national demand for crude oil has increased each year, Kansas' share of the domestic market has decreased; a pattern evident in other prorated states. Natural gas and natural gas liquids have shown annual increases, but an economic development in Kansas depends upon intrastate use of these resources. The petroleum industry in Kansas is not an expanding industry, but production of crude oil, natural gas, and liquefied petroleum gases should continue at a healthy, but declining pace for the next 20 to 25 years. Future developmental and exploratory work will be done in large part by the independent producer.

Nevertheless, marketing of Kansas crude is especially responsive to changes in federal fuels policy. Moreover, there are large areas in Kansas where the possibilities for deep production have not yet been explored, a type of exploration entirely dependent upon economic factors. Wages and salaries generated by the petroleum industry, especially, do not reflect the personal income in the form of royalties, bonuses, and lease payments. About one-third of Kansas landowners receive some sort of rentals on mineral leases.

Water

A vast amount of information concerning the availability of water resources for agricultural, municipal, and industrial uses has been compiled through comprehensive investigations and studies. Even so, distribution of the usable water resources is not totally known. The general nature and location of water in Kansas poses limitations for economic development. In the eastern part of Kansas, surface water is relatively abundant, but usually is confined to river valleys. Large supplies of ground water underlie much of western Kansas, which has a favorable environment for water storage; however, low precipitation and high evaporation limit the opportunity for future recharge of these supplies. Annual, seasonal, and even weekly variations in precipitation lead to problems of both flood and drought in practically every stream in Kansas. The amount of flow needed at present to maintain desirable quality and quantity levels exceeds natural unregulated low stream flow. Significant regulation is needed to accomplish the potential economic value of the water resources of Kansas. Although the exact value that water adds to the economy is difficult to measure, attention must be focused on how water can be used for new economic growth.

The integrated use of water, fuel, and mineral commodities in such a relationship that natural resources could be used most advantageously holds possibility for high economic return in Kansas. The reduction of evapo-transpiration losses in western Kansas will undoubtedly increase crop yields. Water recreation in Kansas should expand and a growing recreational picture should offer an added element of stability to the economy. The conversion of brackish waters, known to be present in unlimited quantities in Kansas' subsurface, may be an important factor in the future of Kansas' economy.

Metals

The metallic mineral industry of Kansas has declined to the point where it is almost nonexistent. Presently-known lead and zinc reserves of high quality are extremely small; and present price levels, determined in part by the competition of imports, are not conducive to expanded development. *Although Kansas is without a major metallic mineral industry at present, the possibility for metallic ore deposits in various rocks in Kansas cannot be discounted. Extensive geophysical exploration is desirable in the Tri-State district in order to learn whether the lead-zinc reserves can be expanded, and broad scale aero-magnetic surveys should be made to delineate possibilities for ore deposits in the very old Precambrian rocks, which are within 600 feet of the surface in places. (Similar exploration in the 1930's has been responsible for the recent discovery and development of large new iron ore deposits in Missouri.)*

Nonmetallic Minerals

Nonmetallic mineral production in Kansas has grown with the rest of the economy at a rate about proportional to the population increase and general construction activity. Most nonmetallic materials are scattered widely throughout Kansas; these commodities are locally consumed and have low unit value. Those commodities that have a more extensive market area face increasingly keen competition, owing mainly to high transportation costs. *Those parts of this industry that have strongest gains historically, are also the parts that have developed new high-quality products, or have im-*

proved the methods of production and processing. Greatest returns can be realized from nonmetallic commodities by developing new uses for them and by encouraging industries that will process them in Kansas. The multiplier effect produced by processing raw materials in the state holds promise for expansion of the Kansas economy. For example, the value of raw clay and shale produced in Kansas in 1960 was $1,224,000; the value of clay products produced from part of this clay and shale was $11,500,000. Primary processing of nonmetallic materials generates an extremely high multiplier effect on dollar value within the state.

In the preceding paragraphs, nonmetallic minerals have been grouped together because they have certain common characteristics. However, development of these nonmetallic minerals will not proceed at the same rate, nor are expectations for future development equal or uniform. Kansas has a seemingly inexhaustible supply of salt and Kansas will share in the increasing domestic market, but be faced with a competitive disadvantage in transportation. *Kansas salt beds have been shown to be favorable locations for the storage of radioactive by-products, and development of new industry related to such storage is a possibility.*

The coal industry in Kansas has suffered the same serious decline in production experienced by other coal-producing states. Kansas has an abundant supply of bituminous coal distributed in relatively thin beds in eastern Kansas. *The outlook for the domestic coal industry in Kansas is encouraging, despite a serious decline in production in recent years; because coal is still the major national source of industrial energy, and technological developments in the coal industry point to a certain amount of long-range confidence in this sector.*

The economy of Kansas depends importantly upon the abundantly available, but low unit-value, mineral commodities of the construction industry—principally cement, clay, gypsum, sand and gravel, stone, and the processed products of these commodities. Kansas has remained a leading cement-producing state since the early 1930's; and with the exception of oil and gas, cement is Kansas' leading dollar-value mineral commodity. The Kansas cement industry is in a healthy condition, and in the next decade or two can look to continued activity but an increasingly competitive market. Kansas is well along in scientific evaluation of its abundant clays and shales, which are the raw materials of its ceramics industry. Manufacture of expanded shale aggregate for poured concrete and building blocks was added to the clay products industry in the early 1950's. Employment and wages for the clay products industry, except for a decline in the recession in 1957, have shown relative stability. It is a curious fact that although Kansas has first-line quality products of the clay industry, brick is not widely used within the state, especially for home construction. Kansas now faces a highly competitive market in clay products that stems largely from high transportation costs. *Aggressive product research and product promotion within the state are necessary for the continued growth of the ceramics industry.*

The two gypsum plants in Kansas, which produce specialized top-quality gypsum plaster and plaster products, are located in Kansas only because Kansas gypsum can be manufactured into superior products. Despite available materials, many economic factors are drawbacks; to permit or encourage expansion, adjustments must be made in transportation, labor, and population concentration.

Sand and gravel are low-unit value mineral materials familiar to everyone. The sand and gravel industry is widely dispersed. More than 120 operations are found in Kansas and practically every county in the state is a potential producer, if not already a producer, of sand and gravel. *The outlook for sand and gravel production in Kansas is excellent; rate of growth depends on growth in other sections of the economy.*

The rock formations of Kansas provide an abundance of stone, principally limestone and sandstone, suitable for use in the dimension stone and the crushed stone segments of the industry. The employment record of the stone industry in the last two years seems not to point at any drastic deviation from normal developments. *The outlook for Kansas building stone industry is only fair, but the outlook for crushed and broken stone industry is brighter.*

A number of mineral materials occurring in Kansas have been produced in the past or are presently produced only in small quantities. These miscellaneous materials have immense potential for future development. Among these products are volcanic ash, glass sand, diatomaceous marl, and raw material for the making of rock wool. *Most of these nonmetallic materials are consumed in the construction industry. Kansas has an abundance of most of them and development will be determined almost entirely by economic activity in other sectors of the economy.*

Kansas has made prudent use of its mineral resources, but if Kansas is to experience an expansion in the mineral industry sector of its economy, there

must be an increase in the primary processing or product development aspect of our mineral industry. Transportation of raw materials to market, as seen throughout this report, is one of the great limiting factors in the development of primary processing of our Kansas raw materials. Product development research, market analysis, and integrated and prudent use of mineral resources must occur if Kansas is to continue to compete for markets with other states in the mineral industries.

APPENDIX TABLES

Table 1

VALUE OF MINERAL PRODUCTION IN U. S. AND SELECTED STATES, 1939-1960

	1939	1940	1941	1942	1943	1944	1945	1946
Value of Total Production								
United States ($1,000,000)	3,808	4,198	5,107	5,623	5,931	6,310	6,231	7,062
Kansas ($1,000)	97,109	102,587	140,054	168,272	177,308[a]	170,560[a]	166,644[a]	194,563[a]
Oklahoma ($1,000)	213,811[a]	207,745[a]	240,426[a]	240,769[a]	221,631[a]	225,833[a]	243,314[a]	263,282[a]
Colorado ($1,000)	64,756	62,715	73,368	94,386	84,335	79,137	75,611	77,208
Missouri ($1,000)	45,634	50,325	61,545	76,122	72,212	72,960	74,171	87,100
Iowa ($1,000)	25,170	26,007	28,872	28,278	24,187	22,462	24,820	34,962
Nebraska ($1,000)	4,390	4,692	6,499	8,428	6,800	5,060	4,953	7,237
Value of Fuels								
United States	2,423	2,662	3,228	3,568	4,028	4,574	4,569	5,090
Kansas	73,662	80,370	111,306	134,336	145,968[a]	137,636[a]	138,803[a]	156,227[a]
Oklahoma	174,524[a]	179,260[a]	204,143	198,026[a]	183,557[a]	196,372[a]	218,800[a]	232,231[a]
Colorado	16,042	18,238	22,093	25,793	30,383	33,055	33,381	39,929
Missouri	6,481	6,521	7,155	8,465	10,864	12,399	10,151	9,179
Iowa	7,189	8,061	8,059	8,408	8,576	7,450	6,995	5,579
Nebraska	2	220	1,600	1,110	570	460	370	360
Value of Nonfuels								
United States	1,385	1,536	1,879	2,055	1,903	1,736	1,662	1,972
Kansas	23,447	22,217	28,748	33,895	31,340	32,924	27,841	38,336
Oklahoma	39,287	28,484	36,283	42,743	38,074	29,461	24,514	31,051
Colorado	47,714	44,477	51,274	68,493	53,952	46,082	42,230	37,279
Missouri	39,153	43,804	54,390	67,657	61,348	60,561	64,020	77,921
Iowa	17,981	17,946	20,813	19,870	15,611	15,012	17,825	29,383
Nebraska	4,388	4,472	4,899	7,318	6,230	4,600	4,583	6,877

Table 1—*Continued*

VALUE OF MINERAL PRODUCTION IN U. S. AND SELECTED STATES, 1939-1960

	1947	1948	1949	1950	1951	1952	1953
Value of Total Production							
United States ($1,000,000)	9,610	12,273	10,580	11,862	13,529	13,396	14,418
Kansas ($1,000)	265,061	361,160	337,162	368,614	400,087	403,370	413,231
Oklahoma ($1,000)	354,387	506,846	434,264	527,095	607,486	621,351	679,003
Colorado ($1,000)	102,448	128,861	139,873	154,898	179,852	189,852	212,690
Missouri ($1,000)	103,928	108,291	111,293	113,191	135,249	140,977	128,207
Iowa ($1,000)	31,023	35,955	37,458	41,773	47,706	52,481	51,994
Nebraska ($1,000)	6,704	8,385	10,102	14,022	18,469	20,597	33,281
Value of Fuels							
United States	7,188	9,502	7,920	8,689	8,779	9,616	10,257
Kansas	227,468	318,526	292,634	316,393	345,578	346,347	352,016
Oklahoma	326,761	475,571	452,587	491,195	562,611	573,665	644,516
Colorado	59,780	74,215	84,801	82,089	92,434	98,570	119,502
Missouri	14,099	15,693	14,923	12,372	13,407	12,051	9,852
Iowa	6,429	7,020	6,912	6,977	6,110	5,297	5,262
Nebraska	420	520	730	3,302	6,459	7,230	18,101
Value of Nonfuels							
United States	2,422	2,771	2,660	3,173	3,750	3,780	4,161
Kansas	47,593	42,634	44,528	52,221	54,509	57,023	61,215
Oklahoma	27,626	31,275	31,677	35,900	44,875	47,686	34,487
Colorado	42,668	54,646	55,072	72,809	87,001	91,282	93,188
Missouri	89,829	92,598	96,370	100,819	121,842	128,926	118,355
Iowa	24,594	28,935	30,546	34,796	41,596	47,184	46,732
Nebraska	6,284	7,865	9,372	10,720	12,010	13,367	15,180

Table 1—*Concluded*

VALUE OF MINERAL PRODUCTION IN U. S. AND SELECTED STATES, 1939-1960

	1954	1955	1956	1957	1958		
Value of Total Production							
United States ($1,000,000)	14,067	15,792	17,365	18,113	16,589	17,241	17,892
Kansas ($1,000)	449,587	470,830	493,770	511,513	503,788	500,464	483,958
Oklahoma ($1,000)	650,205	711,089	757,080	809,004	761,936	751,907	779,116
Colorado ($1,000)	255,852	286,219	321,908	338,504	306,561	313,438	342,223
Missouri ($1,000)	131,280	151,626	163,693	152,913	144,120	157,009	156,033
Iowa ($1,000)	58,798	63,555	66,529	68,986	85,356	88,557	95,030
Nebraska ($1,000)	42,393	54,237	71,311	82,928	90,047	100,213	103,687
Value of Fuels							
United States	9,919	10,780	11,741	12,709	11,589	11,950	12,141
Kansas	385,187	405,746	420,302	453,473	439,438	428,970	420,830
Oklahoma	610,768	665,073	716,695	771,484	727,125	714,416	738,856
Colorado	148,045	169,766	187,818	197,403	180,438	171,951	179,726
Missouri	10,028	12,965	13,401	12,693	11,111	11,937	12,469
Iowa	4,503	4,402	4,732	4,543	4,147	4,214	3,845
Nebraska	22,196	33,363	48,053	61,146	61,608	71,067	72,778
Value of Nonfuels							
United States	4,138	5,012	5,624	5,404	4,940	5,291	5,751
Kansas	64,400	65,084	73,568	58,040	64,450	71,494	63,128
Oklahoma	39,437	46,016	40,385	38,320	34,811	37,491	40,260
Colorado	107,807	116,453	134,090	141,101	126,123	141,587	162,497
Missouri	121,252	138,661	150,292	140,220	133,009	145,072	143,564
Iowa	54,295	59,153	61,797	64,443	81,209	84,343	91,185
Nebraska	20,197	20,874	23,258	21,782	28,439	29,146	30,909

a. Revised 1947 because of substitution of data for natural gas valued at points of consumption for data on natural gas valued at wells.
Source: United States Bureau of Mines, *Minerals Yearbooks.*

Table 2

PERCENT CHANGE IN VALUE OF MINERAL PRODUCTION BY DECADES

	Percent Change 1940–1950	Percent Change 1950–1960
Total Mining		
United States	182.6	50.8
Kansas	259.5	31.3
Oklahoma	153.8	47.8
Colorado	146.9	120.9
Missouri	124.9	37.6
Iowa	60.6	127.5
Nebraska	198.8	639.5
Fuels		
United States	200.0	39.7
Kansas	293.9	33.0
Oklahoma	173.8	50.4
Colorado	350.0	118.9
Missouri	95.2	0.8
Iowa	–13.4	–44.9
Nebraska	1400.9	2104.1
Nonfuels		
United States	106.6	81.2
Kansas	135.0	20.9
Oklahoma	26.0	12.1
Colorado	23.8	123.2
Missouri	130.2	42.4
Iowa	93.8	162.0
Nebraska	139.7	188.3

Source: Computed from Table 1.

Table 3

ANNUAL INDEX OF CHANGE IN VALUE OF MINERAL PRODUCTION, 1950-1960

(1950 Base = 100)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
United States	100.0	114.2	113.0	121.9	118.7	133.1	146.8	153.0	139.5	145.7	151.5
Kansas	100.0	108.8	109.2	112.0	121.8	127.8	133.8	138.7	137.2	135.9	131.1
Oklahoma	100.0	115.2	118.0	128.9	123.5	135.0	143.9	153.2	144.8	142.7	147.9
Colorado	100.0	115.9	122.5	137.3	165.2	185.0	207.0	218.7	198.2	202.3	221.0
Missouri	100.0	119.5	124.0	113.2	115.9	133.8	144.5	134.9	127.2	138.9	138.0
Iowa	100.0	111.8	125.4	124.2	140.9	152.3	159.4	165.0	202.2	212.1	227.9
Nebraska	100.0	131.8	143.5	237.5	302.0	386.5	508.0	591.0	644.0	715.0	739.0

Source: Compiled from Table 1.

Table 4

PERCENT OF TOTAL VALUE OF UNITED STATES PRODUCTION BY COMMODITY—1940, 1950, 1960

Commodity	1940	1950	1960
Total Mining			
Kansas	2.32	3.12	2.71
Oklahoma	4.94	4.25	4.35
Colorado	1.50	1.30	1.93
Missouri	1.09	0.96	0.88
Iowa	0.62	0.35	0.53
Nebraska	0.11	0.12	0.58
Value of Fuels			
Kansas	3.01	3.64	3.46
Oklahoma	6.73	5.74	6.07
Colorado	0.68	0.95	1.48
Missouri	0.24	0.14	0.10
Iowa	0.30	0.08	0.03
Nebraska	0.08	0.04	0.60
Value of Coal			
Kansas	0.77	0.31	0.22
Oklahoma	0.46	0.55	0.48
Colorado	1.67	0.82	1.00
Missouri	0.72	0.47	0.64
Iowa	0.92	0.27	0.20
Nebraska	....	....	....
Value of Petroleum and Natural Gas			
Kansas	4.13	5.08	4.09
Oklahoma	9.77	7.86	7.16
Colorado	0.20	1.00	1.59
Iowa	....	....	....
Nebraska	0.00	0.06	0.73
NonFuels			
Kansas	1.45	1.65	1.10
Oklahoma	1.86	1.13	0.70
Colorado	2.90	2.29	2.83
Missouri	2.86	3.18	2.50
Iowa	1.17	1.09	1.59
Nebraska	0.29	0.34	0.54

Source: Computed from Table 1.

