Coal Production, Distribution and Consumption in Missouri

BY

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INTRODUCTION

Coal mining is an important industry in Missouri. In 1947 the investment in land, equipment, and plant was nearly five million dollars ($4,972,404.05).[1] The industry controlled by ownership or lease 38,769[1] acres. Nearly two thousand (1,994) men were employed during the year and they mined nearly four million tons of coal (3,896,675).[1] The product of the industry, it is estimated, was sold for more than thirteen and one-half million dollars. Further, it is estimated that nearly one-fourth (23.1 per cent) of this coal was used in operation of railroads. Nearly 30 per cent (28.9 per cent) of it was put to industrial uses and approximately 27 per cent (27.4 per cent) went to retail dealers to be used in heating homes and buildings.[2] More than half of the remainder was exported. The use of a few per cent was not reported. A considerable portion of that used industrially was in turn converted into heat, light and power to operate plants and factories and to furnish heat, light and power for consumption in homes.

This report has been prepared to present some of the more important features of coal mining, past and present, in Missouri; its purpose is not to present new facts or new techniques to the operator or miner, but to acquaint all those interested with the facts and factors which contribute to the importance of the coal mining industry in Missouri. Coal itself is only briefly discussed. Reference is made to the extensive use of coal and its importance to civilization. The significance of coal in Missouri economy is evaluated. In order to understand better the background of coal mining in Missouri, the coal beds mined and their thickness and rank are described and discussed. Contribution of various mining methods to coal mining in the State and costs of production are dis-

[1]State Mine Inspector's Report for 1947, p. 41, 1948.

[2]Estimates based on distribution of bituminous coal from 15th production district U. S. Bur. Mines Min. Market Report M. M. S. no. 1557, 1948.

cussed. The history of coal production in Missouri, both overall and in leading coal producing counties is presented, not only to show amounts actually produced but to indicate the shifting centers of coal mining under changing conditions. Analysis of coal consumption in Missouri is made in order to suggest geographic relations of coal to the economy of the State and to indicate the areas where Missouri coal contributes largely to this economy. Some discussion is likewise made of the competition of other sources of energy with coal and the effect of improved utilization techniques and economies. In order that statistical information may be as readily useful as possible, most of the data and statistics have been treated graphically and by the use of maps and diagrams. It is hoped that the background and status of the coal mining industry of Missouri may be of interest and of use to operators, industrialists, and to those interested in the resources of Missouri and their development, particularly to the layman interested in the welfare of the State and in the happiness of its citizens who are so greatly affected by the development of our resources.

Acknowledgments. This study was made at the suggestion of Dr. Edward L. Clark, State Geologist. Both Dr. Clark and Mr. O. M. Bishop, Economic Geologist, have made many suggestions which have been used in assembling and preparing this report. Numerous publications and sources of information other than the files of the Missouri Geological Survey and Water Resources have been used freely and these are cited in the proper places. Diagrams and drawings were made by Mr. Owen Thompson, and the utility of much of the data used is enhanced by his painstaking work.

THE NATURE OF COAL

Coal is so common a substance that we rarely pause to inquire as to what it really is, how it came to be, how it reached its present state, or what an important place it occupies in our daily lives. That coal is found in nature associated with rocks is generally known, and it may well be presumed to be a rock. Altough coal is commonly classed as a rock, and most authorities treat it as such, it differs from the general groups of rocks in several important ways. Rocks, as defined by the geologist, are aggregates of mineral matter. Coal, however, contains very little mineral matter. Rocks include but little of substances which have ever been living. True, some limestones are made up of shells of animals, but these shells, strictly speaking, have never been essentially concerned in the life processes of the animals. Coal, on the other hand, is largely composed of materials which were once structures and organs essential to the life processes of living things. Chemically, also, coal differs from most rocks. Although most rocks consist of an array of chemical elements and compounds which are chiefly concentrated outside the realm of living things, coal is chiefly made up of elements and compounds mainly associated with living things. Thus the chemist who best understands the constitution of coal is the organic rather than the inorganic chemist.

Chief among the elements in coal is carbon, the foundation element of living matter. This element can be obtained by green plants, with the aid of sunlight. The complex process by means of which carbon is removed from the atmosphere is known as photosynthesis, and it is this process which, in ages past, has stored carbon in living plants to be preserved for the use of our own and future generations.

As if to preserve the record so that we make no mistake about it, nature has preserved in coal itself positive evidence of the material from which it is made. The coal expert, using highly specialized techniques, finds in coal identifiable fragments of bark, stem, pith, roots, leaves, seed and spore coats. The cells of these are very frequently preserved in sufficient perfection to permit identification of the function of these cells in the life of the plant. It is thus certain, and coal geologists agree, that coal, if it is a rock, is a substance which has resulted from the accumulation and modification of plant material.

Plants differ greatly one from another, and the parts of plants as trunks of trees, leaves, roots, seeds, and spores are very unlike. Beds of coal or parts of beds made up of material derived from different kinds of plants will be dissimilar. Beds or parts of beds made up mostly of the material of trunks or of leaves or of spores will likewise differ, one from another. The mine owner who said that the coal of the neighboring mine was not good "because it was made of sticks and grass and dirt," whereas his own was derived from "nice clean trunks and the big branches," was correct in principle, because he noted that the original materials forming the two beds were different. Coals differ greatly because the plants or parts of plants from which they are derived were originally different. Some western coals, which were derived from cone-bearing trees, contain masses of unmistakable pure yellow resin which came from the pitch of the original trees. Cannel coals, in Missouri, as elsewhere, which contain so much oily matter that they burn with a luminous, smoky flame like a candle, have large numbers of spores or pollen grains responsible for the peculiar characteristics of these coals.