Table 5

PERCENT OF THE TOTAL VALUE OF MINERAL PRODUCTION OF FUELS AND NONFUELS IN THE UNITED STATES AND SELECTED STATES

(By Decades)

	1940	1950	1960
Fuels			
United States	63.6	73.3	68.0
Kansas	78.3	85.9	87.0
Oklahoma	86.3	93.2	95.0
Colorado	29.1	53.0	52.4
Missouri	13.0	10.9	8.0
Iowa	31.0	16.7	4.0
Nebraska	4.7	23.6	70.0
Petroleum and Natural Gas			
United States	42.6	51.2	57.0
Kansas	71.8	83.7	86.1
Oklahoma	84.4	90.5	93.7
Colorado	5.7	39.0	46.7
Missouri	0.0+	0.0+	0.0+
Iowa	....	....	....
Nebraska	4.7	23.6	70.0
Coal			
United States	21.0	22.2	11.0
Kansas	6.6	2.2	0.9
Oklahoma	1.9	2.8	1.3
Colorado	23.4	14.0	5.7
Missouri	12.5	10.9	8.0
Iowa	31.0	16.7	4.0
Nebraska	....	....	....
Nonfuels			
United States	36.4	26.7	32.0
Kansas	21.7	14.1	13.0
Oklahoma	13.7	6.8	5.0
Colorado	70.9	47.0	47.6
Missouri	87.0	89.1	92.0
Iowa	69.0	83.3	96.0
Nebraska	95.3	76.4	30.0

Source: Compiled from Table 1.

Table 6

TOTAL NONAGRICULTURAL EMPLOYMENT IN THE UNITED STATES—1947 TO 1960

(In Thousands)

1957 SIC [a]

INDUSTRY	1947	1948	1949	1950	1951	1952	1953	1954
Total Nonag Empl.	43,900	44,900	43,800	45,200	47,800	48,800	50,200	49,000
Total Mining	955	944	930	901	929	898	866	791
10 Metal Mining	103	104.2	97.7	96.9	101.0	99.8	106.0	99.3
12 Bit. Coal	425.6	436.1	393.3	367.9	372.0	327.8	288.9	228.5
13 Crude Petroleum & Nat. Gas	248.5	274.0	266.3	266.1	284.4	303.4	311.4	318.1
14 Mining & Quarry of Nonmetals, Ex. Fuels	97.8	99.6	95.0	95.1	102.4	103.8	105.9	105.1

Table 6—*Concluded*

TOTAL NONAGRICULTURAL EMPLOYMENT IN THE UNITED STATES—1947 TO 1960

(In Thousands)

1957 SIC [a]

INDUSTRY	1955	1956	1957	1958	1959	1960	1961
Total Nonag Empl.	50,700	52,400	52,900	51,400	53,400	54,300	53,200
Total Mining	792	822	828	751	731	709	663
10 Metal Mining	101.5	108.8	111.4	93.2	83.6	93.3	87.3
12 Bit. Coal	218.7	228.6	229.8	193.0	178.3	168.2	146.6
13 Crude Petroleum & Nat. Gas	331.9	340.1	344.0	327.5	330.9	313.9	307.6
14 Mining & Quarry of Nonmetals, Ex. Fuels	108.3	115.2	114.3	114.9	119.6	119.5	111.0

a. Standard industrial classification.

Source: Bureau of Labor Statistics, *Employment and Earning Statistics for the United States, 1909-1960*, Bulletin 1312, Washington, 1961.

Table 7

ESTIMATED ANNUAL AVERAGE NONFARM WAGE AND SALARY EMPLOYMENT IN KANSAS MINING INDUSTRIES, 1947-1961

INDUSTRY	1947	1948	1949	1950	1951	1952	1953	1954	1955
Total Nonag. Emp.	426,800	442,800	447,900	463,800	510,800	537,500	543,700	541,000	543,800
Total Mining	16,400	17,000	17,400	17,200	18,600	19,100	18,700	18,600	19,300
10 Metal Mining	1,200	700−	700	700	700−	600	400	300	400
12 Bituminous Coal & Lignite Mining	1,100	1,100	1,100	900	800	700	500−	500+	400+
13 Crude Petroleum & Natural Gas	12,700	13,800	14,300	14,000	15,400	16,100	16,100	16,200	16,700
14 Mining & Quarry of Nonmetallic Minerals, Exc. Fuel	1,400−	1,400	1,300	1,600	1,700	1,700	1,700	1,600	1,800

Table 7—*Concluded*

ESTIMATED ANNUAL AVERAGE NONFARM WAGE AND SALARY EMPLOYMENT IN KANSAS MINING INDUSTRIES, 1947-1961

INDUSTRY	1956	1957	1958	1959	1960	1961	1962 Jan.	1962 Feb.	1962 (Prelim) March
Total Nonag. Emp.....	550,300	554,400	546,300	559,000	559,000	558,900			
Total Mining.....	19,900	19,200	18,200	18,300	17,000	16,200	15,400	15,300	15,600
10 Metal Mining.....	500	300	100	...[a]	100+	100	100	100	100
12 Bituminous Coal & Lignite Mining..	400	400	300	300	300	200−	300	300	300
13 Crude Petroleum & Natural Gas....	16,900	16,800	15,900	16,000	14,900	14,300	13,700	13,600	13,900
14 Mining & Quarry of Nonmetallic Minerals, Exc. Fuel	2,100	1,700	1,900+	2,000+	1,700	1,600	1,300	1,300−	1,300−

a. Less than 100.

Source: Employment Security Division, Kansas Department of Labor.

Table 8

REVISED NONFARM WAGE AND SALARY EMPLOYMENT IN COLORADO
1957 SIC

	1947	1948	1949	1950	1951	1952	1953	1954
Total Nonagricultual Employment..	335,000	344,700	338,400	358,200	393,400	412,600	417,400	411,900
Total Mining.....	13,100	12,600	10,800	10,000	11,000	12,300	12,900	13,200
Metal Mining (10).....	4,000	3,900	3,900	3,900	4,800	5,500	5,400	5,000
Bituminous Coal and Lignite Mining (12).....	6,100	5,800	4,800	4,100	3,700	3,300	3,200	2,400
Crude Petroleum and Natural Gas (13).....	2,200	2,200	1,500	1,400	1,700	2,700	3,600	5,100
Mining and Quarrying of Nonmetallic Minerals, Excl. Fuels (14)...	800	700	600	600	800	800	700	700

Table 8—*Concluded*

REVISED NONFARM WAGE AND SALARY EMPLOYMENT IN COLORADO
1957 SIC

	1955	1956	1957	1958	1959	1960	1961
Total Nonagricultural Employment.....	432,900	452,300	470,800	470,900	492,500	515,400	531,800
Total Mining.....	15,500	16,100	16,600	15,300	15,300	15,400	14,700
Metal Mining (10).....	5,700	6,300	6,600	5,700	5,900	6,300	6,700
Bituminous Coal and Lignite Mining (12).....	2,600	2,400	2,500	2,100	2,000	2,100	1,600
Crude Petroleum and Natural Gas (13).....	6,500	6,600	6,700	6,600	6,700	6,500	5,900
Mining and Quarrying of Nonmetallic Minerals, Excl. Fuels (14).....	700	800	800	900	700	500	500

Source: Department of Labor, Bureau of Labor Statistics.

Table 9

REVISED NONFARM WAGE AND SALARY EMPLOYMENT IN OKLAHOMA
1957 SIC

	1947	1948	1949	1950	1951	1952	1953	1954
Total Nonagricultural Employment[2]	437,300	462,700	466,000	476,900	504,300	526,600	535,300	531,300
Total Mining	40,300	43,100	42,600	43,100	45,200	46,800	48,200	50,000
Bituminous Coal and Lignite Mining (12)	2,300	2,400	2,000	2,000	1,800	1,500	1,500	1,300
Crude Petroleum and Natural Gas (13)	34,600	38,000	37,900	38,600	40,600	42,500	44,700	46,500
Other Mining (10 & 14)	3,500	2,700	2,700	2,500	2,800	2,800	2,000	2,200

Table 9—*Concluded*

REVISED NONFARM WAGE AND SALARY EMPLOYMENT IN OKLAHOMA
1957 SIC

	1955	1956	1957	1958	1959	1960	1961
Total Nonagricultural Employment[2]	550,900	563,400	564,500	557,100	573,200	581,600	583,400
Total Mining	52,000	52,900	51,800	48,500	47,700	45,100	45,000
Bituminous Coal and Lignite Mining (12)	1,300	1,100	1,100				
Crude Petroleum and Natural Gas (13)	48,400	49,400	48,800	45,800	45,000	42,600	42,500
Other Mining (10 & 14)	2,300	2,400	1,900	2,700[1]	2,700[1]	2,500[1]	2,500[1]

1. Includes bituminous coal.
2. Revised 1960.

Source: Oklahoma Employment Security Commission, Oklahoma State Employment Service Research and Planning Division, *Handbook of Oklahoma Employment Statistics, 1939-1962.*

Table 10

TOTAL NONAGRICULTURAL EMPLOYMENT IN MISSOURI—1947 TO 1961
1957 SIC

	1947	1948	1949	1950	1951	1952	1953	1954
Total Nonagricultural Employment	1,126,800	1,152,100	1,132,000	1,173,500	1,244,900	1,275,700	1,294,600	1,252,900
Total Mining	10,200	9,800	9,500	8,900	9,000	9,500	9,000	8,600
Metal Mining (10)								
Bituminous Coal (12)								
Crude Petroleum and Natural Gas (13)								
Mining and Quarrying of Nonmetallic, Excl. Fuels (14)								

Table 10—*Concluded*

TOTAL NONAGRICULTURAL EMPLOYMENT IN MISSOURI—1947 TO 1961

1957 SIC

	1955	1956	1957	1958	1959	1960	1961
Total Nonagricultural Employment	1,271,500	1,298,400	1,306,000	1,298,300	1,334,400	1,347,900	1,322,400
Total Mining	8,500	8,700	8,900	8,400	8,500	8,200	7,300
Metal Mining (10)							
Bituminous Coal (12)							
Crude Petroleum and Natural Gas (13)							
Mining and Quarrying of Nonmetallic, Excl. Fuels (14)							

Source: Missouri Division of Employment Security in cooperation with U. S. Bureau of Labor Statistics.

Table 11

ESTIMATED TOTAL NONAGRICULTURAL EMPLOYMENT FOR NEBRASKA

1957 SIC

	1947	1948	1949	1950	1951	1952	1953	1954
Total Nonagricultural Employment	301,400	313,300	311,700	319,200	333,700	344,300	349,100	348,400
Total Mining	500	700	800	1,100	1,400	1,600	1,600	2,000

Table 11—*Concluded*

ESTIMATED TOTAL NONAGRICULTURAL EMPLOYMENT FOR NEBRASKA

1957 SIC

	1955	1956	1957	1958	1959	1960	1961
Total Nonagricultural Employment	355,000	356,700	356,100	356,900	369,200	381,200	386,500
Total Mining	2,500	2,300	2,400	2,500	2,700	2,700	2,800

Source: Nebraska Department of Labor, Division of Employment, Research and Statistics.

Table 12

PERCENT CHANGE IN NONAGRICULTURAL EMPLOYMENT IN THE UNITED STATES AND SELECTED STATES FROM 1950 TO 1960 AND 1947 TO 1961

	1950 to 1960	1947 to 1961
United States		
Total Nonagricultural Employment	20.1	21.2
Total Mining	-21.3	-30.6
Metal Mining	-3.7	-15.7
Bituminous Coal	-54.5	-65.8
Crude Petroleum and Natural Gas	18.0	24.0
Mining and Quarrying, Excl. Fuels	25.7	13.5
Kansas		
Total Nonagricultural Employment	18.4	31.0
Total Mining	-1.2	-1.2
Metal Mining	-85.8	-91.8
Bituminous Coal	-66.7	-81.8
Crude Petroleum and Natural Gas	6.4	12.6
Mining and Quarrying, Excl. Fuels	6.3	14.3
Oklahoma		
Total Nonagricultural Employment	22.0	33.5
Total Mining	4.6	11.8
Bituminous Coal	....	....
Crude Petroleum and Natural Gas	10.7	22.8
Other Mining (10 & 14)[a]	....	....
Colorado		
Total Nonagricultural Employment	43.9	59.1
Total Mining	54.0	12.2
Metal Mining	61.6	67.5
Bituminous Coal	-48.8	-73.8
Crude Petroleum and Natural Gas	364.0	167.9
Mining and Quarrying, Excl. Fuels	-16.7	-37.6
Missouri[a]		
Nonagricultural Employment	14.7	17.9
Total Mining	-7.8	-28.4
Nebraska[a]		
Nonagricultural Employment	19.5	21.2
Total Mining	145.3	479.5

a. Mining industry breakdown not available or not complete.
Source: Computed from Tables 6-11.

Table 13

ANNUAL INDEX OF CHANGE OF EMPLOYMENT BY MINERAL INDUSTRY
(1950 Base = 100)

Industry	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Total Mining												
United States	100.0	103.0	98.7	96.2	87.8	87.9	91.2	91.8	83.3	81.1	78.6	
Kansas	100.0	108.1	111.1	108.7	108.1	112.1	115.8	111.5	105.8	106.2	98.9	93.1
Oklahoma	100.0	105.0	108.8	112.0	116.1	120.9	122.9	120.5	112.7	110.9	104.7	104.5
Colorado	100.0	110.0	123.0	129.0	132.0	155.0	161.0	166.0	153.0	153.0	154.0	147.0
Missouri	100.0	101.1	106.9	101.1	96.7	95.6	97.8	100.0	94.5	95.6	92.2	83.0
Nebraska	100.0	127.2	145.3	145.3	181.9	227.5	209.3	218.2	227.5	245.7	245.7	254.5
Crude Petroleum and Natural Gas												
United States	100.0	106.9	113.8	116.8	119.2	124.1	127.6	129.0	122.8	124.0	117.6	
Kansas	100.0	110.0	115.0	115.0	115.8	119.1	120.8	120.0	113.5	114.1	106.2	102.1
Oklahoma	100.0	105.2	110.1	115.9	120.3	125.3	128.0	126.5	118.8	115.6	110.3	110.0
Colorado	100.0	121.4	192.9	257.0	364.5	464.5	471.5	478.5	471.5	478.5	464.5	421.0
Missouri												
Nebraska												

Source: Computed from Tables 6-11.

Table 14

ANNUAL AVERAGE NONFARM EMPLOYMENT IN SELECTED INDUSTRIES—1947-1961

1957 SIC

	1947	1948	1949	1950	1951	1952	1953	1954
				Petroleum Refining (29)				
United States	221,000	228,000	221,000	218,000	231,300	234,600	241,400	238,100
Kansas	5,200	5,400	4,700	5,000	5,300	5,200	5,400	5,000
Oklahoma	9,900	11,000	10,700	10,000	10,600	10,700	10,800	10,100
Colorado	NA	NA	NA	NA	NA	NA	NA	NA
Missouri	2,200	2,400	2,300	2,300	2,500	2,700	2,500+	2,400
Nebraska	Not available as individual group figure.							
				Stone, Clay, and Glass Products (32)				
United States	537,000	549,000	514,000	547,000	587,000	564,000	581,300	552,600
Kansas	4,000	4,600	4,600	5,100	5,700	5,700	5,800	5,800
Oklahoma	4,700	5,100	5,400	6,200	6,100	5,900	6,200	6,100
Colorado	2,900	2,900	2,900	3,000	3,500	3,300	3,300	3,300
Missouri	16,300	16,500	15,100	15,800	17,600	17,400	16,700	15,400
Nebraska[a]	Not available as individual group figure.							

Table 14—*Concluded*

ANNUAL AVERAGE NONFARM EMPLOYMENT IN SELECTED INDUSTRIES—1947-1961

1957 SIC

	1955	1956	1957	1958	1959	1960	1961
			Petroleum Refining (29)				
United States	237,100	235,500	232,200	223,800	215,300	211,700	204,000
Kansas	4,900	4,900	4,800	4,800	4,900	4,700	4,600
Oklahoma	9,700	8,700	8,400	8,000	7,900	7,700	7,600
Colorado	NA	NA	NA	1,080	1,113	1,124	1,114
Missouri	2,400	2,400	2,300	2,100	1,800	1,800	1,900−
Nebraska							
			Stone, Clay, and Glass Products (32)				
United States	588,400	605,300	595,400	562,400	601,700	595,300	553,100
Kansas	6,500	6,800	6,200	6,100	6,700	6,700	6,800
Oklahoma	6,200	5,800	5,800	6,700	7,200	7,100	7,300
Colorado	3,800	3,900	4,100	4,300	4,600	4,800	4,900
Missouri	16,200	16,900	16,000	13,700	14,700	14,400	13,500
Nebraska[a]							

a. Nebraska carried as "Construction Material" which includes a small percentage other than Group 32.

Sources: Missouri Division of Employment Security.
Oklahoma Employment Security Commission.
Nebraska Department of Labor, Division of Employment and Security.
Employment Security Division, Kansas Department of Labor.
Bureau of Labor Statistics, *Employment and Earning Statistics for the U. S., 1909-1960*, Bulletin 1312, 1961.

Table 15

PERSONAL INCOME—WAGE AND SALARY DISBURSEMENTS

(Millions of Dollars)

	1939	1940	1941	1942	1943	1944	1945	1946
United States								
Personal Income	72,753	78,522	95,953	122,417	148,409	160,118	164,549	175,701
Wages and Sal. Disburs.	45,806	49,656	61,763	81,012	102,505	111,132	110,567	108,576
Mining	1,137	1,287	1,540	1,769	1,983	2,197	2,173	2,368
Bit. and Soft Coal	456	542	678	823	918	1,052	1,020	1,065
Crude Pet. and Nat. Gas	315	336	363	355	407	515	569	623
Min. and Quarry Exc. Fuels	242	291	364	435	480	428	388	443
Kansas								
Personal Income	694	762	976	1,502	1,863	2,052	1,992	2,012
Wages and Sal. Disburs.	385	402	500	775	1,075	1,188	1,118	972
Mining	22	22	25	26	32	36	37	40
Bit. and Soft Coal	2	2	3	3	3	3	3	3
Crude Pet. and Nat. Gas	16	17	18	19	23	27	27	30
Min. and Quarry Exc. Fuels	4	3	4	4	7	7	6	8
Oklahoma								
Personal Income	805	867	982	1,390	1,706	1,940	1,958	2,000
Wages and Sal. Disburs.	449	464	531	758	1,052	1,181	1,186	1,001
Mining	62	62	68	73	80	93	100	106
Bit. and Soft Coal	1	2	2	3	4	4	4	5
Crude Pet. and Nat. Gas	56	54	58	60	65	79	88	91
Min. and Quarry Exc. Fuels	4	6	8	10	11	9	8	10
Colorado								
Personal Income	578	617	728	1,010	1,185	1,195	1,317	1,429
Wages and Sal. Disburs.	339	350	408	594	726	734	792	804
Mining	19	21	25	29	32	32	32	32
Bit. and Soft Coal	10	10	12	15	17	19	18	16
Crude Pet. and Nat. Gas	1	1	1	1	1	2	3	6
Min. and Quarry Exc. Fuels	9	11	12	13	14	11	10	11
Missouri								
Personal Income	1,914	1,982	2,463	3,097	3,553	3,814	3,984	4,459
Wages and Sal. Disburs.	1,154	1,210	1,500	1,869	2,260	2,445	2,453	2,542
Mining	10	12	14	19	22	20	14	21
Bit. and Soft Coal	3	3	4	4	5	5	4	4
Crude Pet. and Nat. Gas	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]
Min. and Quarry Exc. Fuels	7	8	10	15	17	15	10	16
Iowa								
Personal Income	1,183	1,272	1,511	2,014	2,321	2,258	2,460	2,978
Wages and Sal. Disburs.	573	599	694	811	995	1,087	1,152	1,204
Mining	6	6	6	7	7	7	7	6
Bit. and Soft Coal	4	4	4	5	5	5	4	3
Crude Pet. and Nat. Gas	.....	.....	.....	.....	.....	.....	.....	.....
Min. and Quarry Exc. Fuels	1	1	2	2	2	2	2	3
Nebraska								
Personal Income	521	578	697	1,010	1,226	1,302	1,407	1,446
Wages and Sal. Disburs.	295	299	332	459	614	692	723	655
Mining	1	1	1	1	1	1	1	1
Bit. and Soft Coal	.....	.....	.....	.....	.....	.....	.....	.....
Crude Pet. and Nat. Gas	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]	0.5[a]
Min. and Quarry Exc. Fuels	1	1	1	1	1	1	1	1

Table 15—*Continued*

PERSONAL INCOME—WAGE AND SALARY DISBURSEMENTS

(Millions of Dollars)

	1947	1948	1949	1950	1951	1952	1953	1954
United States								
Personal Income	189,077	207,414	205,452	225,473	252,960	269,050	283,140	284,747
Wages and Sal. Disburs.	121,357	133,793	133,005	145,092	168,413	182,251	194,529	192,961
Mining	2,920	3,340	2,931	3,158	3,584	3,643	3,718	3,393
Bit. and Soft Coal	1,378	1,529	1,166	1,291	1,425	1,265	1,206	916
Crude Pet. and Nat. Gas	742	914	929	969	1,131	1,292	1,374	1,431
Min. and Quarry Exc. Fuels	550	620	613	665	791	871	955	904
Kansas								
Personal Income	2,385	2,415	2,397	2,643	2,950	3,382	3,251	3,410
Wages and Sal. Disburs.	1,064	1,218	1,287	1,373	1,694	1,919	2,038	2,052
Mining	45	55	55	58	70	76	76	76
Bit. and Soft Coal	4	4	3	3	4	3	3	2
Crude Pet. and Nat. Gas	35	44	45	48	58	63	65	66
Min. and Quarry Exc. Fuels	7	6	6	7	8	9	8	8
Oklahoma								
Personal Income	2,166	2,359	2,432	2,514	2,806	3,060	3,161	3,159
Wages and Sal. Disburs.	1,087	1,259	1,312	1,412	1,650	1,848	1,935	1,965
Mining	126	152	155	164	186	207	220	229
Bit. and Soft Coal	7	7	6	7	7	6	6	5
Crude Pet. and Nat. Gas	110	137	141	149	169	190	206	216
Min. and Quarry Exc. Fuels	9	8	8	8	10	11	8	9
Colorado								
Personal Income	1,654	1,760	1,794	1,930	2,284	2,468	2,492	2,519
Wages and Sal. Disburs.	895	995	1,019	1,127	1,371	1,528	1,574	1,623
Mining	38	40	35	34	41	51	54	57
Bit. and Soft Coal	18	18	15	13	14	13	12	9
Crude Pet. and Nat. Gas	7	7	5	5	7	10	15	21
Min. and Quarry Exc. Fuels	13	15	15	15	20	28	28	27
Missouri								
Personal Income	4,695	5,321	5,219	5,705	6,306	6,660	7,000	7,066
Wages and Sal. Disburs.	2,831	3,129	3,173	3,449	3,975	4,327	4,610	4,580
Mining	28	28	30	28	32	35	33	33
Bit. and Soft Coal	5	6	6	6	6	5	4	4
Crude Pet. and Nat. Gas	1	1	1	1	1	1	1	1
Min. and Quarry Exc. Fuels	23	22	23	22	25	29	28	28
Iowa								
Personal Income	2,986	3,934	3,403	3,799	4,072	4,272	4,110	4,489
Wages and Sal. Disburs.	1,398	1,581	1,610	1,724	1,954	2,058	2,131	2,144
Mining	7	9	9	9	9	12	11	11
Bit. and Soft Coal	4	4	3	4	3	3	2	2
Crude Pet. and Nat. Gas	.....	.....	.....	.....	.....	.....	.....	.....
Min. and Quarry Exc. Fuels	3	5	6	5	6	9	8	9
Nebraska								
Personal Income	1,574	1,851	1,699	1,949	2,045	2,179	2,106	2,236
Wages and Sal. Disburs.	730	816	844	909	1,040	1,111	1,161	1,194
Mining	1	2	2	3	4	6	6	7
Bit. and Soft Coal	.....	.....	.....	.....	.....	.....	.....	.....
Crude Pet. and Nat. Gas	0.5[a]	0.5[a]	0.5[a]	1	2	3	3	4
Min. and Quarry Exc. Fuels	1	2	2	2	2	3	3	3

Table 15—*Concluded*

PERSONAL INCOME—WAGE AND SALARY DISBURSEMENTS

(Millions of Dollars)

	1955	1956	1957	1958	1959	1960	1961
United States							
Personal Income	303,391	330,380	347,911	357,542	380,664	400,002	414,362
Wages and Sal. Disburs.	207,693	225,070	235,866	237,063	258,500	271,300	279,700
Mining	3,656	4,088	4,237	3,774	3,834	3,832	.....
Bit. and Soft Coal	993	1,152	1,182	942	926	887	.....
Crude Pet. and Nat. Gas	1,548	1,698	1,774	1,691	1,758	1,712	.....
Min. and Quarry Exc. Fuels	995	1,132	1,155	1,043	1,067	1,165	.....
Kansas							
Personal Income	3,393	3,641	3,843	4,214	4,238	4,504	4,730
Wages and Sal. Disburs.	2,115	2,246	2,348	2,401	2,514	2,570	.....
Mining	80	87	86	81	83	77	76
Bit. and Soft Coal	2	2	2	2	2	2	2
Crude Pet. and Nat. Gas	70	74	75	71	72	67	67
Min. and Quarry Exc. Fuels	9	11	8	8	9	8	7
Oklahoma							
Personal Income	3,328	3,572	3,734	3,975	4,138	4,312	4,434
Wages and Sal. Disburs.	2,092	2,260	2,326	2,388	2,521	2,593	.....
Mining	243	267	268	260	266	254	.....
Bit. and Soft Coal	5	5	5	5	5	4	.....
Crude Pet. and Nat. Gas	228	250	254	248	252	242	.....
Min. and Quarry Exc. Fuels	10	10	8	8	8	8	.....
Colorado							
Personal Income	2,729	3,067	3,357	3,508	3,737	4,079	4,361
Wages and Sal. Disburs.	1,774	1,982	2,134	2,217	2,402	2,608	.....
Mining	67	79	85	76	81	86	.....
Bit. and Soft Coal	10	12	12	10	10	10	.....
Crude Pet. and Nat. Gas	28	30	35	34	37	38	.....
Min. and Quarry Exc. Fuels	29	37	39	32	34	38	.....
Missouri							
Personal Income	7,560	8,082	8,264	8,644	9,248	9,522	9,894
Wages and Sal. Disburs.	4,871	5,254	5,415	5,530	5,989	6,179	.....
Mining	34	37	38	35	35	36	38[b]
Bit. and Soft Coal	4—	5	6	5	5	5	.....
Crude Pet. and Nat. Gas	1	1	1	1	1	.....	.....
Min. and Quarry Exc. Fuels	29	31	31	29	29	30	.....
Iowa							
Personal Income	4,260	4,519	5,056	5,245	5,409	5,531	.....
Wages and Sal. Disburs.	2,301	2,436	2,537	2,661	2,918	3,014	.....
Mining	12	14	13	16	15	14	.....
Bit. and Soft Coal	2	2	2	2	2	2	.....
Crude Pet. and Nat. Gas	.....	.....	.....	.....	.....	.....	.....
Min. and Quarry Exc. Fuels	10	12	12	14	13	13	.....
Nebraska							
Personal Income	2,147	2,294	2,635	2,795	2,797	2,988	3,085
Wages and Sal. Disburs.	1,258	1,326	1,360	1,419	1,550	1,675	.....
Mining	10	10	10	10	12	12	.....
Bit. and Soft Coal	.....	.....	.....	.....	.....	.....	.....
Crude Pet. and Nat. Gas	6	6	6	6	7	7	.....
Min. and Quarry Exc. Fuels	4	4	4	4	5	5	.....

a. Less than 0.5 million.

b. 1961 figure from Missouri Division of Employment Security, Department of Labor. (Not exactly comparable with previous years, *i. e.*, 1960 was 38.1.)

Source: *A Supplement to the Survey of Current Business*, "Personal Income by States since 1929," Tables 4, 28, 31, 32, 47, 55. *Survey of Current Business*, August, 1957, 1958, 1959, 1960, 1961; April, 1962.

Table 16

PERCENT CHANGE IN ANNUAL WAGES AND SALARIES IN THE MINING INDUSTRY BY DECADES

	Percent Change 1940–1950	Percent Change 1950–1960
All Mining		
United States	145.5	21.4
Kansas	163.6	32.8
Oklahoma	164.5	54.9
Colorado	62.0	153.0
Missouri	133.3	28.6
Nebraska	200.0	300.0
Iowa	50.0	55.5
Fuels[a]		
United States	156.5	15.0
Kansas	168.5	35.3
Oklahoma	178.7	57.6
Colorado	63.6	166.5
Missouri	133.3	28.6
Nebraska	0.0	600.0
Iowa	0.0	−50.0
Mining and Quarrying (Excl. Fuels)		
United States	128.6	75.3
Kansas	133.3	14.3
Oklahoma	33.3	0.0
Colorado	36.0	153.7
Missouri	175.0	36.4
Nebraska	100.0	150.0
Iowa	400.0	160.0

a. Combined bituminous coal and petroleum and natural gas.
Source: Compiled from Table 15.

Table 17

ANNUAL INDEX OF CHANGE OF U. S. AND STATE WAGES AND SALARIES DISBURSED BY MINING INDUSTRY DURING 1950-1960

(1950 Base = 100)

Industry	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Mining											
United States	100.0	113.8	115.5	117.5	107.2	115.8	129.5	134.1	119.5	121.2	121.2
Kansas	100.0	120.7	130.0	130.0	130.0	137.8	149.9	148.1	139.6	143.0	132.8
Oklahoma	100.0	118.4	132.0	140.1	145.9	154.8	170.1	170.9	165.7	169.3	161.8
Colorado	100.0	120.8	150.0	158.9	167.9	197.2	232.5	250.1	223.8	238.2	253.5
Missouri	100.0	114.1	125.1	117.9	117.9	121.5	132.1	135.9	128.1	125.1	128.7
Nebraska	100.0	133.3	200.0	200.0	233.3	333.3	333.3	333.3	333.3	400.0	400.0
Crude Petroleum & Natural Gas											
United States	100.0	116.9	133.8	141.9	148.0	159.9	175.2	183.2	174.9	181.3	177.0
Kansas	100.0	120.7	131.1	135.2	137.3	145.8	154.0	156.1	147.9	149.9	139.5
Oklahoma	100.0	113.3	127.5	138.2	145.0	153.0	167.8	170.3	166.4	169.0	162.5
Colorado	100.0	140.0	200.0	300.0	420.0	560.0	600.0	700.0	680.0	740.0	760.0
Missouri	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0
Nebraska	100.0	200.0	300.0	300.0	400.0	600.0	600.0	600.0	600.0	700.0	700.0
Mining & Quarrying Except Fuels											
United States	100.0	119.0	131.0	143.6	135.8	149.6	170.4	173.8	157.0	160.3	175.2
Kansas	100.0	114.2	128.8	114.2	114.2	128.8	157.1	114.2	114.2	128.8	114.2
Oklahoma	100.0	125.0	137.5	100.0	112.5	125.5	125.5	100.0	100.0	100.0	100.0
Colorado	100.0	133.3	186.7	186.7	180.0	193.3	246.5	260.0	213.3	226.5	253.5
Missouri	100.0	113.8	132.0	127.2	127.2	132.0	141.0	141.0	132.0	132.0	136.3
Nebraska	100.0	100.0	150.0	150.0	150.0	200.0	200.0	200.0	200.0	250.0	250.0
Bituminous and Soft Coal											
United States	100.0	110.2	97.3	93.5	70.9	76.8	89.3	91.5	73.0	71.8	68.7
Kansas	100.0	133.3	100.0	100.0	66.7	66.7	66.7	66.7	66.7	66.7	66.7
Oklahoma	100.0	100.0	85.7	85.7	71.5	71.5	71.5	71.5	71.5	71.5	57.1
Colorado	100.0	107.7	100.0	92.3	69.3	77.0	92.3	92.3	77.0	77.0	77.0
Missouri	100.0	100.0	83.4	66.7	66.7	66.7	83.4	100.0	83.4	83.4	83.4

Source: Computed from Table 15.

Table 18

PERCENT OF TOTAL UNITED STATES AND STATE WAGES AND SALARIES DISBURSED BY MINING INDUSTRY

1950-1960

Industry	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Total Mining											
United States	2.17	2.13	2.00	1.91	1.76	1.76	1.82	1.80	1.58	1.48	1.41
Kansas	4.22	4.13	3.96	3.73	3.70	3.79	3.81	3.66	3.37	3.31	3.03
Oklahoma	11.61	11.26	11.10	11.35	11.71	11.51	11.72	11.55	10.90	10.54	9.79
Colorado	3.15	2.99	3.34	3.43	3.51	3.77	4.46	3.98	3.44	3.38	3.20
Missouri	0.81	0.81	0.82	0.72	0.72	0.71	0.70	0.70	0.63	0.58	0.58
Iowa	0.24	0.22	0.28	0.27	0.25	0.28	0.31	0.26	0.30	0.27	0.25
Nebraska	0.33	0.38	0.54	0.52	0.59	0.79	0.75	0.74	0.71	0.77	0.72
Crude Petroleum & Natural Gas											
United States	0.67	0.67	0.71	0.71	0.74	0.75	0.75	0.75	0.71	0.68	0.63
Kansas	2.78	3.43	3.21	3.20	3.21	3.31	3.29	3.19	2.96	2.97	2.61
Oklahoma	10.05	10.02	10.03	10.63	10.99	10.91	11.05	10.92	10.39	10.00	9.53
Colorado	0.44	0.51	0.66	0.95	1.29	1.57	1.51	1.63	1.53	1.54	1.46
Missouri	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	.....
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nebraska	0.11	0.19	0.27	0.26	0.21	0.48	0.45	0.44	0.42	0.45	0.42
Mining & Quarrying Except Fuels											
United States	0.46	0.47	0.48	0.49	0.47	0.48	0.50	0.49	0.44	0.41	0.43
Kansas	0.51	0.47	0.47	0.39	0.39	0.42	0.49	0.33	0.33	0.36	0.31
Oklahoma	0.57	0.61	0.60	0.41	0.46	0.48	0.44	0.34	0.33	0.32	0.31
Colorado	1.34	1.45	1.83	1.75	1.66	1.64	1.86	1.83	1.45	1.41	1.46
Missouri	0.64	0.63	0.67	0.62	0.62	0.60	0.59	0.57	0.52	0.49	0.49
Iowa	0.14	0.15	0.21	0.19	0.20	0.23	0.27	0.24	0.27	0.24	0.23
Nebraska	0.22	0.19	0.27	0.25	0.25	0.32	0.30	0.29	0.28	0.32	0.30
Bituminous and Soft Coals											
United States	0.89	0.85	0.69	0.62	0.48	0.48	0.51	0.50	0.40	0.36	0.33
Kansas	0.22	0.24	0.16	0.15	0.10	0.09	0.09	0.08	0.08	0.08	0.08
Oklahoma	0.50	0.42	0.32	0.31	0.24	0.22	0.21	0.21	0.21	0.20	0.15
Colorado	1.15	1.02	0.85	0.76	0.55	0.57	0.61	0.56	0.45	0.42	0.38
Missouri	0.17	0.15	0.12	0.09	0.09	0.08	0.10	0.11	0.09	0.08	0.08
Iowa	0.11	0.07	0.07	0.05	0.04	0.05	0.04	0.04	0.04	0.04	0.04

Source: Computed from Table 15.