Geologists agree that coal is formed from plant matter which originally lived as plants in an environment of poor drainage, like that of swamps and bogs. Identifiable plant remains in coal indicate such an environment and in addition strongly suggest that these swampy areas of accumulation existed in times of warm, equable climate. It is significant that, whereas plant structures adapted to swamp life and warm climate are abundant, structures adapted to dry seasons and freezing cold are not known in coal.

Differences in coals due to variations in type of original material have been mentioned. Other important differences are due to the history of the plant matter after its accumulation. Coals and coal-like deposits thus range from peat, through lignite, sub-bituminous, bituminous, semi-anthracite, anthracite to meta-anthracite, in an unbroken progressive series. The position of any coal in this series is in part due to chemical and physical modification within the coal itself, to increasing loads of overlying sediments, and to forces

and pressures produced by earth movements. The position of a coal in the above mentioned series is the rank of the particular coal as defined by coal technologists.

COAL AND CIVILIZATION

Coal and the use of coal as fuel have probably been known for more than 2000 years. Cast iron coins and other iron castings made in China as early as 900 A. D. suggests the use of coal. Coal cinders in the ruins of Roman habitations show that coal was possibly used during the Roman occupation of England, prior to 400 A. D. Along the North Sea, sea waves uncovered coal; women and children gleaned the naturally mined fuel ("secole" or "sea coal") before monks in north England first mined and shipped coal from the port of Tynemouth in 1269. Coal in those times was not in high favor as a fuel as fireplaces were without chimneys. Use was restricted to smiths, lime burners, and brewers. Indeed, in 1306 King Edward I, because of its odor and smoke, barred the use of coal by others than smiths, and so instituted what was probably the first smoke ordinance. Later in the century, however, monasteries and castles were heated by coal, and movable chimneys were used until stationary fireplaces and chimneys were built.[3]

Early in the seventeenth century coal had displaced charcoal in Britain in such important industries as brewing and distilling, brick, tile and pottery making, manufacture of soap and sugar, and evaporation of water for salt. Coking of coal for use in iron and copper smelting was introduced, and early in the eighteenth century a successful commercial process for making coke was developed.[4]

Coal mining became the parent of the modern railway. At first the fuel was moved in and out of the mines in baskets or corves, but later wheels were added to facilitate movement. With the addition of tracks or tramways the railroad was born. The standard railroad gauge of England today is the distance between the wheels of the wagons in use in north England more than a century and a half ago. First attempts at the use of steam were made in the coal fields of South Wales and in the Tyne fields, and significantly, George Stephenson, who invented the steam engine, was an engineer at a coal mine.[5]

Coal was known in North America before 1672 on Cape Breton Island in Canada. It was shipped by boat from what is now Port Morien to Boston in 1720. In the United States, Joliet and Marquette noted the occurrence of coal in what is now Illinois, and Joliet's map of 1674 shows coal near the present site of Utica. Coal was first mined in what is now the United States near Richmond, Virginia as early as 1750.[6]

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[3]Eavenson, A. N., Coal through the ages: A. I. M. E. Series, New York, pp. 5-10, 1935.
[4]Eavenson, op. cit., pp. 10-14.
[5]Eavenson, op. cit., p. 35.
[6]Eavenson, op. cit., pp. 43-46.

From these beginnings came the American coal industry of our time. Coal, with its co-partner steel, is the foundation stone of modern industry. How little of our modern world is not immediately or ultimately concerned with coal and iron!

"Pick a product—any product—and if it is manufactured in America, coal has touched it first. Think back to where your product came from. How were its raw materials drawn from the earth, the sea, the sky? Where did the machinery come from to make it? Were light, power, heat, energy necessary to its manufacture? Did electricity enter in? Steel? Transportation?

"At every turn you will find coal, derivatives of coal, or functions made possible by coal. It is probable that you will run into coal's amazing by-products—some 200,000 of them, ranging from sulpha drugs, anesthesias, dyestuffs, perfumes, fertilizers, plastics, or explosives."[7]

Areas of dense population in America are the sites of manufacturing and industrial activities and the centers of distribution of manufactured products. Important trade and industrial centers of the United States are those where coal and iron or steel are readily accessible. Not only do coal and steel form the foundation of industry, but it is through development of the railroads that products of one locality are exchanged for those of another. Thus the farmer exchanges the fruits of his fields for clothing he wears, his tools and equipment, and even the bread on his table. And the railroads, in spite of increased competition from petroleum products as fuel, consume more than one-fifth of all the coal mined in the United States.

The importance of coal to our economy is shown in Figure 1. The large amounts used by the railroads and electric power utilities is significant, and that amount delivered to retail dealers suggests likewise the extent to which coal is used to furnish heat for homes. Of greatest importance, however, is that relatively small amount utilized in production of coke and that used to make iron and steel.

MISSOURI COAL AND MISSOURI ECONOMY

Missouri is an important mining area from which a long list of mineral products are recovered. Chief among these are lead, zinc, refractory clays, barite, and coal. Although the amount of coal mined is not great when compared with that of the great coal mining states, West Virginia, Pennsylvania, Kentucky, Illinois, Ohio, and others, the total all-time value of coal mined in Missouri is second only to that of lead.

Coal has been long known in Missouri. "Among the earliest notices of fine seams of coal, far up the Osage River, are those of Captain (Zebulon) Pike, in 1806. More recently, other deposits of excellent coal have been discovered nearer to the mouth of the same river."[8]

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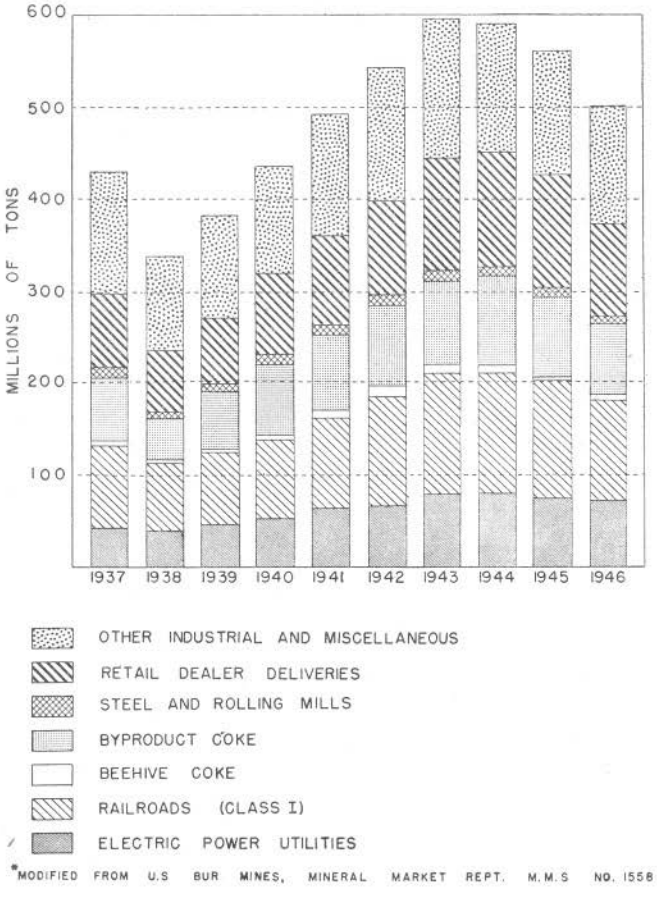
[7]McConnell, F. S., Coal—Generator of jobs: Engineering Experiment Station News, Ohio State University, vol. XV, no. 2, p. 3, 1948.

[8]Taylor, R. C., Statistics of Coal: Philadelphia, p. 170, 1848.

MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE I

CONSUMPTION OF BITUMINOUS COAL AND LIGNITE, BY CONSUMER CLASS, WITH RETAIL DELIVERIES IN THE UNITED STATES*



*MODIFIED FROM U.S BUR MINES, MINERAL MARKET REPT. M.M.S NO. 1558

Pike, who went up the upper Osage in 1806, reached the site of Fort Carondelet August 17 of that year. The river bank, he said, was:

> ". . . one solid bed of stone coal, just below which is a very shoal and rapid ripple, 'Kaw rapids', the head of navigation whence the village of Grand Osage is nine miles south across a grand prairie."[9]

The head of navigation in 1839 was indicated at the mouth of Marais des Cygnes River on a map prepared by the Surveyor General Office at St. Louis, and a ford appears to have been used at the site of the present town of Papinsville. Possibly the coal seen by Pike was between the mouth of Marais des Cygnes and the present town of Papinsville. Prior to 1843 coal was mined near the Osage River not far from the present site of Rich Hill in Bates County (T. 39 N., R. 31 W.). The 1845 map of the Surveyor General Office showing the location of this coal pit is of interest, as it is the oldest map known that shows a coal mining operation in Missouri. That other coal mining was in progress is well known since nearly 10,000 tons were mined in Missouri in 1840. Taylor states that in 1840, 249,302 bushels, or 8,903 (long) tons of coal were mined.[10]

The contribution, present and past, of Missouri coal to the economy of the State is most important. Missouri is both an agricultural and an industrial state. With the exception of extreme southeastern Missouri, the most intensively farmed portion of the State is northwest of a line connecting the southwest corner with the northeast corner. The industrial areas are found along the eastern and western borders with greatest concentration in and around St. Louis and Kansas City. The proximity of the Ozark region, particularly the eastern part and the industrial area around St. Louis, to the Illinois coal fields permits these areas to be supplied from Illinois. Freight differentials are so great that little or no coal from Missouri fields enters the St. Louis market. Little use is made of Missouri coal in the Ozark region except in the western part. In the area of intensive farming, however, near and within which most of the coal resources of Missouri lie, low cost, and readily available coal has been an asset. Even the small, local truck mines perform a service to the community far beyond their importance to the coal industry by supplying cheap fuel where domestic fuel is needed for several months in the year. The saving in fuel cost to every family, both rural and urban, in north and northwest Missouri is considerable, and the aggregate saving due to freight differentials is very large indeed.

Not only is Missouri coal of immediate importance to an agricultural population, but it is likewise important in industrial areas based directly on agriculture. The industries within and near the Missouri coal fields are basically those which process the agricultural products, or those which make and dis-

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[9]Shepard, E. M., Early history and exploration: Geology of Vernon County: Missouri Bureau of Geology and Mines, vol. XIX, 2d. ser., p. 18, 1926.

[10]Taylor, R. C., op. cit., p. 171.

tribute these products to an agricultural market. Kansas City and St. Joseph are the hoppers into which are fed the wheat of Kansas and the cattle, hogs and other farm products of a great agricultural region. In turn, industries of the area manufacture those products required for continuous agricultural activity and contribute to the well-being of the people of an agricultural area. To say that either wheat, hogs, cattle, poultry, corn, oil and gas, or coal alone determines the economic stability and well-being of the area cannot be true, as each of these, and other factors as well, are essential parts of the economy of Missouri. The loss or curtailment of any one would tend to throw the entire economy out of balance.