Table 19

PERCENT OF TOTAL UNITED STATES WAGE AND SALARY DISBURSEMENTS BY MINING INDUSTRIES BY STATES 1940, 1950-1960

Industry	1940	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
Total Mining												
Kansas	1.71	1.84	1.95	2.08	2.05	2.22	2.18	2.08	2.03	2.14	2.16	2.01
Oklahoma	4.81	5.20	5.18	5.68	5.93	6.77	6.65	6.54	6.34	6.90	6.94	6.63
Colorado	1.63	1.08	1.14	1.40	1.46	1.68	1.83	1.92	2.01	2.01	2.11	2.24
Missouri	0.93	0.89	0.89	0.96	0.89	0.97	0.93	0.93	0.90	1.01	0.91	0.94
Iowa	0.47	0.29	0.31	0.33	0.30	0.32	0.33	0.34	0.31	0.42	0.39	0.37
Nebraska	0.08	0.10	0.11	0.16	0.16	0.21	0.27	0.24	0.24	0.26	0.31	0.31
Bituminous Coal												
Kansas	0.37	0.23	0.28	0.24	0.25	0.29	0.20	0.18	0.17	0.21	0.22	0.23
Oklahoma	0.37	0.54	0.49	0.47	0.50	0.50	0.50	0.44	0.42	0.53	0.54	0.45
Colorado	1.85	1.01	0.98	1.11	1.00	0.98	1.01	1.05	1.01	1.06	1.08	1.13
Missouri	0.55	0.46	0.42	0.40	0.33	0.44	0.40	0.44	0.51	0.53	0.54	0.56
Iowa	0.74	0.31	0.21	0.24	0.17	0.22	0.20	0.17	0.17	0.21	0.22	0.23
Nebraska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Crude Pet. & Nat. Gas												
Kansas	5.06	4.95	5.12	4.87	4.73	4.60	4.59	4.25	4.23	4.20	4.10	3.91
Oklahoma	16.07	15.37	14.91	14.69	15.00	15.10	14.95	14.86	14.31	14.65	14.34	14.13
Colorado	0.30	0.52	0.62	0.77	1.09	1.47	1.84	1.77	1.97	2.00	1.54	2.22
Missouri	.....	0.10	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.06	0.06	.....
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nebraska	.....	0.10	0.15	0.23	0.22	0.28	0.39	0.35	0.34	0.35	0.40	0.41
Mining & Quarry (Excl. Fuels)												
Kansas	1.03	1.05	1.01	1.03	0.84	0.89	0.90	0.98	0.69	0.77	0.84	0.68
Oklahoma	2.06	1.20	1.26	1.26	0.84	0.99	1.00	0.89	0.69	0.77	0.75	0.68
Colorado	3.78	2.26	2.52	3.22	2.93	2.98	2.92	3.20	3.38	3.06	3.19	3.26
Missouri	2.75	3.31	3.16	3.33	2.93	2.80	2.92	2.75	2.68	2.78	2.72	2.58
Iowa	0.34	0.75	0.76	1.03	0.84	1.00	1.04	1.06	1.04	0.83	1.22	1.12
Nebraska	0.34	0.30	0.25	0.34	0.31	0.33	0.40	0.35	0.35	0.38	0.47	0.43

Source: Computed from Table 15.

Table 20

PETROLEUM DATA AND PERCENTAGE CHANGES FOR KANSAS AND UNITED STATES, 1960-1961

	Kansas figures		Change from previous year, percent	
	1960	1961	Kansas	United States
Crude oil production (barrels)	113,401,548[a]	112,210,936[a]	−1.0	+1.65
Value of crude oil produced	$336,608	$333,266,480	−1.0	.....
Kansas oil production as percentage of U. S. total	4.6	4.5	−2.2	.....
Average price of oil	$2.97	$2.97	.....	.....
Rank of Kansas among oil-producing states	6th	6th	.....	.....
Proved reserves of liquid hydrocarbons (at year end), thousands of barrels	1,082,252[b]	1,061,606[b]	−1.9	+0.98
Ratio of proved liquid hydrocarbon reserves to current annual production	9.0:1	8.9:1	−1.1	.....
Oil-producing area of "western Kansas," acres	922,370[c]	908,880	−1.5	.....
Natural gas production, M cu. ft.	632,609,850[d]	676,235,505	+6.9	+2.76
Value of natural gas produced	$69,587,083[e]	$74,385,906	+6.9	.....
Production of natural gas and LPG (natural gas liquids), gallons	250,789,014[f]	258,303,612	+3.0	+7.0
Value of natural gasoline and LPG	$13,196,279[g]	$13,591,690	+3.0	.....
Proved reserves of natural gas, millions of cubic feet	19,620,224[f]	19,190,005	−2.2	+1.50
Ratio of proved natural gas reserves to current annual production	31.1:1	27.5:1	−11.6	.....
Gas-producing area of "western Kansas," acres	3,105,450	3,056,740	−1.6	.....
New oil and gas pools discovered	99[h]	104		
Recorded well completions in Kansas				
Oil[h]	1,556	1,315		
Gas[h]	159	221		
Oil and gas[i]	68	87		
Dry	1,572	1,485		
Salt-water disposal[j]	181	227		
Unrecorded, estimated	953[k]	904		
Total recorded and estimated	4,489	4,239		
Wildcats and discovery wells (included in above total)	631	533		

a. Figures supplied by State Corporation Commission, Conservation Division.

b. Figures from American Petroleum Institute and American Gas Association, 1962. Barrels have 42 U. S. gallons and gas is based at 14.65 p. s. i. a. at 60° F.

c. The petroleum area of "western Kansas" includes all producing counties west of the west line of Cowley, Butler, Marion, and Dickinson Counties.

d. Figures supplied by State Corporation Commission, base 14.65 p. s. i. a.

e. The minimum value of 11 cents per M cubic feet of gas at 14.65 p. s. i. a. has been applied to all Kansas gas production.

f. Corrected figures.

g. This aggregate figure is based on unit values of the several products that reflect wholesale prices at the plant.

h. Omitting revived pools.

i. Includes pool wells and new discoveries.

j. Includes salt-water disposal and recorded secondary recovery input wells.

k. Counties for which number of wells drilled in 1961 is entirely or in part estimated include Allen, Anderson, Bourbon, Chautauqua, Coffey, Crawford, Elk, Franklin, Greenwood, Labette, Linn, Miami, Montgomery, Neosho, Wilson, and Woodson. Estimates based on "intent to drill" records.

Table 21

CRUDE OIL, NATURAL GAS, AND LPG PRODUCTION, VALUE, AND RESERVES, KANSAS, 1946-1961

	Crude Oil				Natural Gas			Natural Gasoline and LPG	
			Reserves Millions bbls.						
	Millions $	Millions bbls.	(crude oil)	Liquid hydro.	Millions $	M cu. ft.	Reserves Trillions cu. ft.	Millions $	Millions gals.
1946	138.8	97.2	545.3	.....	.....	.....	....	....	82.5
1947	203.6	103.9	562.7	651.5	10.23	205.5	14.6	4.7	99.2
1948	280.0	108.0	674.4	776.4	12.84	240.2	14.4	9.5	107.5
1949	257.4	100.0	738.4	844.8	23.6	294.7	14.5	6.7	113.8
1950	275.4	107.3	732.2	895.8	25.9	361.8	13.8	9.6	155.3
1951	292.8	113.9	791.9	951.5	29.0	407.2	13.5	11.3	183.0
1952	294.0	114.4	917.0	1,085.3	32.7	408.7	14.2	12.0	196.5
1953	307.6	114.4	913.0	1,091.0	37.7	420.6	15.8	13.0	211.7
1954	333.6	118.3	978.5	1,153.6	44.6	405.8	15.8	11.8	193.8
1955	341.7	121.2	998.1	1,171.3	51.3	466.2	16.3	12.0	206.6
1956	351.0	124.5	992.2	1,163.8	57.8	525.9	17.6	11.7	199.4
1957	380.8	124.0	947.5	1,136.6	63.9	580.7	19.3	13.3	223.6
1958	362.2	119.9	922.4	1,122.9	59.0	535.7	20.2	10.3	225.2
1959	354.8	119.5	917.5	1,114.4	65.5	595.2	20.0	12.3	232.9
1960	336.6	113.4	883.9	1,082.3	69.6	632.6	19.6	13.2	250.8
1961	333.3	112.2	878.0	1,061.6	74.4	676.2	19.2	13.6	258.3

Sources: Oil and Gas Development Reports, State Geological Survey of Kansas, 1946-1961.

Table 22

ESTIMATED PROVED RESERVES OF CRUDE OIL

(Thousands of Barrels)

Year	Colorado	Kansas	Nebraska	Oklahoma	Wyoming
1961	419,664	878,027	100,429	1,787,429	1,380,498
1960	363,859	883,849	86,174	1,790,632	1,427,375
1959	380,952	917,503	80,558	1,864,749	1,402,938
1958	392,060	922,434	69,242	1,898,128	1,408,717
1957	309,939	947,484	63,059	1,941,521	1,419,718
1956	363,750	992,211	62,861	2,009,798	1,363,164
1955	334,003	998,068	57,697	2,016,045	1,373,630
1954	328,651	978,449	38,031	1,955,348	1,303,577
1953	319,254	913,341	25,621	1,752,228	1,279,110
1952	305,691	916,989	21,836	1,557,620	1,064,722
1951	325,178	791,946	15,918	1,476,457	973,440
1950	339,529	732,187	9,700	1,396,913	841,016

Source: American Petroleum Institute, Annual Reserves Reports, 1950-1961.

Table 23

ESTIMATED PROVED RECOVERABLE RESERVES OF NATURAL GAS

(Millions of Cubic Feet)

Year	Colorado	Kansas	Nebraska	Oklahoma	Wyoming
1961	2,170,716	19,190,005	104,282	17,350,924	4,127,048
1960	2,042,754	19,620,224	117,828	17,311,402	3,934,749
1959	2,496,159	19,981,403	132,719	16,651,292	3,847,064
1958	2,349,240	20,233,847	143,321	15,206,769	3,649,818
1957	2,380,679	19,295,978	189,339	14,259,480	3,457,433
1956	2,422,769	17,566,257	225,402	13,775,049	3,235,932
1955	2,253,562	16,293,080	203,421	13,204,739	3,196,103
1954	1,932,913	15,758,332	192,946	12,396,148	2,855,071
1953	1,864,275	15,787,602	182,110	12,228,373	2,739,631
1952	1,164,249	14,193,565	93,958	11,764,829	2,321,124
1951	1,138,451	13,457,498	67,351	7,368,214	1,479,958
1950	1,115,473	13,790,834	44,106	11,634,287	2,194,989

Source: American Gas Association, Annual Reserves Reports, 1950-1961.

Table 24

ESTIMATED PROVED RESERVES OF NATURAL GAS LIQUIDS

(Thousands of Barrels)

Year	Colorado	Kansas	Nebraska	Oklahoma	Wyoming
1961	20,777	183,579	3,851	329,180	100,386
1960	24,024	198,403	6,155	338,313	96,375
1959	24,914	196,912	5,432	367,569	73,279
1958	21,268	199,552	5,699	357,507	50,876
1957	10,965	189,155	7,135	342,643	51,165
1956	11,545	171,615	6,504	355,588	53,874
1955	12,511	173,236	6,436	354,354	50,348
1954	12,747	175,197	2,268	333,911	50,686
1953	10,689	177,728	3,034	304,232	50,559
1952	11,339	168,227	2,716	284,906	57,090
1951	11,910	159,569	2,586	311,125	45,886
1950	12,921	163,378	235	279,903	48,987

Source: American Gas Association, Annual Reserves Reports, 1950-1961.

Table 25

SECONDARY RECOVERY OF CRUDE OIL IN KANSAS, 1949-1961 (BARRELS)

Year	Total	Secondary
1961	112,210,936	20,245,000
1960	113,344,548	19,300,000
1959	119,473,875	17,900,000
1958	119,942,094	17,100,000
1957	124,054,043	16,900,000
1956	124,467,713	15,100,000
1955	121,161,234	15,100,000
1954	118,309,260	11,200,000
1953	114,390,176	10,900,000
1952	114,399,556	10,000,000
1951	113,912,366	8,000,000
1950	107,339,000	7,000,000
1949	100,164,092	7,000,000

Source: Kansas Geological Survey Annual Reports, Oil and Gas Division.

Table 27

DAILY AVERAGE CRUDE OIL PRODUCTION AND NUMBER OF PRODUCING WELLS IN KANSAS 1952-1961

Year	Number producing wells	Total barrels per day	Daily average per well (barrels)
1961	41,248	307,975	7.5
1960	40,297	310,109	7.7
1959	39,376	329,595	8.4
1958	39,200	330,518	8.4
1957	38,258	338,956	8.9
1956	37,095	339,664	9.2
1955	35,669	333,265	9.3
1954	34,561	325,677	9.4
1953	33,184	314,104	9.5
1952	32,076	313,724	9.8

Source: Oil and Gas Journal. *Annual Review Forecast Issues*, 1953-1962.

Table 26

HELIUM AND CARBON BLACK PRODUCTION AND VALUE IN KANSAS, 1937-1961

	Helium			Carbon Black	
Year	Production, cu. ft.	Shipments, cu. ft.	Value of shipments, $	Production, lbs.	Value, $
1937–1948	.....	.....	.....	415,000,000	17,620,000
1949	.....	.....	.....	78,833,470	3,515,827
1950	.....	.....	.....	82,508,506	3,992,268
1951	26,280,000	26,280,000	327,000	112,205,669	5,334,126
1952	38,509,000	38,509,000	491,000	82,000,000	3,900,000
1953	42,782,800	42,782,800	563,923	69,985,475	3,207,600
1954	37,530,000	37,530,000	593,162	54,328,515	3,014,316
1955	42,749,600	42,749,600	662,619	97,496,155	5,553,883
1956	45,035,200	45,035,200	698,000	105,680,834	6,590,663
1957	37,249,000	36,743,000	569,517	76,419,500	5,131,569
1958	25,858,000	27,888,000	432,264	75,443,750	5,261,142
1959	24,004,300	21,642,500	342,619	91,644,160	6,387,598
1960	21,930,600	21,696,300	349,750	87,302,185	5,621,236
1961	23,049,600	23,250,900	433,682	89,936,075	6,243,192
Totals	364,978,100	364,107,300	5,463,536	1,518,784,294	81,373,420

Sources: Oil and Gas Development Reports, State Geological Survey of Kansas; Annual Mineral Industries Reports, State Geological Survey of Kansas.

Table 28

EXPLORATORY WELLS IN KANSAS, 1939-1960

Year	Number dry holes	Dry hole footage	Number producing wells	Producing footage
1960	889	3,205,185	215	732,181
1959	1,301	4,665,855	344	1,220,064
1958	1,220	4,397,270	339	1,166,518
1957	1,207	4,478,905	385	1,363,993
1956	1,430	5,255,055	477	1,671,598
1955	1,353	5,113,971	422	1,523,321
1954	1,074	4,002,981	355	1,282,804
1953	1,285	4,716,127	344	1,219,782
1952	1,161	4,335,606	310	1,122,741
1951	1,082	3,930,428	263	906,408
1950	785	2,720,458	189	621,210
1949	539	1,884,857	141	460,741
1948	514	1,867,268	100	349,770
1947	429	1,523,908	99	343,767
1946	335	1,227,804	90	305,086
1945	375	1,365,157	107	364,545
1944	422	1,568,814	66	230,168
1943	379	1,416,605	57	199,532
1942	296	1,039,753	34	122,041
1941	200	688,189	37	140,284
1940	122	408,887	23	75,142
1939	74	258,031	21	67,259

Source: American Association of Petroleum Geologists, Annual June Issues, 1940-1961.

Table 31

PERCENTAGE OF PRODUCING WELLS DRILLED TO TOTAL WELLS, KANSAS, 1950-1960

Year	Producing wells	Total wells	Percentage, producing wells
1960	2,287	4,187	54.6
1959	1,993	4,075	48.9
1958	1,951	3,810	51.2
1957	2,280	4,252	53.6
1956	2,328	4,375	53.2
1955	2,701	4,655	58.0
1954	2,581	4,352	59.0
1953	2,405	4,450	54.0
1952	2,375	4,350	54.6
1951	2,587	4,539	57.0
1950	2,427	4,090	59.3

Source: *American Association of Petroleum Geologists Bulletin*, June Issues, 1951-1961.

Table 29

DAILY CRUDE OIL PRODUCTION, 1961

State	Barrels, daily	Producing wells	Daily average per well
Colorado	128,097	2,204	58.1
Kansas	307,975	41,248	7.5
Nebraska	67,693	1,735	39.0
Oklahoma	523,274	80,679	6.5
Wyoming	393,473	7,535	52.2

Source: *Oil and Gas Journal*, Jan. 29, 1962, p. 123.

Table 30

NUMBER OF OIL AND GAS FIELDS DISCOVERED IN KANSAS, 1938-1960

Year	Number	Year	Number
1938	79	1950	122
1939	38	1951	154
1940	28	1952	167
1941	34	1953	187
1942	42	1954	144
1943	57	1955	149
1944	54	1956	173
1945	47	1957	175
1946	37	1958	157
1947	64	1959	198
1948	74	1960	99
1949	96		

Source: Kansas Geological Survey Annual Reports, Oil and Gas Division.

Table 32

GIANT FIELD OIL PRODUCTION FROM SELECTED STATES, 1961

(Millions of Barrels)

State	Giant Fields	All Fields
Kansas	19.94	112.41
Oklahoma	83.29	191.00
Colorado	24.31	46.76
Illinois	50.56	79.48
Wyoming	69.33	143.62

Source: *Oil and Gas Journal*, Jan. 29, 1962, p. 134.

Table 33

SUMMARY OF MAJOR CRUDE OIL PRODUCERS WITH DAILY AVERAGE PRODUCTION (BBLS.), 1956-1960 MONTHS OF DECEMBER ONLY

	1956	1957	1958	1959	1960
Anderson-Prichard	3,104	3,776	4,129	3,026	2,975
Champlin	3,061	3,270	3,257	3,467	2,769
Cities Service	30,467	29,743	29,184	28,237	26,299
Colorado Oil & Gas	4,462	4,462	3,717	3,283	3,028
Continental	12,643	11,425	10,751	9,925	9,231
Coop. Refg. Assn.	5,384	5,341	5,759	5,593	5,417
Gulf	5,812	6,105	5,597	4,957	4,181
Magnolia	5,508	5,019	4,644	5,011	4,582
Natl. Coop. Refg. Assn.	5,730	5,755	5,519	5,053	4,555
Phillips	10,612	10,204	8,353	7,851	7,393
Shell	6,173	5,398	4,496	3,970	3,531
Sinclair	5,681	6,414	5,171	4,514	3,205
Skelly	9,683	9,228	8,322	8,286	7,836
Sohio	4,785	4,248	4,059	3,463	3,220
Stanolind	8,112	7,963	7,427	6,648	5,915
Sunray Mid-Continent	8,252	8,625	7,427	6,957	6,788
Texas	9,541	9,018	8,150	8,322	7,876
All Principal	165,270	163,350	152,681	142,973	129,317
Others	172,415	181,149	186,635	188,430	182,227
State Total	337,685	344,499	339,316	331,403	311,544
Difference	7,145	17,799	33,954	45,457	52,910

Source: Petroleum Statistical Guide, Inc., *Kansas, Summary Production by Principal Companies*, December, 1961.
Note: Principal producers have had decline in percent of daily average of state.

Table 34

CHANGES IN CRUDE OIL PRODUCTIVE CAPACITY—UNITED STATES

(Thousand Barrels Daily)

	Jan. 1 1951	Jan. 1 1953	July 1 1954	Jan. 1 1957	Jan. 1 1960	Annual Rate of Change (2) 1951–53	1953–54	1954–57	1957–60
District									
1. East Coast	54	49	43	37	29	−2	−4	−2	−3
2. Mid-Continent	1,083	1,238	1,380	1,591	1,555	78	95	85	−12
3. Gulf Coast	4,161	4,686	5,224	6,613	7,331	262	359	555	239
4. Rocky Mountain	350	394	561	615	664	22	111	21	16
5. West Coast (1)	1,079	1,098	1,123	1,011	1,006	9	16	−45	−2
Total	6,727	7,465	8,331	9,867	10,585	369	577	614	238

(1) Including Elk Hills. The estimate for January 1, 1960, included Elk Hills at 175,000 barrels daily, of which 163,000 barrels daily was shut in. Prior reports included Elk Hills at 158,000 barrels daily in 1954 and at 87,000 barrels daily for January 1957. The 1957 estimate was reduced because of facility limitations, whereas the 1960 estimate was based on efficient capacity of existing wells irrespective of the limitations of surface facilities.

(2) Rates of change influenced slightly by difference in estimates of productive capacity for Elk Hills, as per note (1).

Source: The National Petroleum Council, "Proved Discoveries and Productive Capacities of Crude Oil, Natural Gas Liquids in the United States, 1961," Washington, 1962.

Table 35

MAXIMUM PRODUCTIVE CAPACITY OF NATURAL GAS IN THE UNITED STATES

(Thousand Cubic Feet Daily at 14.65 psia and 60° F.)

	Non-Associated	Associated	Dissolved	Total
1–1–1960				
PAD Dist. 1	983,200	0	7,100	990,300
2	5,466,900	888,400	1,848,300	8,203,600
3	41,892,600	4,267,800	11,960,800	58,121,200
4	1,720,000	151,000	456,000	2,327,000
5	728,000	0	1,134,000	1,862,000
Total	50,790,700	5,307,200	15,406,200	71,504,100
1–1–1961*				
PAD Dist. 1	711,600	0	5,100	716,700
2	5,436,500	883,200	1,655,600	7,975,300
3	39,861,850	4,004,600	11,349,400	55,215,850
4	1,596,000	132,000	429,000	2,157,000
5	687,000	0	1,037,000	1,724,000
Total	48,292,950	5,019,800	14,476,100	67,788,850
1–1–1962*				
PAD Dist. 1	580,500	0	4,100	584,600
2	5,396,900	880,000	1,470,500	7,747,400
3	37,830,625	3,731,300	10,829,000	52,390,925
4	1,459,000	119,000	403,000	1,981,000
5	647,000	0	974,000	1,621,000
Total	45,914,025	4,730,300	13,680,600	64,324,925

* Projected on basis of no drilling after January 1, 1960.

Notes:

(i) This statement does *not* include any gas available from storage reservoirs.

(ii) This statement *does* include gas available from reservoirs being cycled.

Source: The National Petroleum Council, "Proved Discoveries and Productive Capacities of Crude Oil, Natural Gas Liquids in the United States, 1961," Washington, 1962.

Table 36

MAXIMUM PRODUCTIVE CAPACITY OF NATURAL GAS LIQUIDS IN THE UNITED STATES

(Thousand Barrels Daily)

	PAD Districts					
	1	2	3	4	5	Total
1–1–1960						
Non-Associated	10.2	70.2	843.4	15.0	—	938.8
Associated	—	13.3	125.7	2.0	—	141.0
Dissolved	—	79.1	532.7	20.0	88.0	719.8
Total	10.2	162.6	1,501.8	37.0	88.0	1,799.6
1–1–1961*						
Non-Associated	7.5	70.1	803.5	14.0	—	895.1
Associated	—	13.3	116.2	2.0	—	131.5
Dissolved	—	71.5	521.5	20.0	80.0	693.0
Total	7.5	154.9	1,441.2	36.0	80.0	1,719.6
1–1–1962*						
Non-Associated	6.3	69.1	764.7	14.0	—	854.1
Associated	—	13.3	108.3	2.0	—	123.6
Dissolved	—	65.1	512.6	19.0	73.0	669.7
Total	6.3	147.5	1,385.6	35.0	73.0	1,647.4

* Projected on basis of no drilling after January 1, 1960.

Source: The National Petroleum Council, "Proved Discoveries and Productive Capacities of Crude Oil, Natural Gas Liquids in the United States, 1961," Washington, 1962.

Table 37

CRUDE REFINERY CAPACITIES (BARRELS PER CRUDE DAY), KANSAS AND U. S.

Year	Kansas	Number of refineries	United States	Number of refineries
1962	346,900	13	10,006,982	299
1961	343,240	13	9,933,725	298
1960	331,600	13	9,785,355	294
1959	327,947	14	9,615,787	293
1958	307,000	14	9,130,436	298
1957	297,000	14	.....	...
1956	287,000	14	8,632,340	318
1955	.....	..	8,420,630	326
1954	262,000	13	8,006,894	337
1953	.....	..	7,638,661	343
1952	.....	..	7,332,885	350
1951	227,000	15	6,963,644	357
1950	.....	..	6,696,300	367
1949	.....	..	6,438,995	375
1948	.....	..	6,034,252	390
1947	.....	..	5,569,482	399
1946	189,000	21	5,315,856	393
1945	.....	..	5,301,153	413

Source: *Oil and Gas Journal*, Special Refinery Issue (1958-1962). U. S. Bureau of Mines, Inf. circ. 7761, previous to 1958.

Table 38

NATURAL GASOLINE PROCESSING CAPACITIES (IN BILLIONS CUBIC FEET), KANSAS AND U. S.

Year	Kansas	Number of plants	United States	Number of plants
Jan. 1, 1962	1,925	14	44,400.1	715
" 1961	1,840	13	40,520.9	633
" 1960	1,830	13	30,635.5	501
" 1959	1,859	13	27,975.9	488
" 1958	.....	..	.....	...
" 1957	1,867	16	22,874	487
" 1956	1,836	14	21,626	465

Source: *Oil and Gas Journal*, Annual Gas Processing Issues, 1956-1962, Kansas.

Table 39

PRODUCTION OF NATURAL GAS LIQUIDS IN KANSAS AND THE UNITED STATES

(Barrels)

Year	United States	Kansas
1961	461,649,000	6,150,089*
1960	431,379,000	4,862,000
1959	385,154,000	5,545,000
1958	341,548,000	5,362,000
1957	352,364,000	5,450,000
1956	346,053,000	4,748,000
1955	320,400,000	4,919,000
1954	300,815,000	4,614,000
1953	302,698,000	5,038,000
1952	284,789,000	4,667,000
1951	267,052,000	4,167,000
1950	227,411,000	3,690,000

* Kansas Corporation Commission.

Source: American Gas Association, *Annual Reserves Reports*. Kansas State Geological Survey Development Reports.

Table 40

PRODUCTION AND VALUE OF RECOVERABLE LEAD AND ZINC IN KANSAS 1939-1960

	Lead		Zinc	
	Production (tons)	Value	Production (tons)	Value
1939	13,697	$1,287,518	68,971	$7,172,984
1940	11,927	1,192,700	57,032	7,186,032
1941	14,538	1,657,332	71,403	10,710,450
1942	9,419	1,262,146	55,874	10,392,546
1943	9,213	1,381,950	56,944	12,299,904
1944	9,394	1,503,040	63,703	14,524,284
1945	7,370	1,267,640	48,394	11,130,620
1946	6,445	1,405,010	47,703	11,639,532
1947	7,285	2,098,080	41,497	10,042,274
1948	8,386	3,002,188	35,577	9,463,482
1949	9,772	3,087,952	29,433	7,299,384
1950	9,487	2,561,940	21,176	7,717,984
1951	8,947	3,095,662	28,905	10,521,056
1952	5,916	1,904,952	25,482	8,460,024
1953	3,347	876,914	15,515	3,568,450
1954	4,033	1,105,042	19,110	4,127,760
1955	5,498	1,640,603	27,611	6,792,306
1956	7,635	2,397,390	28,665	7,854,210
1957	4,257	1,217,502	15,859	3,679,288
1958	1,299	303,966	4,421	901,884
1959	481	110,630	1,017	233,910
1960	781	182,754	2,117	546,186
Total, 1940–1949	103,749	17,858,038	507,560	104,658,508
1950–1959	50,900	15,204,601	187,761	53,856,172
1939–1960	169,908	34,532,911	766,409	166,234,550

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1939-1960. W. H. Schoewe, "Geography in Kansas, Part IV, Economic Geography: Mineral Resources," *Transactions of Kansas Academy of Science*, Vol. 61, No. 4, p. 424.

Table 41

ZINC, LEAD PRODUCTION IN UNITED STATES, TRI-STATE DISTRICT, KANSAS, 1939-1960

(In short tons)

	Zinc			Lead		
	United States	Tri-State	Kansas	United States	Tri-State	Kansas
1960	435,427	4,449	2,117	246,669	1,717	781
1959	425,303	2,066	1,017	255,586	1,082	481
1958	412,005	9,688	4,421	267,377	4,991	1,299
1957	531,735	30,895	15,059	338,216	11,462	4,257
1956	542,340	57,215	28,665	352,826	20,373	7,635
1955	514,671	69,696	27,611	338,025	19,679	5,498
1954	473,471	64,322	19,110	325,419	18,314	4,033
1953	547,430	55,729	15,515	342,644	13,273	3,347
1952	666,001	90,512	25,482	390,162	27,356	5,916
1951	681,189	91,553	28,904	388,164	26,906	8,947
1950	623,375	80,558	27,176	430,827	31,157	9,487
1949	593,203	78,628	29,433	409,908	30,883	9,772
1948	629,977	84,839	35,577	390,476	26,901	8,386
1947	637,608	109,338	41,497	384,221	24,239	7,285
1946	574,833	139,038	47,703	335,475	23,363	6,445
1945	614,358	139,274	48,394	390,831	23,556	7,370
1944	718,642	190,270	63,703	416,861	28,059	9,394
1943	744,196	200,514	56,944	453,313	34,722	9,213
1942	768,025	237,936	55,874	496,239	34,341	9,419
1941	749,125	258,837	71,403	461,426	41,080	14,538
1940	665,068	232,437	57,032	457,392	35,311	11,927
1939	583,807	224,446	68,971	413,979	44,176	13,697

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1939-1960.

Table 42

LEAD AND ZINC PRODUCTION IN COLORADO, KANSAS, MISSOURI, AND OKLAHOMA, 1951-1960

In terms of recoverable metals

(In thousands of tons and thousands of dollars)

	1951–55 Average					1956				
	Lead		Zinc			Lead		Zinc		
	Tons	Value	Tons	Value	Total value	Tons	Value	Tons	Value	Total value
Colorado	23.1	$7,094	43.4	$12,586	$19,680	19.8	$6,235	40.2	$11,027	$17,262
Kansas	5.5	1,724	23.4	6,694	8,418	7.6	2,397	28.6	7,854	10,251
Missouri	124.2	37,277	3.3	900	38,177	123.4	38,746	3.3	917	39,663
Oklahoma	13.9	4,230	45.3	12,983	17,213	12.3	3,878	27.5	7,539	11,417

	1957					1958				
	Lead		Zinc			Lead		Zinc		
	Tons	Value	Tons	Value	Total value	Tons	Value	Tons	Value	Total value
Colorado	21.0	$6,007	47.0	$10,904	$16,911	14.1	$3,302	37.1	$7,575	$10,877
Kansas	4.3	1,218	15.9	3,679	4,897	1.3	304	4.4	902	1,206
Missouri	126.3	36,128	2.9	665	36,793	113.1	26,471	.4	74	26,545
Oklahoma	7.2	2,054	14.9	3,469	5,523	3.7	864	5.3	1,074	1,938

	1959					1960				
	Lead		Zinc			Lead		Zinc		
	Tons	Value	Tons	Value	Total value	Tons	Value	Tons	Value	Total value
Colorado	12.9	$2,969	35.4	$8,139	$11,108	18.0	$4,231	31.3	$8,070	$12,301
Kansas	0.5	111	1.0	234	345	.8	183	2.1	546	729
Missouri	105.2	24,188	.9	21	24,209	111.9	26,196	2.8	728	26,927
Oklahoma	.6	138	1.0	241	379	.9	219	2.3	602	821

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Area Reports, Vol. 3, pp. 220, 419, 581, 815.

Table 43

UNITED STATES IMPORTS OF LEAD AND ZINC, 1951-1960

(In short tons)

	1951–55 Average	1956	1957	1958	1959	1960	Principal producing countries 1960
Lead							
ore, flue, dust, and matte	134,357	196,452	198,479	201,599	138,834	145,953	Union of South Africa, Peru, Canada
base bullion	716	31	84	460	80	293	North America
pigs and bars	323,052	262,654	324,279	368,452	263,416	206,033	Mexico, Australia, Yugoslavia
reclaimed scrap	10,631	20,738	9,213	6,570	8,279	7,638	Canada, Australia
Grand Total Lead	468,756	479,875	532,055	577,081	410,609	359,917	Mexico, Australia, Peru, Canada
Zinc							
ore (zinc content)	439,922	525,350	526,014	461,560	500,115	456,221	Mexico, Canada, Peru
blocks, pigs, or slabs	158,176	244,978	269,007	195,199	156,963	120,767	Canada
Grand Total Zinc	598,098	770,328	795,021	656,759	657,078	576,988	Mexico, Canada, Peru

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Metals and Minerals (Except Fuels), Vol. I, pp. 684-690, 1227-1228.

Table 44

UNITED STATES EXPORTS OF LEAD AND ZINC, 1951-1960

(In short tons)

	1951–59 Average	1956	1957	1958	1959	1960	Principal producing countries 1960
Lead							
ore, matte, base bullion	773	1,055	906	1,012	224	1,297	Asia
pigs, bars, anodes	969	4,628	4,339	1,359	2,756	1,967	Taiwan (Asia)
total scrap	2,050	2,136	885	1,015	1,141	2,579	United Kingdom
Grand Total Lead	3,792	7,819	6,130	3,386	4,121	5,843	Taiwan (Asia)
Zinc							
zinc ore concentrates (zinc content)	1,883	854	7	.....	1	13	.....
slabs, pigs, blocks	31,051	8,813	10,785	2,073	11,629	75,144	United Kingdom, Japan, India
sheets, plates, strip or other forms	4,628	4,444	4,056	3,818	3,529	3,324	Canada
zinc scrap and dross (zinc content)	8,977	14,921	5,469	5,344	11,332	12,169	.....
zinc dust	.....	372	595	519	521	777	.....
Grand Total Zinc	46,539	29,404	20,912	11,754	27,012	91,427	United Kingdom, Japan, India

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Metals and Minerals (Except Fuels), Vol. I, pp. 684-690, 1227-1228.

Table 45

WORLD PRODUCTION OF RECOVERABLE ZINC, LEAD, 1949-1950
UNITED STATES CONSUMPTION OF REFINED LEAD, SLAB ZINC, 1939-1960
PRICE, NEW YORK, LONDON, ST. LOUIS

	World production		United States consumption		Price					
					Zinc			Lead		
	Zinc	Lead	Zinc	Lead	New York	London	St. Louis	New York	London	St. Louis
1960	3,510,000	2,560,000	877,884	1,021,172	.....	$11.05	$12.95	$11.95	$ 9.04	.....
1959	3,360,000	2,530,000	956,197	1,091,149	$11.96	10.27	11.46	12.21	8.88	$12.01
1958	3,320,000	2,560,000	868,327	986,387	10.81	8.24	10.31	12.11	9.13	11.91
1957	3,440,000	2,610,000	935,620	1,138,115	11.90	10.18	11.40	14.66	12.05	14.46
1956	3,430,000	2,490,000	1,008,790	1,209,717	13.99	12.19	13.49	16.01	14.52	15.81
1955	3,210,000	2,420,000	1,119,812	1,212,644	12.80	11.30	12.30	15.14	13.19	14.94
1954	2,930,000	2,270,000	884,299	1,094,871	11.19	9.78	10.69	14.05	12.08	13.85
1953	2,940,000	2,100,000	985,927	1,201,604	11.53	9.47	10.86	13.48	11.48	13.28
1952	2,850,000	2,030,000	852,783	1,130,795	17.03	18.53	16.21	16.47	16.82	16.27
1951	2,600,000	1,890,000	933,971	1,184,793	18.75	21.46	17.99	17.49	20.25	17.29
1950	2,370,000	1,850,000	967,134	1,237,981	14.60	14.89	13.88	13.30	13.29	13.10
1949	1,910,000	1,550,000	711,841	957,674	12.86	14.41	12.15	15.36	16.95	15.18
1948	.....	.....	817,735	1,133,895	14.21	14.38	13.58	18.04	17.16	17.87
1947	.....	.....	786,360	660,657	11.01	12.58	10.50	14.67	15.27	14.50
1946	.....	.....	801,242	530,588	9.15	7.75	8.73	8.11	8.63	7.96
1945	.....	.....	852,311	637,499	8.65	5.18	8.25	6.50	4.99	6.35
1944	.....	.....	888,626	722,820	8.65	4.63	8.25	6.50	4.49	6.35
1943	.....	.....	816,777	675,465	8.66	4.63	8.25	6.50	4.49	6.35
1942	.....	.....	728,169	607,111	8.66	4.63	8.25	6.48	.....	6.33
1941	.....	.....	827,435	812,647	7.87	4.63	7.48	5.79	.....	5.64
1940	.....	.....	719,000	782,000	6.73	.....	6.34	5.50	.....	5.03
1939	.....	.....	626,000	667,000	5.51	.....	5.12	5.50	.....	4.90

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1939-1960.