Coal is so important a factor in the economic life of Missouri, particularly in the northwestern half, that the equivalent of most of Missouri production is consumed there. Likewise the industrial heart of this region, centered around Kansas City and St. Joseph, depends, in large measure, on Missouri coal and is its chief consumer. Kansas City alone, in the year ending September 30, 1946[11] consumed the equivalent of considerably more than one-fourth (1,080,738 tons) of the total coal production of Missouri coal fields (3,545,691 tons). Furthermore, more than half of this fuel went into industry.

OCCURRENCE AND DISTRIBUTION OF COAL IN MISSOURI

Coal is found in Missouri associated with rocks known to the geologist as the Pennsylvanian system. These rocks consist of shales, sandstones, clays and limestones. The coal beds, although the most economically important, are actually a subordinate part of the Pennsylvanian and make up but a fraction of the total thickness of these rocks.

The rocks associated with coal have wide distribution in Missouri (Figure 2). In general they lie northwest of an irregular line extending from Jasper County, at the Kansas boundary in southwest Missouri, across the State in a northeasterly direction to the Iowa boundary in northern Clark County. A prominent southeastward extension of Pennsylvanian rocks projects into Callaway, Audrain, and Montgomery counties. Patches of Pennsylvanian rocks are present southeast and outside of the boundary shown on the map, Figure 2, but these are not of great importance in so far as coal is concerned. Coal pockets are found in many places outside of the main Pennsylvanian area as sink fillings. These pockets may be very thick but are quite small and of little economic value.

All of the important coal beds lie in the lower part of the Pennsylvanian. The coal beds and the associated rocks do not lie flat below the surface, but, in general, dip gently toward the northwest. Thus the coal beds crop out, or come to the surface, for the most part, near the eastern boundary of the Pennsylvanian system. Furthermore, the coal beds become progressively deeper

[11]U. S. Bur. Mines, Mineral Market Report, M. M. S. no. 1557, Jan. 1948.

below the surface toward the northwestern corner of the State. As depth of occurrence is a most important factor in mining in Missouri, the coals along the outcrop boundary are the best known and the most extensively exploited.

COAL BEDS MINED IN MISSOURI

Coal beds in Missouri range from paper-thin, carbonaceous sheets to beds six feet or more in thickness. Beds from less than a foot to the maximum thickness have been mined. Much of the thicker coal, however, has been exhausted, and the thinner beds have been mined only in a small way. Current mining operations are recovering coal from beds 16 inches to 54 inches thick.

Although twenty-five or more coal beds occur in Missouri, only seventeen of these are sufficiently thick to be mined, and most of the coal production has been from six beds, the Weir-Pittsburg, Tebo, Bevier, Mulky, Lexington, and Mulberry, Figure 2. Beds known in Kansas as the Fleming and Croweburg are now recognized in Missouri and have been mined in Bates and Vernon counties; but unless they are mentioned specifically, they have been included with the Tebo. The other nine beds have been mined only locally or have been important only locally. For the purposes of this report the Jordan, Mammoth, Eureka, Cainesville, and Bowen beds are included with the Weir-Pittsburg; the Rich Hill is included with the Tebo.

The Weir-Pittsburg coal bed has been mined chiefly in Barton County. Beds called the Jordan, Mammoth, Bowen, Montserrat, and Cainesville have been mined in Henry, Johnson, and Harrison counties and are herewith, for statistical purposes, included with the Weir-Pittsburg. The Weir-Pittsburg coal is 28 to 36 inches thick, where it is mined in Barton County. The Jordan coal of southern Henry County and northern St. Clair County, although very erratic in thickness, has been mined where it was at least 48 inches thick. The Mammoth trough of Henry County and the Bowen trough of Henry and Johnson counties, respectively, contained coal 48 to 80 inches thick. These thicker deposits have been mostly depleted. The Cainesville coal bed of Harrison County contained coal from 44 to 60 inches thick and averaged 48 inches.

The Bevier coal bed is thickest in Macon and Randolph counties where 72 inches have been reported. The Bevier coal now mined in this district is from 36 inches to 54 inches thick. In Adair County the Bevier currently mined is from 40 inches to 48 inches thick but in Boone and Callaway counties it is between 24 inches and 42 inches thick.

The Tebo (Rich Hill) coal in Bates and Vernon counties is one of the thicker coals of Missouri. The bed varies greatly from less than six inches to 72 inches. At New Home in Bates County the bed was 72 inches thick. The Tebo (Rich Hill) currently mined in Bates and Vernon counties is 16 to 42 inches thick. The Tebo of Henry County is fairly consistent in thickness from 26 to 36 inches but commonly is about 30 inches. Outside the places mentioned, the bed has not been extensively mined.

The Lexington coal is relatively thin, but the bed has been extensively mined for many years in Lafayette and Ray counties. Although it is one of the most productive coal beds in Missouri coal mining history, in these most important counties the bed was from 16 inches to 28 inches thick. In Putnam County the Lexington is thicker and current mining shows the bed between 36 and 44 inches.[12]

The Mulberry coal is from less than 24 inches to 36 inches thick. It has been mined almost exclusively in Bates County.

Other locally important beds are the Croweburg and Fleming. The Croweburg ("One Foot" of Vernon and the "Bevier" of southern Johnson and northeastern Henry counties) is about 12 inches thick in Vernon County and 18 inches thick in Henry and southern Johnson counties. The Fleming which is being mined at present in Vernon County is a little more than 24 inches thick.

IMPORTANCE OF THE VARIOUS COAL BEDS

In order to determine the relative importance of the various beds to Missouri coal economy, the total coal mined from each bed has been estimated by decades, Figure 3. Production from a county whose main output was essentially from one bed was classified as entirely from that bed. Where several beds were mined in a county, no attempt was made to break down the production to estimates for each, but the total was tabulated as unclassified. The results are of sufficient accuracy to show definitely the relative importance of the various coal beds to the Missouri mining industry. The per cent of total Missouri production of the five important coal beds has been indicated by decades from 1895 to 1945, Figure 3. The outstanding importance of the Bevier bed of northeast Missouri is well demonstrated, as in every decade the bed has contributed from about one-sixth to nearly one-half of all coal mined in Missouri. Much of the coal of the Bevier bed where it is thickest and most readily recoverable has been mined. Operators in this bed must anticipate increased mining costs incident to deeper and thinner deposits.

The Lexington bed has likewise been a consistent and important producer of from more than one-tenth to more than one-fourth of the coal produced in any decade. As readily accessible areas of other beds are exhausted and as advanced methods of mechanized underground mining are adopted, the thin Lexington with its excellent roof and deeper reserves will doubtless be an important source of coal.

The Weir-Pittsburg bed has been very important, especially in the two decades from 1916 to 1935, but it appears that this bed will be exhausted for large scale operation in the relatively near future.

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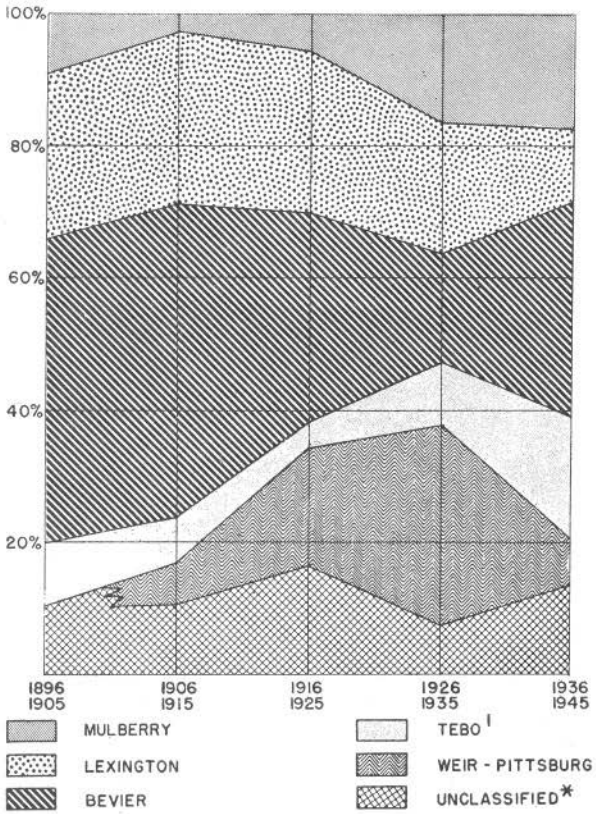
[12]Keith, C. C., Fifty-ninth Annual Report, Division of Mine Inspection, p. 37, 1947.

MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE 3



COAL BEDS MINED BY DECADES

IN PERCENT OF TOTAL MISSOURI PRODUCTION

[1] INCLUDES RICH HILL COAL

* INCLUDES ADDITIONAL SMALL INCREMENTS INCLUDED IN CHART AND ALSO THE FLEMING, MULKY, AND SUMMIT COALS

Much of the thicker Tebo (Rich Hill) coal has been mined out. The areas of thin Mulberry coal will probably increase in importance as thicker and readily accessible deposits of other beds are exhausted.

RANK OF MISSOURI COALS

In the classification of coal, the term "rank" refers to the position of a coal in the metamorphic series from lignite to anthracite. "Grade" is the quality of coal as determined by calorific value, by impurities such as ash and sulphur, and by the softening of the ash during combustion. Coals are most readily classified over a large area by rank, and a revised system of classification has been devised by a sectional committee on classification of coals, The American Society of Testing Materials.[13, 14, 15] By this agreement, coal is classified by rank chiefly on the basis of the amount of fixed carbon in the dry, mineral-matter-free proximate analysis and on moist, mineral-matter-free calorific value expressed in B.t.u. Bituminous coal has a moist, mineral-matter-free B.t.u. value of more than 11,000 and less than 86 per cent fixed carbon on a dry, mineral-matter-free basis. Bituminous coals are classified as high-volatile, medium-volatile, and low-volatile on the basis of calorific value and fixed carbon. High-volatile bituminous coals are those with moist, mineral-matter-free B.t.u. values greater than 11,000 and dry, mineral-matter-free fixed carbon less than 69 per cent Those high-volatile coals in the lower ranges of fixed carbon content, which weather and are non-agglomerating, are classed as sub-bituminous rather than bituminous.

High-volatile bituminous coals are still further subdivided into three classes on the basis of calorific value. Those with moist, mineral-matter-free B.t.u. values between 11,000 and 13,000 are classed as high-volatile C bituminous coals. Bituminous high-volatile coals between 13,000 B.t.u. and 14,000 B.t.u. are classed as high-volatile B bituminous coals, whereas those high-volatile coals of more than 14,000 B.t.u. value are high-volatile A bituminous coals.