Table 46

EMPLOYMENT AND WAGES FOR THE LEAD AND ZINC INDUSTRY IN KANSAS

Year	Units	Number of workers	Number of workers
1956	12	433	2,002,241
1957	11	281	1,238,724
1958	10	82	487,285
1959	9	24	122,982
1960	7	42	134,856
1961	7	57	183,070

Source: Employment Security Division, Kansas Department of Labor.

Table 47

KANSAS SALT PRODUCTION AND VALUE BY DECADE, 1880-1959

Decade	Production, short tons	Value
1880–1889	88,000*	$ 440,000*
1890–1899	1,930,151	5,147,354
1900–1909	2,924,427	8,152,776
1910–1919	5,302,346	16,843,882
1920–1929	7,848,068	32,852,325
1930–1939	6,846,336	27,824,087
1940–1949	8,442,339	40,895,739
1950–1959	9,570,809	87,634,549

* Estimated.

Sources: United States Geological Survey, *Mineral Resources of the United States;* United States Bureau of Mines, *Minerals Yearbooks;* Robert Taft, "Kansas and the Nation's Salt," *Transactions of the Kansas Academy of Science,* Vol. 49, No. 3, 1946, p. 267; Walter H. Schoewe, *The Mineral Industry in Kansas,* State Geological Survey of Kansas.

Table 48

SALT PRODUCTION AND VALUE IN KANSAS, LOUISIANA, TEXAS, AND THE UNITED STATES, 1939-1960

(In thousands of tons, thousands of dollars)

	Kansas		Louisiana		Texas		United States	
Year	Production	Value	Production	Value	Production	Value	Production	Value
1960	1,213	$14,109	4,792	$21,959	4,756	$18,222	25,479	$161,140
1959	1,123	13,670	4,807	20,918	4,519	17,498	25,163	155,877
1958	1,073	11,348	3,442	18,960	3,843	15,114	21,912	141,500
1957	1,018	10,353	3,461	18,944	4,612	17,104	23,854	148,991
1956	1,004	9,167	3,704	17,695	3,963	14,370	24,216	136,240
1955	911	8,432	3,563	15,407	3,583	12,867	22,704	123,389
1954	877	7,778	3,089	11,101	2,864	9,310	20,669	105,586
1953	905	7,481	3,061	9,190	2,845	5,011	20,789	78,277
1952	912	6,850	2,553	7,808	2,640	4,402	19,545	71,010
1951	901	6,639	2,737	7,662	2,401	4,000	20,207	69,735
1950	846	5,915	2,279	6,903	1,852	2,847	16,630	59,911
1949	832	5,218	2,030	5,838	1,641	2,420	15,572	53,626
1948	832	4,961	2,223	6,445	1,354	1,712	16,403	54,332
1947	904	4,534	1,955	5,899	1,192	2,090	16,054	52,192
1946	815	4,015	1,847	4,612	1,099	1,357	15,132	44,913
1945	856	3,838	1,868	4,466	1,101	1,336	15,394	43,914
1944	932	4,357	1,844	4,102	1,147	1,354	15,717	43,715
1943	945	4,198	1,620	3,678	1,128	3,611	15,214	43,878
1942	860	3,809	1,332	3,382	821	2,203	13,693	38,144
1941	781	3,255	1,242	3,251	657	1,714	12,721	33,620
1940	684	2,711	1,133	2,804	402	792	10,360	26,475
1939	642	2,592	1,073	2,830	352	605	9,278	24,510

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1941-1960.

Table 49

THE KANSAS SALT INDUSTRY, 1955-1962

EMPLOYMENT, WAGES, CAPITAL INVESTMENTS, MARKETING, TRANSPORTATION

Year	Number employees	Total wages	Capital investments
1955	829	$3,330,593	$1,888,262
1956	831	3,478,100	2,100,797
1957	822	3,663,826	1,962,899
1958	836	3,785,105	1,759,990
1959	903	3,986,665	1,874,598
1960	832	4,150,007	1,816,825
1961	828	4,169,555	2,352,898
1962 (1st qtr)	819	1,351,221	1,391,553

Marketing 13.75% sold in Kansas
86.25% shipped out of state

Transportation 24.25% by rail, 75.75% by truck

Market area: Principal: *Central midwestern states* (Iowa, Missouri, Kansas, Nebraska, Minnesota, Oklahoma, Illinois, Colorado)

Other: *Southeast, South* (Florida, Georgia, South Carolina, Alabama, Tennessee, Mississippi, Louisiana, Arkansas, Texas)
Southwest, West (New Mexico, Arizona, California, Montana, Wyoming)

Source: Information provided the Kansas Geological Survey by four of seven Kansas salt companies.

Table 50

COAL PRODUCTION AND VALUE, NUMBER OF MINES, NUMBER EMPLOYED IN KANSAS, 1939-1960

Year	Total production		Production, tons		Number of mines			Number employed		
	Tons	Dollars	Strip	Deep	Total	Strip	Deep	Total	Strip	Deep
1939	3,007,349	$5,683,890	2,300,242	707,107	245	76	169	3,503	1,106	2,397
1940	3,693,455	6,906,761	2,805,464	887,991	237	73	164	3,317	1,083	2,234
1941	4,008,080	7,935,998	3,307,169	740,911	171	56	115	3,091	1,085	2,006
1942	4,209,386	9,218,555	3,593,368	616,018	141	56	85	2,668	1,096	1,572
1943	3,387,766	8,469,415	2,998,514	389,252	119	51	68	2,236	1,113	1,123
1944	3,316,360	8,589,372	3,017,707	298,653	111	48	63	1,909	994	915
1945	3,197,908	8,218,624	2,904,521	293,387	79	42	37	1,585	924	661
1946	2,519,516	7,004,254	2,305,715	213,801	82	44	38	1,701	967	734
1947	2,720,376	9,165,208	2,465,090	255,286	88	51	37	1,660	856	804
1948	2,503,612	9,653,566	2,330,966	172,646	91	58	33	1,372	854	518
1949	1,877,579	7,968,140	1,763,473	114,106	88	54	34	1,323	879	444
1950	2,145,714	8,303,913	2,041,132	104,582	84	52	32	1,261	864	397
1951	1,951,132	7,687,460	1,876,412	74,720	69	46	23	998	686	312
1952	2,016,096	7,862,774	1,971,183	44,913	47	32	15	754	575	179
1953	1,720,306	7,122,067	1,688,741	31,565	41	30	11	654	528	126
1954	1,331,241	5,444,680	1,305,056	26,185	44	34	10	635	522	113
1955	739,086	3,118,942	724,536	14,550	42	34	8	512	428	84
1956	876,006	4,003,500	862,858	13,148	33	29	4	503	372	131
1957	754,439	3,470,419	743,816	10,623	34	30	4	467	411	56
1958	830,009	3,818,042	820,329	9,680	29	26	3	371	334	37
1959	774,360	3,491,688	768,632	5,728	19	17	2	338	301	37
1960	876,343	4,301,177	872,742	3,601	18	16	2	303	275	28

Total Production 1940-1949—31,434,038 tons valued at— $831,298.93.
Total Production 1950-1959—13,138,389 tons valued at— $543,234.85.
Total Production 1939-1960—48,456,119 tons valued at—$1,474,384.45.

Source: 1939-1956: Walter H. Schoewe, "The Geography of Kansas, Part IV, Economic Geography: Mineral Resources," *Transactions of the Kansas Academy of Science*, Vol. 61, Winter 1958, p. 387.
1957-1960: Kansas Mine Inspection Division and Mine Rescue Station, *Production Statistics*, State Inspection of Coal Mine, Annual Report. Walter H. Schoewe, *The Mineral Industry in Kansas in 1957*, Kansas Geological Survey Bulletin 130, Part 6; *in 1958*, KGS Bulletin 134, Part 7; *in 1959*, KGS Bulletin 142, Part 6; *in 1960*, KGS Bulletin 152, Part 3.

Table 51

COAL PRODUCED IN THE UNITED STATES, COLORADO, IOWA, KANSAS, MISSOURI, AND OKLAHOMA 1939-1960

(In thousands of tons)

	1939	1940	1941	1942	1943	1944	1945	1946	1947	1949	1949
United States	446,342	512,257	570,517	643,021	650,821	683,277	577,617	533,922	630,624	599,518	437,868
Colorado	5,923	6,589	6,949	8,086	8,324	8,168	7,621	5,914	6,358	5,631	4,636
Iowa	2,948	3,231	2,939	2,948	2,771	2,141	2,046	1,788	1,684	1,670	1,725
Kansas	2,675	3,579	4,008	4,230	3,437	3,369	3,228	2,493	2,745	2,538	2,031
Missouri	3,273	3,097	3,145	3,520	4,310	4,779	3,983	3,733	4,236	4,023	3,647
Oklahoma	1,188	1,646	1,771	2,387	2,838	3,209	2,909	2,647	3,421	3,462	3,022

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
United States	516,311	533,665	466,841	457,290	391,706	464,633	500,874	492,704	410,446	412,028	415,512
Colorado	4,259	4,103	3,623	3,575	2,900	3,568	3,502	3,594	2,974	3,294	3,607
Iowa	1,891	1,630	1,381	1,388	1,197	1,258	1,358	1,312	1,179	1,180	1,068
Kansas	2,125	1,961	2,029	1,715	1,372	742	884	749	823	772	888
Missouri	2,963	3,269	2,955	2,393	2,514	3,232	3,283	2,976	2,592	2,748	2,890
Oklahoma	2,679	2,223	2,193	2,168	1,915	2,164	2,007	2,195	1,630	1,525	1,342

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1946, p. 285; Fuels, Vol. II, 1954, p. 41; Fuels, Vol. II, 1960, p. 60.

Table 52

PRODUCTION STATISTICS AND RESERVES FOR COLORADO, IOWA, KANSAS, MISSOURI, OKLAHOMA, AND THE UNITED STATES

(Production in thousands of net tons; reserves in millions of short tons)

	Maximum production		Production 1960	Total production from earliest record to end of 1960	Recoverable coal reserves, Jan. 1, 1960, assuming 50 percent recovery
	Year	Quantity			
Colorado	1917	12,483	3,607	510,120	40,387
Iowa	1917	8,966	1,068	352,575	14,223
Kansas	1918	7,562	888	280,111	10,374
Missouri	1917	5,671	2,890	289,283	39,394
Oklahoma	1920	4,489	1,342	180,816	1,656
United States	1947	630,624	415,512	29,926,015	830,145

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Fuels, Vol. II, Table 21, p. 46; Table 11, p. 60.

Table 53

AVERAGE VALUE PER TON, F. O. B. MINES, AND SALE OF BITUMINOUS COAL AND LIGNITE PRODUCED IN COLORADO, IOWA, KANSAS, MISSOURI, OKLAHOMA, AND THE UNITED STATES

	1959			1960				
	Average value per ton			Average value per ton			Number of mines	
State	Underground mines	Strip mines	Total all mines	Underground mines	Strip mines	Total all mines	Underground mines	Strip mines
Colorado	$7.00	$3.34	$6.39	$6.35	$3.73	$5.85	87	7
Iowa	4.21	3.42	3.57	4.44	3.41	3.60	19	25
Kansas	6.52	4.66	4.67	7.58	4.71	4.73	2	11
Missouri	4.94	4.32	4.34	5.04	4.28	4.31	10	23
Oklahoma	8.93	6.09	6.74	9.02	6.29	6.79	11	15
United States	5.23	3.76	4.77	5.14	3.74	4.69	5,989	1,530

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Fuels, Vol. II, Table 63, p. 137; Table 12, p. 61; Table 34, p. 92.

Table 54

OPERATIONS IN THE BITUMINOUS COAL AND LIGNITE FIELDS OF COLORADO, IOWA, KANSAS, MISSOURI, OKLAHOMA, AND THE UNITED STATES, 1960

	All mines					Strip mines				
State	Number	Production (net tons)	Average number of men working daily	Average number of days worked	Average tons per man per day	Number	Production (net tons)	Average number of men working daily	Average number of days worked	Average tons per man per day
Colorado	94	3,607,286	2,170	178	9.34	7	692,849	133	183	28.46
Iowa	44	1,068,024	458	201	11.58	25	867,924	202	237	18.15
Kansas	13	888,274	226	235	16.70	11	884,690	202	256	17.11
Missouri	33	2,890,210	1,839	144	10.88	23	2,801,937	1,669	142	11.83
Oklahoma	26	1,341,533	762	193	9.14	15	1,093,965	315	212	16.34
United States	7,865	415,512,347	169,400	191	12.83	1,530	122,629,664	25,161	213	22.93

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Fuels, Vol. II, Table 12, p. 61; Table 34, p. 92.

Table 55

EMPLOYMENT AND WAGES FOR THE BITUMINOUS COAL INDUSTRY IN KANSAS

Year	Units	Number of Workers	Wages of Workers
1956	14	339	$2,059,054
1957	14	331	1,941,434
1958	10	384	1,725,661
1959	10	281	1,753,549
1960	10	276	1,972,321
1961	7	236	1,648,688

Source: Employment Security Division, Kansas Department of Labor.

Table 57

MECHANICAL CLEANING AT BITUMINOUS COAL AND LIGNITE MINES IN COLORADO, KANSAS, MISSOURI, OKLAHOMA, AND UNITED STATES 1960

	Total production (net tons)	Mechanical cleaning	
		Percentage of refuse to raw coal	Percentage of total production cleaned
Colorado	3,607,286	[a]17.5	[a]26.5
Kansas	888,274	35.0	92.7
Missouri	2,890,210	25.7	66.5
Oklahoma	1,341,533	16.2	32.1
United States	415,512,347	19.3	65.7

a. Includes Arkansas.

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Fuels, Vol. II, Table 46, p. 108.

Table 56

METHOD OF HAULAGE FROM BITUMINOUS COAL AND LIGNITE MINES IN COLORADO, IOWA, KANSAS, MISSOURI, OKLAHOMA, AND THE UNITED STATES, 1960

	All mines			Strip mines reporting method of haulage		
	Total production (net tons)			Strip mines using trucks		
State	Shipped by rail or water[a]	Shipped by truck	Used at mine[b]	Production (net tons)	Number of trucks	Average capacity per truck (net tons)
Colorado	2,535,132	961,966	110,188	667,265	21	18.7
Iowa	668,919	397,951	1,154	835,392	63	10.1
Kansas	709,428	177,444	1,402	877,736	25	19.8
Missouri	1,737,656	439,166	713,388	2,693,295	76	22.1
Oklahoma	1,250,659	90,498	376	1,032,557	124	9.9
United States	350,649,243	52,699,165	12,163,939	104,099,974	4,855	15.5

a. Includes coal loaded at mines directly into railroad cars or river barges, hauled by trucks to railroad sidings, and hauled by trucks to waterways.

b. Includes coal used at mine for power and heat, made into beehive coke at mine, used by mine employees, all other uses at mine, taken by locomotive tender, and transported from mine to point of use by conveyor, tram, or pipeline.

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Fuels, Vol. II, Table 12, p. 61; Table 33, p. 90.

Table 58

NUMBER AND PRODUCTION OF BITUMINOUS COAL AND LIGNITE MINES IN COLORADO, IOWA, KANSAS, MISSOURI, OKLAHOMA, AND THE UNITED STATES, 1960

	COLORADO	IOWA	KANSAS	MISSOURI	OKLAHOMA	UNITED STATES
Total						
Mines	94	44	13	33	26	7,865
Production (net tons)						
Total	3,607,286	1,068,024	888,274	2,890,210	1,341,533	415,512,347
Average per mine	38,375	24,273	68,329	87,582	51,597	52,831
Class 1—500,000 tons and over						
Mines	..	..	1	3	..	202
Production						
Net tons	.....	.....	549,056	2,023,030	.....	204,998,565
Percentage	.....	.....	61.8	70.0	.....	49.3
Class 2—200,000 to 500,000 tons						
Mines	5	..	1	1	1	258
Production						
Net tons	1,432,078	.....	236,753	281,518	203,278	81,013,328
Percentage	39.7	.....	26.6	9.8	15.2	19.5
Class 3—100,000 to 200,000 tons						
Mines	7	2	..	3	4	262
Production						
Net tons	977,938	318,789	.....	369,538	618,055	37,203,934
Percentage	27.1	29.9	.....	12.8	46.1	9.0
Class 4—50,000 to 100,000 tons						
Mines	8	5	..	..	3	396
Production						
Net tons	549,850	348,683	.....	.....	248,522	27,894,379
Percentage	15.2	32.6	.....	.....	18.5	6.7
Class 5—10,000 to 50,000 tons						
Mines	24	13	3	7	9	2,102
Production						
Net tons	465,379	290,453	77,106	160,110	244,186	44,237,708
Percentage	12.9	27.2	8.7	5.5	18.2	10.6
Class 6—less than 10,000 tons						
Mines	50	24	8	19	9	4,645
Production						
Net tons	182,041	110,099	25,359	56,014	27,492	20,164,433
Percentage	5.1	10.3	2.9	1.9	2.0	4.9

Source: United States Bureau of Mines, *Minerals Yearbook*, 1960, Fuels, Vol. II, Table 14, pp. 64, 65.