A chart[16] prepared by the United States Bureau of Mines indicates the classification by rank of representative coals of the United States on the basis described. A diagram, Figure 4, has been made from the data on that chart which shows the moist, mineral-matter-free B.t.u. range of Missouri coals as compared with the range of coals from neighboring fields. All coals included in the diagram, except those from Oklahoma and Kansas, vary from coals of sub-bituminous A rank through the high-volatile C, B, and A classes. A few Oklahoma coals range beyond class A bituminous. Missouri coals included in

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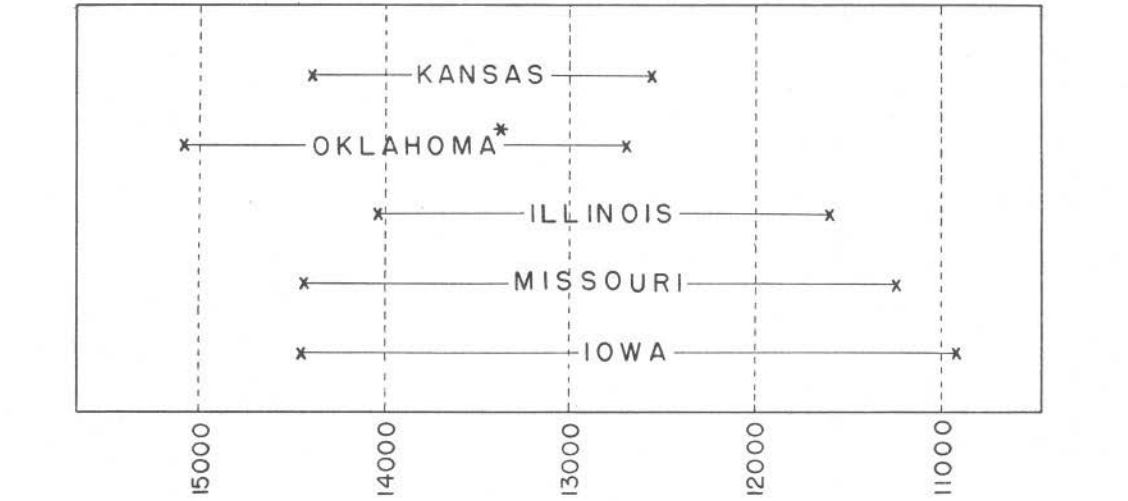
[13]Tentative specifications for classification of coals by rank (D388-35T) Proc. Am. Soc. for Testing Materials, vol. 1, pt. 1, pp. 847-853, 1935.

[14]Fieldner, A. C., Selvig, W. A., Frederic, W. H.: Classification chart of typical coals of the United States, U. S. Bur. Mines R. I. 3296, 1935.

[15]Fieldner, A. C., Standardization of coal classification: Keystone Coal Buyers Manual, McGraw-Hill Publishing Co., pp. 79-88, 1937.

[16]Fieldner, A. C., Selvig, W. A., Frederic, W. H., Classification chart of typical coals of the United States: U. S. Bur. Mines R. I. 3296, 1935.

RANK OF MISSOURI AND COMPETITIVE COALS



*Some Oklahoma coal is medium volatile bituminous
All others are high volatile coals
Data from classification chart
U. S. Bur. Mines R.I. 3296 1935

the Bureau of Mines chart range from sub-bituminous A into the high-volatile A class. The highest dry, mineral-matter-free fixed carbon content of Missouri coals now known is less than 69 per cent; therefore, they do not extend into the medium-volatile classification.

Analyses cited in the Bureau of Mines study, as well as in others available, suggest that rank of Missouri coals increases from north toward the south and that rank of coals tends to decrease from older through younger beds.

Classification of Missouri coals is important to the future recovery, preparation, and utilization of this important resource. Data are being accumulated which will permit evaluation with increasing precision of the rank of coals from the various beds and from the various districts of the State. Before such a classification can be satisfactorily completed, precise identification and correlation must be made of the various coal beds within the State. The Missouri Geological Survey and Water Resources is engaged in a study of the identification and correlation of coal beds.

MINING METHODS

Coal is mined underground and in open pits. It is mined underground through drifts, slopes or shafts. A horizontal opening is a drift. An opening which descends at a gentle angle to the coal is a slope. A shaft is vertical. Much coal is mined in Missouri through each type of opening, depending chiefly on the position of the coal relative to the surface. More coal, however, has been brought to the surface through shafts than from the other kinds of mines combined. Until the last two decades large operations were shaft mines, their depths varying from only a few feet to 480 feet at Cainesville in Harrison County. Two-hundred fifty thousand tons of coal were mined annually from Missouri through a 720-foot shaft at Leavenworth, Kansas.

Whatever the type of opening to the coal bed, modifications of two systems of mining and removal are used, long wall and room and pillar. In long wall mining a continuous circular face of coal is mined either from the shaft or other opening outward or from the limits of the property inward. In room and pillar mining entries or tunnels are driven out from the shaft or other opening. From these entries, rooms are opened with relatively narrow supporting walls or pillars. The final stage of mining is termed "pulling or robbing the pillars." Thicker beds, like the Bevier and Weir-Pittsburg, are commonly mined by the room and pillar system; whereas thinner beds are most readily mined by the long wall method.

Underground mines operating in Missouri are largely mechanized. In 1946, only 7.3 per cent was mined by hand and only 6.1 per cent was shot from the solid; that is, blasted off the coal face with explosives without undercutting the coal. Of the coal mined underground, 86.6 per cent was cut by

machines.[17] It should be noted that the average mechanization of all underground mines in the United States, in terms of coal cutting machines, is 90.8 per cent; in Illinois 95.7 per cent of the coal mined underground is from mines using cutting machines. In 1946, in Kansas and Iowa, only 59.8 per cent and 49.7 per cent, respectively, of the coal recovered in underground mining was by the aid of cutting machines. Oklahoma underground mined coal, on the other hand, was 93.1 per cent machine cut.