Table 59

COMPARISON OF CONSTRUCTION CONTRACT VALUE AND VALUE OF NONFUELS BY STATES 1956-1960

(In millions of dollars)

	1956		1957		1958		1959		1960	
	Construction[a]	Nonfuels[b]	Construction	Nonfuels	Construction	Nonfuels	Construction	Nonfuels	Construction	Nonfuels
Missouri	620	150	575	140	770	133	742	145	807	144
Colorado	594	134	465	141	478	126	510	142	461	162
Oklahoma	368	40	364	38	507	35	462	37	489	40
Kansas	346	74	383	58	462	64	457	71	462	63
Iowa	349	62	371	64	419	81	391	84	411	91
Nebraska	196	23	227	22	246	28	262	29	288	31
United States	31,612	5,624	32,173	5,404	35,090	4,940	36,268	5,291	36,315	5,751

a. Source: Department of Commerce, *Statistical Abstract of the United States*, Washington, 1961, Table 1052, p. 755.
b. Source: United States Bureau of Mines, *Minerals Yearbooks*, 1956-1960.

Table 60

BUILDING CONSTRUCTION IN SELECTED CITIES, SELECTED YEARS

CITY	Value of All Construction (thousands of dollars)				Number of New Housing Units				
	1950	1955	1958	1959	1950	1955	1958	1959	1960
Denver, Colorado	$66,275	$77,136	$75,832	$63,288	6,911	5,392	2,803	2,097	3,149
Kansas City, Kansas	7,046	10,533	10,148	10,089	554	204	281	259	597
Kansas City, Missouri	44,098	71,230	77,291	74,547	2,957	1,588	2,896	2,600	1,612
Oklahoma City, Oklahoma	50,646	42,709	46,734	59,901	4,120	2,779	2,079	3,024	3,162
Omaha, Nebraska	28,014	27,738	50,870	48,173	2,533	1,610	2,503	2,920	3,054
St. Louis, Missouri	74,659	49,239	53,075	78,002	4,145	1,758	1,361	2,262	869
Tulsa, Oklahoma	18,173	23,584	31,967	19,306	1,430	1,074	1,274	924	895
Wichita, Kansas	28,204	43,125	22,923	24,060	3,853	3,045	1,662	1,144	347
Des Moines, Iowa	24,877	31,219	42,533	35,647	1,842	1,250	1,235	1,411	988

Source: Department of Commerce, *Statistical Abstract of the United States*, Washington, 1961, Table 1056, pp. 758-759.

Table 61

PRODUCTION, SHIPMENTS, AND VALUE OF PORTLAND AND MASONRY CEMENT, 1939-1960

	Production (barrels)			Shipments (barrels)			Value (shipments)		
	Portland	Masonry	Total	Portland	Masonry	Total	Portland	Masonry	Total
1939	.....	.....	3,739,000	.....	.....	3,746,000	.....	.....	$5,614,000
1940	.....	.....	3,433,000	.....	.....	3,442,000	.....	.....	5,192,000
1941	.....	.....	4,681,000	.....	.....	4,734,000	.....	.....	7,137,000
1942	.....	.....	7,255,000	.....	.....	7,726,000	.....	.....	11,415,000
1943	.....	.....	5,959,000	.....	.....	5,306,000	.....	.....	8,036,000
1944	.....	.....	2,819,000	.....	.....	2,867,000	.....	.....	4,454,000
1945	.....	.....	3,001,000	.....	.....	3,299,000	.....	.....	5,158,000
1946	.....	.....	6,405,000	.....	.....	6,894,000	.....	.....	11,575,000
1947	.....	.....	7,132,000	.....	.....	7,208,000	.....	.....	13,017,000
1948	.....	.....	7,934,000	.....	.....	7,931,000	.....	.....	16,188,000
1949	.....	.....	7,825,000	.....	.....	7,641,000	.....	.....	16,880,000
1950	.....	.....	8,616,000	.....	.....	8,759,000	.....	.....	19,400,000
1951	.....	.....	8,515,000	.....	.....	8,164,000	.....	.....	19,413,000
1952	.....	.....	8,673,000	.....	.....	8,812,000	.....	.....	20,957,000
1953	.....	.....	8,766,000	.....	.....	8,546,000	.....	.....	21,429,000
1954	.....	.....	8,803,000	.....	.....	9,076,000	.....	.....	23,874,000
1955	9,219,000	406,000	9,625,000	9,072,000	383,000	9,455,000	24,521,000	1,334,000	25,855,000
1956	10,486,000	381,000	10,867,000	10,239,000	359,000	10,598,000	29,371,000	1,325,000	30,696,000
1957	8,118,000	305,000	8,423,000	7,864,000	314,000	8,178,000	23,593,000	1,221,000	24,814,000
1958	9,244,000	293,000	9,537,000	9,298,000	302,000	9,600,000	28,843,000	1,205,000	30,048,000
1959	10,177,000	348,000	10,525,000	10,056,000	349,000	10,405,000	30,889,000	1,393,000	32,282,000
1960	7,996,000	291,000	8,287,000	7,877,000	285,000	8,162,000	25,194,000	1,179,000	26,370,000

Total Shipments Portland and Masonry....1940–1949.... 57,048,000 bbls.....Total Value Shipments....$ 99,053,000
Total Shipments Portland and Masonry....1950–1959.... 91,593,000 bbls.....Total Value Shipments....$248,768,000
Total Shipments Portland and Masonry....1939–1960....160,549,000 bbls.....Total Value Shipments....$279,805,000

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1939-1960.

Table 62

PORTLAND CEMENT PRODUCTION AND VALUE OF SHIPMENTS [a]

Year	1950–1960					
	Kansas		5-State Area [b]		United States	
	Production (thous. bbls.)	Value (thous. $)	Production (thous. bbls.)	Value (thous. $)	Production (thous. bbls.)	Value (thous. $)
1960	7,996	$25,194	21,235	$68,230	319,009	$1,045,246
1959	10,177	30,889	24,546	74,849	339,091	1,099,244
1958	9,244	28,843	21,152	67,086	311,471	997,701
1957	8,118	23,593	18,606	55,281	298,424	921,959
1956	10,486	29,371	21,113	59,555	316,438	940,020
1955	9,220	24,521	20,521	56,089	297,453	837,526
1954	8,803	23,874	19,134	51,633	272,353	759,861
1953	8,766	21,429	18,118	45,133	264,181	697,263
1952	8,673	20,957	17,563	43,938	249,256	638,512
1951	8,515	19,413	17,223	39,349	246,022	613,170
1950	8,616	19,400	16,810	38,036	226,026	535,321

a. Portland cement used for masonry included 1950-1955.
b. Arkansas, Kansas, Nebraska, Oklahoma, and Western Missouri.
Source: United States Bureau of Mines, *Minerals Yearbooks*, 1951-1961.

Table 63

EMPLOYMENT AND WAGES FOR THE CEMENT INDUSTRY IN KANSAS

	Units	Number of covered workers	Estimated* total workers	Wages of covered workers	Estimated* total wages
1956	8	1,507	1,511	$6,450,043	$6,467,143
1957	8	1,345	1,349	6,166,223	6,184,873
1958	7	1,279	1,283	6,282,392	6,302,092
1959	7	1,317	1,321	7,218,683	7,240,633
1960	7	1,307	1,311	7,474,477	7,497,377
1961	7	1,459	1,463	9,077,265	9,102,165

* Estimated by Kansas State Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 64

VALUE OF CLAY AND CLAY PRODUCTS IN KANSAS BY DECADES, 1860-1960 [a]

1860–1869	Less than $500,000	1920–1929	$39,820,000
1870–1879	500,000	1930–1939	9,536,000
1880–1889	4,000,000	1940–1949	18,722,000
1890–1899	3,000,000	1950–1959	96,500,000
1900–1909	18,194,000	1960	12,700,000
1910–1919	23,927,000		

a. Value for 1860-1890 estimated by Kansas Geological Survey.
Source: Kansas producers, Kansas Geological Survey publications, file data.

Table 65

PRODUCTION AND VALUE OF CLAY AND CLAY PRODUCTS IN KANSAS, 1939-1960

Year	Raw Clay and Shale		Clay Products
	Tons	Value	Value
1939	.....	.....	$1,051,000
1940	.....	.....	1,035,000
1941	.....	.....	1,121,000
1942	.....	.....	840,000
1943	.....	.....	700,000
1944	251,000	$135,000	1,100,000
1945	255,000	197,000	1,594,000
1946	464,000	283,000	2,771,000
1947	536,000	377,000	2,229,000
1948	587,000	445,000	3,050,000
1949	613,000	474,000	4,282,000
1950	725,000	601,000	5,000,000
1951	732,000	729,000	7,000,000
1952	666,000	789,000	8,500,000
1953	671,000	750,000	8,500,000
1954	697,000	778,000	8,500,000
1955	768,000	873,000	9,000,000
1956	977,000	1,169,000	10,000,000
1957	909,000	1,240,000	10,000,000
1958	875,000	1,145,000	10,500,000
1959	1,021,000	1,270,000	11,500,000
1960	893,000	1,224,000	11,500,000

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1939-1960.
Kansas Geological Survey files, ceramic producers.

Table 66

EMPLOYMENT AND WAGES FOR THE STRUCTURAL CLAY PRODUCTS INDUSTRY IN KANSAS

	Units	Number of covered workers	Estimated* total workers	Wages of covered workers	Estimated* total wages
1956	12	1,002	1,005	$4,167,821	$4,180,321
1957	12	844	847	3,524,866	3,537,426
1958	11	873	875	3,680,480	3,693,080
1959	10	979	982	4,448,271	4,461,881
1960	10	1,036	1,039	4,803,552	4,817,502
1961	9	975	978	4,915,210	4,930,470

* Estimated by Kansas Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 67

VALUE OF CLAYS PRODUCED IN COLORADO, IOWA, KANSAS, MISSOURI, NEBRASKA, OKLAHOMA, AND THE UNITED STATES, 1950-1960

(In thousands of dollars)

	1960	1959	1958	1957	1956	1955	Kinds of Clay Produced
Colorado	1,424	1,160	1,111	978	1,215.3	1,117.9	Miscellaneous clay, fire clay, bentonite. (Value of bentonite produced in 1950, 1951 and 1953 not included; no production 1952, 1956, 1958, 1959)
Iowa	1,345	1,168	1,054	944	1,077.6	927.5	Miscellaneous clay, fire clay. (Value of fire clay produced 1950–1953 and 1955–1958 not included)
Kansas	1,224	1,271	1,145	1,240	1,169.1	873.0	Miscellaneous clay, fire clay. (Value of fire clay produced 1950–1955 not included)
Missouri	7,207	6,898	5,986	7,648	8,016.2	6,902.3	Miscellaneous clay, fire clay (not including diaspore and burley clays)
Nebraska	109	133	110	135	153.6	150.8	Miscellaneous clay, fire clay. (Value of production for 1952 not reported; value of fire clay production for 1950–1951 not included)
Oklahoma	739	970	579	642	701.0	726.9	Miscellaneous clay, fire clay. (Bentonite produced 1952–1960 but not included in values)
United States	162,372	159,659	143,487	155,805	163,145	139,661	

	1954	1953	1952	1951	1950	Kinds of Clay Produced
Colorado	1,002.8	1,422.6	1,087.1	1,168.9	758	Miscellaneous clay, fire clay, bentonite. (Value of bentonite produced in 1950, 1951 and 1953 not included; no production 1952, 1956, 1958, 1959)
Iowa	920.9	940.4	2,642.9	1,013.5	828.8	Miscellaneous clay, fire clay. (Value of fire clay produced 1950–1953 and 1955–1958 not included)
Kansas	777.8	621.4	738.5	680.8	563.7	Miscellaneous clay, fire clay. (Value of fire clay produced 1950–1955 not included)
Missouri	5,858.8	9,656.7	10,322.7	9,109.2	3,883.4	Miscellaneous clay, fire clay (not including diaspore and burley clays)
Nebraska	163.8	186.9	Prod. not included	114.8	148.0	Miscellaneous clay, fire clay. (Value of production for 1952 not reported; value of fire clay production for 1950–1951 not included)
Oklahoma	1,244.5	576.5	527.2	561.8	593.7	Miscellaneous clay, fire clay. (Bentonite produced 1952–1960 but not included in values)
United States	123,284	123,608	129,022	127,173	94,127	

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1951-1961.

Table 68

BRICKS PRODUCED IN KANSAS, 1948-1961
BRICKS PRODUCED AND SHIPPED IN THE UNITED STATES AND KANSAS, JANUARY 1, 1960 TO MARCH 1, 1962

Bricks Produced		Bricks Produced	
1961	121,311,000	1954	92,828,000
1960	121,779,000	1953	90,280,000
1959	144,116,000	1952	89,558,000
1958	110,910,000	1951	100,184,000
1957	100,639,000	1950	88,825,000
1956	124,003,000	1949	79,322,000
1955	118,707,000	1948	71,143,000

Bricks produced in United States, January 1, 1960—March 1, 1962	14,875,384,000
Bricks shipped in United States, January 1, 1960—March 1, 1962	14,354,196,000
Bricks produced but not sold	521,188,000
Percent of bricks produced but not sold	3.5+%
Bricks produced in Kansas, January 1, 1960—March 1, 1962	259,591,000
Bricks shipped in Kansas, January 1, 1960—March 1, 1962	226,588,000
Bricks produced but not sold	33,003,000
Percent of bricks produced but not sold	12.7+%

Source: Center of Research for Business, The University of Kansas, *Kansas Business Review*, January, 1948-1961.
United States Department of Commerce, Bureau of Census, *Current Industrial Reports Series: M32D(62)-2*, Washington, 1949-1962.

Table 69

GYPSUM PRODUCTION AND VALUE, 1889-1927

	Tons	Value		Tons	Value
1889	17,332	$94,235	1909	137,697	$321,921
1890	20,250	72,457	1910	135,697	377,222
1891	40,217	161,322	1911	122,576	319,504
1892	46,016	195,197	1912	131,031	324,820
1893	43,631	181,599	1913	110,510	308,308
1894	64,889	301,884	1914	80,774	278,343
1895	71,852	368,450	1915	60,919	250,014
1896	42,783	199,563	1916	78,257	322,785
1897	50,045	252,811	1917	79,333	424,611
1898	39,776	129,652	1918	54,958	343,749
1899	61,103	262,743	1919	78,479	520,673
1900	56,112	244,611	1920	130,444	968,298
1901	49,217	209,172	1921	92,526	655,164
1902	51,386	256,930	1922	105,905	690,740
1903	36,929	159,021	1923	135,019	842,740
1904	173,721	522,360[a]	1924	141,908	894,262
1905	47,276	150,402	1925	166,952	1,009,510
1906	105,091	247,572	1926	195,440	1,220,720
1907	155,980	414,266	1927	175,351	975,649
1908	130,184	281,335			

a. Includes Texas.
Source: 1889-1903: Erasmus Haworth, *Mineral Resources of Kansas, 1903*, University Geological Survey of Kansas, Annual Report, 1904, p. 40.
1904-1927: United States Geological Survey, *Mineral Resources*.

Table 70

COMBINED VALUE OF RAW GYPSUM, VOLCANIC ASH, NATURAL CEMENT, DIATOMACEOUS MARL[a] 1939-1960

1939	$317,545	1950	$603,624
1940	297,201	1951	662,541
1941	329,605	1952	703,010
1942	395,992	1953	775,644
1943	314,704	1954	883,441
1944	290,444	1955	1,501,469
1945	329,007	1956	1,503,069
1946	459,195	1957	791,079
1947	412,474	1958	1,111,433
1948	549,089	1959	1,573,833
1949	501,738	1960	1,043,678

a. Value of diatomaceous marl included for 1953-1960 only.
Source: Kansas Geological Survey files.

Table 71

EMPLOYMENT AND WAGES FOR THE CONCRETE, GYPSUM, AND PLASTER PRODUCTS INDUSTRY IN KANSAS

	Units	Number of covered workers	Estimated* total workers	Wages of covered workers	Estimated* total wages
1956	37	3,319	3,359	$15,279,642	$15,468,642
1957	39	2,997	3,037	14,629,999	14,825,499
1958	86	1,702	1,742	7,937,533	8,124,033
1959	95	1,928	1,968	9,061,043	9,250,343
1960	95	1,889	1,929	8,890,142	9,078,142
1961	96	2,015	2,055	9,981,380	10,179,380

* Estimated by Kansas State Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 72

SAND AND GRAVEL PRODUCTION AND VALUE IN KANSAS, SELECTED YEARS 1905-1940

Year	Tons	$ Value
1905	70,988	21,552
1906	293,918	66,762
1910	776,638	165,659
1914	1,347,394	381,065
1917	823,403	195,578
1920	1,275,309	905,936
1929	3,389,783	1,879,899
1930	3,232,858	1,649,476
1932	1,851,211	878,733
1937	2,495,196	1,017,053
1940	2,264,871	893,962

Source: Walter H. Schoewe, "The Geography of Kansas, Part IV, Economic Geography: Mineral Resources," *Transactions of the Kansas Academy of Science*, Vol. 61, Winter 1958, p. 443.

Table 73

PRODUCTION AND VALUE OF SAND AND GRAVEL, KANSAS
1939-1960

	Tons	Value		Tons	Value
1939	1,935,000	$822,000			
1940	2,265,000	894,000	1950	9,781,000	$6,782,000
1941	2,928,000	1,289,000	1951	7,677,000	4,748,000
1942	5,201,000	2,773,000	1952	8,380,000	5,024,000
1943	3,616,000	2,104,000	1953	8,728,000	5,668,000
1944	2,786,000	1,603,000	1954	10,422,000	7,194,000
1945	3,082,000	1,675,000	1955	10,665,000	6,910,000
1946	4,443,000	2,506,000	1956	12,515,000	8,022,000
1947	4,352,000	2,330,000	1957	9,345,000	6,175,000
1948	5,083,000	2,749,000	1958	10,579,000	7,045,000
1949	6,187,000	3,328,000	1959	11,334,000	7,937,000
Total 1940—1949	39,943,000 tons—$21,250,000				
Total 1950—1959	99,426,000 tons—$65,505,000				
1960—9,710,000	$6,808,000				
Total 1939—1960	151,013,000 tons—$94,384,000				

Source: 1939-1954: U. S. Bureau of Mines, *Minerals Yearbooks;* 1954-1960: Kansas Geological Survey, *The Mineral Industry in Kansas;* in 1955 (Bull. 119, Part 8); in 1956 (Bull. 127, Part 6); in 1957 (Bull. 130, Part 6); in 1958 (Bull. 134, Part 7); in 1959 (Bull. 142, Part 6); in 1960 (Bull. 152, Part 3).

Table 74

SAND AND GRAVEL PRODUCTION AND VALUE
KANSAS, 5-STATE AREA, UNITED STATES
1950-1960

Year	KANSAS		5-STATE AREA*		UNITED STATES	
	Production (thous.) short tons	Value (thous.)	Production (thous.) short tons	Value (thous.)	Production (thous.) short tons	Value (thous.)
1960	9,710	$6,808	56,270	$51,505	707,254	$718,793
1959	11,334	7,937	59,714	52,388	730,205	728,712
1958	10,317	6,769	57,588	48,143	684,498	652,789
1957	9,345	6,175	47,129	39,507	632,255	599,750
1956	12,515	8,022	53,549	41,468	626,495	596,195
1955	10,665	6,910	48,195	36,791	592,153	536,236
1954	10,422	7,194	47,837	37,681	560,828	504,127
1953	8,728	5,668	37,630	27,821	440,089	374,518
1952	8,380	5,024	32,838	24,200	435,511	353,384
1951	7,677	4,747	29,556	20,969	401,620	333,826
1950	9,781	6,782	29,532	21,515	370,455	295,040

* Colorado, Kansas, Missouri, Nebraska, and Oklahoma.
Source: United States Bureau of Mines, *Minerals Yearbooks,* 1951-1961.

Table 75

EMPLOYMENT AND WAGES FOR THE SAND AND GRAVEL INDUSTRY IN KANSAS

	Units	Number of covered workers	Estimated* total workers	Wages of covered workers	Estimated* total wages
1956	50	630	685	$2,758,311	$2,998,311
1957	50	543	598	2,515,394	2,769,394
1958	58	638	693	3,160,175	3,432,475
1959	60	745	800	3,727,178	3,995,178
1960	61	729	784	3,448,571	3,708,571
1961	60	732	787	3,560,327	3,829,127

* Estimated by Kansas Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 76

STONE PRODUCTION AND VALUE IN KANSAS, SELECTED YEARS 1887-1940

Year	Tons, All Stone	$ Value
1887	.....	100,000
1890	.....	628,111
1893	.....	199,934
1895	.....	410,082
1900	.....	487,616
1905	.....	1,003,006
1914	.....	600,576
1918	.....	561,382
1920	699,190	1,013,891
1929	1,419,890	1,461,146
1932	733,350	650,843
1936	4,934,510	5,747,261
1940	2,880,930	3,672,644

Source: Walter H. Schoewe, "The Geography of Kansas, Part IV, Economic Geography: Mineral Resources," *Transactions of the Kansas Academy of Science,* Vol. 61, Winter 1958, p. 458.

Table 77

PRODUCTION AND VALUE OF STONE, KANSAS
1939-1960

	Tons	Value		Tons	Value
1939	3,407,000	$4,551,000			
1940	2,881,000	3,673,000	1950	7,630,000	$8,920,000
1941	2,727,000	3,172,000	1951	7,191,000	9,059,000
1942	2,222,000	2,979,000	1952	8,831,000	12,052,000
1943	1,877,000	2,235,000	1953	8,385,000	10,681,000
1944	1,682,000	1,948,000	1954	10,367,000	13,910,000
1945	1,774,000	2,409,000	1955	12,470,000	15,887,000
1946	2,377,000	3,461,000	1956	13,434,000	15,703,000
1947	2,937,000	4,357,000	1957	10,400,000	11,890,000
1948	3,541,000	4,916,000	1958	12,504,000	15,039,000
1949	4,603,000	7,496,000	1959	13,988,000	17,073,000
Total 1940—1949	26,622,000 tons—$ 36,644,000				
Total 1950—1959	105,202,000 tons—$130,213,000				
1960—12,024,000	$15,276,000				
Total 1939—1960	147,254,000 tons—$186,683,000				

Source: 1939-1952: Bureau of Mines, *Minerals Yearbooks.* 1953-1960: Kansas Geological Survey, *The Mineral Industry in Kansas;* in 1950 to 1954 (Bull. 119, Part. 4); in 1956 (Bull. 119, Part 6); in 1957 (Bull. 130, Part 6); in 1958 (Bull. 134, Part 7); in 1959 (Bull. 142. Part 6); in 1960 (Bull. 152, Part 3).

Table 78

STONE PRODUCTION AND VALUE
KANSAS, 5-STATE AREA, UNITED STATES
1950-1960

Year	KANSAS		5-STATE AREA*		UNITED STATES	
	Production (thous.) short tons	Value (thous.)	Production (thous.) short tons	Value (thous.)	Production (thous.) short tons	Value (thous.)
1960	11,814	$15,031	58,826	$79,309	617,028	$952,871
1959	13,999	17,108	59,681	79,295	584,163	911,982
1958	12,424	15,036	53,979	69,836	535,923	826,685
1957	10,412	11,926	50,029	63,737	533,423	825,402
1956	13,433	15,682	53,871	71,035	499,707	755,205
1955	12,482	15,925	51,349	67,118	465,593	698,968
1954	10,377	12,942	42,696	52,407	406,441	604,851
1953	8,769	11,304	33,407	42,492	301,860	473,279
1952	8,831	12,052	36,528	46,215	299,005	461,064
1951	7,191	9,059	27,865	35,004	284,947	434,879
1950	7,630	8,920	25,369	31,993	250,884	387,911

* Colorado, Kansas, Missouri, Nebraska, and Oklahoma.
Source: United States Bureau of Mines, *Minerals Yearbooks,* 1951-1961.

Table 79

EMPLOYMENT AND WAGES FOR THE STONE INDUSTRY IN KANSAS

(Totals for Crushed and Broken Stone, Dimension Stone, Cut Stone and Stone Products)

	Units	Number of covered workers	Estimated* total workers	Wages of covered workers	Estimated* total wages
1956	29	564	585	$2,127,324	$2,208,184
1957	29	510	531	1,884,528	1,964,708
1958	55	1,144	1,165	4,613,716	4,697,056
1959	53	1,049	1,070	4,575,730	4,670,810
1960	51	908	929	4,073,066	4,171,426
1961	48	852	873	3,892,268	3,991,528

* Estimated by Kansas Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 80

EMPLOYMENT AND WAGES FOR THE DIMENSION STONE AND CUT STONE-STONE PRODUCTS INDUSTRIES IN KANSAS

	Units		Number of covered workers		Estimated* total workers		Wages of covered workers		Estimated* total wages	
	Dim. stone	Cut stone	Dim. stone	Cut stone	Dim. stone	Cut stone	Dim. stone	Cut stone	Dim. stone	Cut stone
1956	7	4	135	116	135	117	$464,624	$448,290	$464,624	$452,150
1957	7	5	131	128	131	129	434,989	472,338	434,989	476,018
1958	5	6	158	140	158	141	716,017	538,224	716,017	542,064
1959	4	7	79	143	79	144	240,272	575,831	240,272	579,911
1960	4	7	52	151	52	152	148,828	613,201	148,828	617,261
1961	4	7	57	146	57	147	183,070	620,408	183,070	624,668

* Estimated by Kansas State Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 81

EMPLOYMENT AND WAGES FOR THE CRUSHED AND BROKEN STONE INDUSTRY IN KANSAS

	Units	Number of covered workers	Estimated* total workers	Wages of covered workers	Estimated* total wages
1956	18	313	333	$1,214,410	$1,291,410
1957	17	251	271	977,201	1,053,701
1958	44	846	866	3,359,475	3,438,975
1959	42	827	847	3,759,627	3,850,627
1960	40	705	725	3,311,037	3,405,337
1961	37	649	669	3,088,790	3,183,790

* Estimated by Kansas State Geological Survey on basis of available data.
Source: Employment Security Division, Kansas Department of Labor.

Table 82

COMMERCIAL AND NONCOMMERCIAL PRODUCTION AND VALUE OF SAND AND GRAVEL IN KANSAS, AND LEADING PRODUCING COUNTIES, BY USE, 1955-1960

	Building sand and gravel					
	Commercial			Noncommercial		
	Production (tons)	Value	Leading counties	Production (tons)	Value	Leading counties
1955.....	4,427,058	$3,180,890	Sedgwick Shawnee Saline Ford Reno	38,493	$8,570	Sheridan Russell
1956.....	3,799,451	$2,815,349	Sedgwick Wyandotte Riley Shawnee Reno	28,977	$7,079	Sheridan Pottawatomie
1957.....	3,170,209	$2,301,650	Wyandotte Sedgwick Shawnee Saline Reno	27,181	$5,436	Sheridan Comanche Harper
1958.....	2,986,190	$2,251,329	Wyandotte Sedgwick Shawnee Saline Reno	85,141	$25,112	Sherman Sheridan Pratt Hamilton Wabaunsee
1959.....	3,771,893	$2,815,515	Wyandotte Sedgwick Shawnee Reno Saline	195,831	$74,361	Harper Sheridan Pawnee Cowley Kiowa
1960.....	3,370,000	$2,617,000	Wyandotte Sedgwick Shawnee Reno Ford	12,315	$3,695	Cowley

Table 82—*Concluded*

COMMERCIAL AND NONCOMMERCIAL PRODUCTION AND VALUE OF SAND AND GRAVEL IN KANSAS, AND LEADING PRODUCING COUNTIES, BY USE, 1955-1960

	Paving sand and gravel					
	Commercial			Noncommercial		
	Production (tons)	Value	Leading counties	Production (tons)	Value	Leading counties
1955.....	3,980,838	$2,704,050	Sedgwick Barton Pratt Cowley Reno	1,363,949	$389,498	Sumner Barton Osborne Ottawa Morris
1956.....	7,336,153	$4,195,908	Sedgwick Wyandotte Rice Barton Sumner	686,294	$266,804	Saline Barton Sumner Pratt Washington
1957.....	4,376,516	$2,973,623	Sedgwick Rice Marshall Cloud Ford Barton	1,393,117	$576,177	Sedgwick Ottawa Sumner Pottawatomie Washington
1958.....	3,926,830	$2,745,257	Sedgwick Wyandotte Marshall Barton Reno Shawnee	1,418,505	$522,719	Russell Barton Pratt Sumner Jackson
1959.....	4,078,468	$3,009,726	Sedgwick Trego Wyandotte Marshall Saline	1,615,831	$1,009,566	Russell Barton Washington Finney Harper
1960.....	4,076,807	$3,072,222	Sedgwick Wyandotte Trego Clay Dickinson Shawnee	1,381,709	$582,196	Russell Pratt Clark Harper Wallace

Source: United States Bureau of Mines, unpublished data.

Table 83

COMMERCIAL PRODUCTION AND VALUE OF STONE IN KANSAS, AND LEADING PRODUCING COUNTIES. BY USE, 1955-1960

	Crushed stone					
	Concrete, road metal, and screenings			Riprap		
	Production (tons)	Value	Leading counties	Production (tons)	Value	Leading counties
1955.....	6,332,518	$8,681,435	Wyandotte Elk Shawnee Leavenworth Dickinson Butler	208,491	$208,949	Doniphan Atchison Wyandotte Leavenworth
1956.....	7,135,772	$9,284,599	Wyandotte Elk Leavenworth Butler Wilson	724,392	$735,103	Doniphan Graham Clay
1957.....	5,062,783	$6,768,503	Wyandotte Shawnee Jefferson Leavenworth Dickinson Anderson	257,420	$243,437	Doniphan Atchison Geary Wyandotte Elk
1958.....	6,842,310	$9,132,710	Wyandotte Elk Wilson Leavenworth Shawnee Jefferson	541,046	$423,876	Doniphan Atchison Graham Dickinson Elk
1959.....	8,429,027	$11,067,567	Wyandotte Johnson Dickinson Elk Leavenworth Wilson	356,831	$316,434	Doniphan Atchison Dickinson Shawnee Elk
1960.....	7,214,084	$10,242,028	Wyandotte Elk Dickinson Butler	522,359	$445,655	Doniphan Shawnee Atchison Dickinson

Table 83—*Concluded*

COMMERCIAL PRODUCTION AND VALUE OF STONE IN KANSAS, AND LEADING PRODUCING COUNTIES, BY USE, 1955-1960

	Crushed stone								
	Agricultural lime			Rock for cement			Building stone		
	Production (tons)	Value	Leading counties	Production (tons)	Value	Leading counties	Production (cu. ft.)	Value	Leading counties
1955	426,090	$611,407	Elk Labette Wilson Bourbon Neosho	2,955,020	$2,955,050	Allen Montgomery Neosho Wyandotte Jewell Wilson	291,682	$700,517	Cowley Pottawatomie Geary
1956	261,368	$378,191	Bourbon Wilson Linn Neosho Coffey	2,897,487	$2,617,362	Allen Wyandotte Montgomery Wilson Neosho	305,412	$702,777	Cowley Pottawatomie Geary Riley
1957	181,606	$236,034	Jefferson Elk Atchison Neosho Bourbon	2,211,274	$2,211,274	Allen Neosho Montgomery Wilson Wyandotte	180,837	$468,297	Cowley Pottawatomie Geary
1958	288,213	$430,584	Bourbon Elk Linn Neosho Osage	2,464,135	$2,464,135	Allen Neosho Wilson Wyandotte Montgomery	232,863	$548,358	Cowley Pottawatomie Geary
1959	352,759	$545,766	Bourbon Atchison Linn Elk Jefferson	2,810,559	$2,719,245	Allen Neosho Wyandotte Wilson Montgomery	220,367	$512,546	Cowley Pottawatomie Geary
1960	885,704	$567,309	Neosho Bourbon Allen Marion	2,193,618	$2,316,446	Allen Neosho Wyandotte Jewell Wilson Montgomery	117,172	$136,682	Cowley Pottawatomie Geary

Source: United States Bureau of Mines, unpublished data.

Table 84

DIMENSION LIMESTONE PRODUCED IN THE UNITED STATES, INDIANA, KANSAS, MINNESOTA, MISSOURI, TEXAS, WISCONSIN

For selected years, 1940-1960

(In thousands of short tons, thousands of dollars)

	1940		1944		1948		1952		1956		1960		1960 Active plants
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value	
Indiana	248	$2,132	51	$361	366	$7,438	451	$10,745	570	$14,350	529	$11,500	18
Kansas	107	114	10	32	25	397	51	826	28	684	14	137	8
Minnesota	20	198	6	27	20	530	24	693	27	973	42	1,587	10
Missouri	65	99	4	29	25	238	43	194	33	104	29	101	7
Texas	394	677	2	54	30	675	45	606	26	875	51	1,213	8
Wisconsin	66	485	30	50	43	530	50	987	95	1,705	106	1,372	32
United States	1,082	4,260	162	623	607	10,583	787	15,061	1,029	20,696	860	17,140	114

Source: United States Bureau of Mines, *Minerals Yearbooks*, 1940-1960.

Table 85

PRODUCTION AND VALUE OF VOLCANIC ASH PRODUCED IN KANSAS 1916-1946, 1950-1955

	Production (tons)	Value		Production (tons)	Value
1916...	23,804	.....	1937...	38,438	$111,655
1921...	34,172	$125,642	1938...	38,136	112,823
1923...	51,907	170,459	1939...	41,643	123,163
1924...	39,489	148,177	1940...	39,215	129,959
1925...	35,385	122,349	1941...	23,659	111,835
1926...	48,869	152,190	1942...	36,810	139,930
1927...	45,439	152,748	1943...	43,918	163,366
1928...	46,836	183,589	1944...	43,034	163,538
1929...	49,768	195,784	1945...	47,484	187,651
1930...	38,024	134,896	1946...	35,466	105,084
1931...	47,783	152,520	1950...	3,852	12,065
1932...	39,375	117,558	1951...	3,688	11,801
1933...	42,355	109,454	1952...	3,218	.....
1934...	39,283	102,668	1953...	3,203	36,569
1935...	41,111	108,349	1954...	23,433	92,899
1936...	42,057	117,757	1955...	2,320	59,710

Source: United States Bureau of Mines, *Minerals Yearbooks;* State Geological Survey of Kansas Publications and files.

Table 86

EMPLOYMENT PROJECTIONS
TOTAL MINING EMPLOYMENT
(1950 Index = 100)

	1950 Employment	1950 Index	1955	1960	1961	1965	1970	1975
United States.....	901,000	100	87.9	78.6	.....	75	72	70
Kansas.....	17,200	100	112.1	98.9	93.1	95	90	90
Oklahoma.....	43,100	100	120.9	104.7	104.5	102	100	98
Colorado.....	10,000	100	155.0	154.0	147.0	150	145	145
Missouri.....	8,900	100	95.6	92.2	83.0	86	88	88
Nebraska.....	1,100	100	227.5	245.7	254.5	270	285	293

NUMERICAL PROJECTIONS BASED ON INDEX NUMBERS AND SEMILOG EMPLOYMENT PROJECTION TO 1975

	1955 Actual Employment	1960 Actual Employment	1961 Actual Employment	1965 Index	1965 Semilog High	1965 Graph Low	1970 Index	1970 Semilog High	1970 Graph Low	1975 Index	1975 Semilog High	1975 Graph Low
United States..	792,000	709,000	663,000	675,000	649,300	622,000	648,000	635,700	581,000	630,000	622,000	540,000
Kansas.....	19,300	17,000	16,200	16,325	16,070	15,130	15,480	15,930	14,070	15,480	15,800	13,000
Oklahoma.....	52,000	45,100	45,000	44,000	46,330	42,330	43,100	47,670	39,670	42,225	49,000	37,000
Colorado.....	15,500	15,400	14,700	15,000	16,300	14,400	14,500	17,900	14,100	14,500	18,500	13,800
Missouri.....	8,500	8,200	7,300	7,650	7,430	6,970	7,840	7,570	6,630	7,840	7,700	6,300
Nebraska.....	2,500	2,700	2,800	2,970	3,570	3,100	3,140	4,330	3,400	3,220	5,100	3,700

Source: Computed from Tables 6-11 and 13 and projected from Figure 9.