The manner of loading coal in underground mining is an important factor in cost of coal mined. Hand loading underground is rapidly being displaced by various loading devices such as mobile loading machines, scrapers, conveyors equipped with self-loading heads, pit-car loaders, or hand-loaded conveyors. The use of mobile loading machines and conveyors, either hand-loaded or self-loading, is increasing rapidly in important areas of underground mining. In Missouri, these cost-reducing aids to underground mining have not been adopted because of the relative thinness of the coal beds. If Missouri is to continue to compete successfully with coal mined underground elsewhere, efficient underground loading machines must be adopted.

Cost differences owing to modernization and mechanization of underground mining are indicated by the tonnage output per man per day under various conditions of mechanization. In 1946, Illinois underground mines averaged 7.83 tons per man per day, Iowa 3.52 tons per man per day, Kansas 1.59 tons per man per day, Missouri 2.38 tons per man per day, and Oklahoma 3.97 tons per man per day. Output per man per day in Missouri and Illinois is not strictly comparable, as most Illinois coal mined is much thicker than that of Missouri. Mechanization, however, accounts for a considerable part of the difference in output.

Mining coal by open or strip pit methods is most important in Missouri at the present time, Figure 5. So important have these methods of recovery become that the State in 1946 ranked seventh in the United States in coal produced by stripping. Pennsylvania, Illinois, West Virginia, Ohio, Indiana, and Kentucky rank above Missouri in volume of coal stripped, but all of these are among the foremost coal producing states. In Missouri 89.5 per cent of all coal mined in 1946 was by stripping methods.[18] None of the other leading states recovers so great a percentage of total production by open pit methods. In 1946, Indiana with 54.5 per cent, Ohio with 44.0 per cent, and Pennsylvania with 25.2 per cent most closely approached Missouri. Kansas obtains 91.6 per cent of the total production by stripping methods. Obviously, conditions very favorable to open pit methods exist in parts of the Missouri coal fields.

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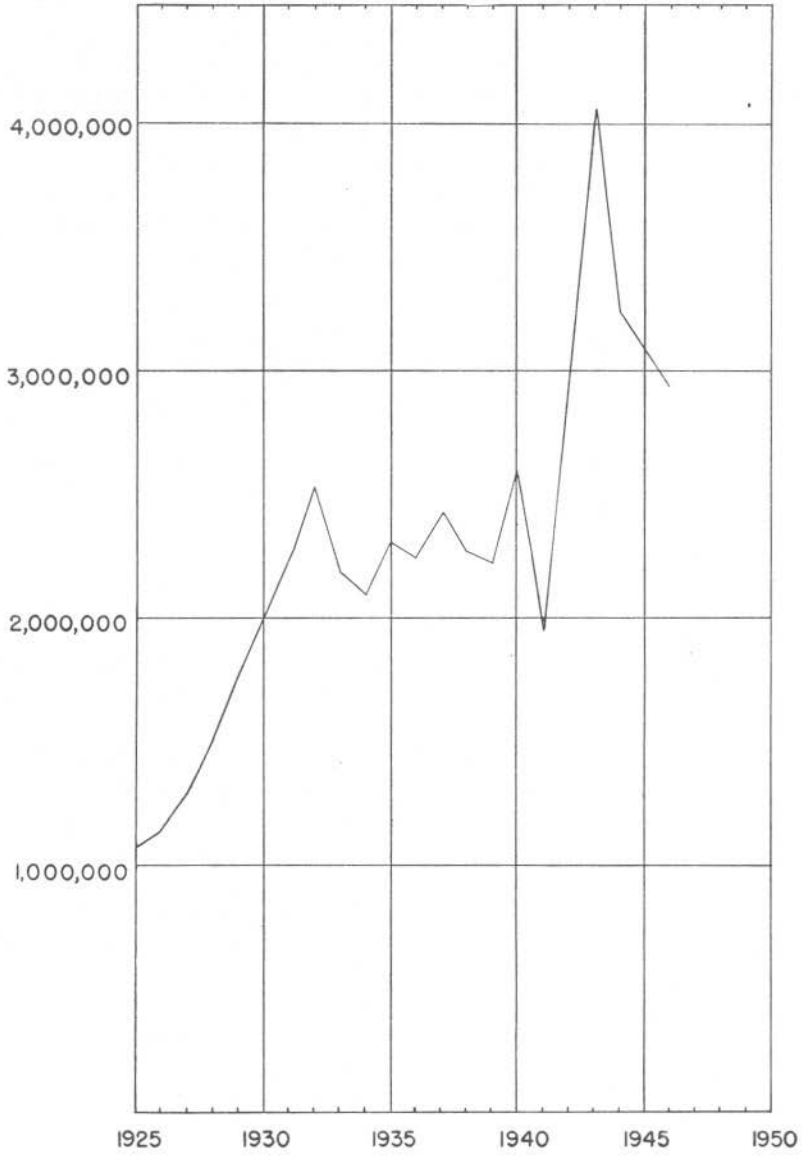
[17]Bituminous coal and lignite in 1946: U. S. Bur. Mines, Mineral Market Report M. M. S. no. 1558, 1947.

[18]Bituminous coal and lignite in 1946: U. S. Bur. Mines, Mineral Market Report M. M. S. no. 1558, 1947.

MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE 5

COAL MINED IN MISSOURI BY STRIPPING
IN TONS



Conditions most favorable to open pit methods are: 1) flat terrain, 2) horizontal coal beds, 3) thick coal, 4) coal at relatively shallow depths, 5) good drainage, 6) low water table, 7) relatively soft rocks over the coal, 8) readily accessible power supplies, 9) cheap and readily available transportation, and 10) nearby markets. All of these conditions are not completely satisfied anywhere, and the absence of any one adds to mining and distribution costs. In any area of strip mining, the absence of one of these factors must be balanced by the more favorable existence of others.

In many places in Missouri conditions closely approach ideal conditions for strip mining. Flat terrain and horizontal coal beds are not found over wide areas; but in parts of Barton, Vernon, Bates, Henry, Johnson, Macon, Randolph, Boone and Callaway counties considerable areas of relatively flat topography and coal beds whose dip is very slight combine to permit considerable acreages of coal to be stripped under relatively thin overburden. In addition, the relief permits adequate drainage during the mining operation. Where slight dips and gentle slopes are in the same direction, as they are in many places, parallelism of surface and bed are approached, and drainage conditions are ideal when the mine is properly developed. Missouri coal beds are relatively thin compared with those mined in eastern fields, particularly those in Illinois, Kentucky, Indiana, and Ohio. The disadvantages of this factor must be, and have largely been, balanced by such other favorable factors as flatness, near horizontality of beds, depth of stripping, relatively soft rocks, good transportation, nearby markets, and mining efficiency. As depth of stripping increases with depletion of reserves, the thinness of Missouri coal beds will weigh more and more heavily in cost of mining and in competition with other fields. A fairly low water table is present in most localities but in many mines, drainage must be supplemented by the use of pumps to keep water from the pits during recovery of the coal.

Thickness of overburden, or depth of stripping, varies greatly, depending on local geological conditions, thickness of the coal bed, and type of equipment used. In some small operations as little as four feet of overburden are removed, though more than fifty-eight feet are removed in larger operations. Ratio of overburden to coal thickness is a significant factor and varies from as little as 3.5 to 1, (3.5 feet of overburden to one foot of coal) to 22.8 to 1. In general, stripping ratio is lowest in small operations and greatest in large ones. In 1947 the stripping ratio was 12.5 to 1 in Missouri's single Class 1A mine (production more than 500,000 tons), 8.6 to 1 to 20 to 1 in four Class 1B mines (production 200,000 to 500,000 tons). Data are available on 21 mines which recovered less than 5,000 tons in 1947. Only three of these were worked with a stripping ratio greater than 10.0 to 1 (two at 12.5 to 1 and one at 10.8 to 1). Thirteen removed overburden at a ratio of 8.0 to 1 or less. Data are available on only five mines producing between 5,000 and 100,000 tons in 1947. Stripping ratios in these mines vary between 5.3 to 1 and 22.8 to 1. The mine with the low ratio produced less than 15,000 tons,

however, and the mine operating with the high ratio has been abandoned by a large operator. Comparative stripping ratios for production-size groups of mines are significant. In 1947, those producing more than 100,000 tons average 13.4 to 1, those between 5,000 and 100,000 tons 11.7 to 1 and those less than 5,000 tons was 7.8 to 1.

Large operations in Missouri utilize relatively cheap electric power from nearby power lines. Smaller mines depend largely on diesel-powered stripping equipment. A few operations use gasoline. Large operations, for the most part, are relatively near railway facilities which connect them with nearby markets. The use of high tonnage diesel-powered and butane-powered semi-trailer tractor trucks (capacity to 80 tons) has been found economical for mine and mine-to-railroad hauls. Good highways and farm-to-market roads are available for truck transportation and permit smaller operators to supply local domestic needs, in many mines directly to the consumer. Missouri coal available for strip mining is near or within market areas.

Although coal has been mined by stripping since the early days of coal mining in Missouri, strip coal made up only a small part of commercial production until after World War I. Coal is known to have been stripped in Bates County before 1843. Before 1873 many open pits had been in operation, but descriptions of methods used were not recorded.[19] Before the turn of the century, horses and scrapers were used extensively for the larger strippings; but difficulty in handling thick overburden made it necessary for large shipping mines to be developed underground before the advent of the steam shovel. The first steam shovel for the mining of coal was used at Pittsburg, Kansas, only a few miles west of the Missouri line. Only eight to twelve feet of overburden could be successfully removed by that pioneer machine, but operation continued successfully for three years. Numerous later attempts to use steam-powered shovels and draglines were essentially unsuccessful, chiefly because of difficulty in manipulation. In 1910 the revolving stripping shovel was unsuccessfully introduced at Pittsburg, Kansas, but the next year in the Mission field in Illinois, a revolving steam shovel with a 3½-yard dipper, a 40-foot dipper stick and 65-foot boom was operated with complete success. The machine weighed 150 tons and was at the time the largest shovel in the world.[20] Four years later in 1915, 3,953,222 tons of coal were mined in the United States by stripping. In that year Kansas led in the amount of coal stripped (780,789 tons), Missouri was second (655,670 tons), Indiana a close third (638,220 tons), and Illinois fourth (455,195 tons).[21] By 1917, steam shovels with 90-foot booms, dipper sticks 45 to 55 feet long and dippers with a capacity to 6½ yards were in use. The larger shovels and draglines of the Missouri and Kansas fields have since been powered by electricity. Some

[19]Geological Survey of Missouri, 1873.

[20]Stoek, H. H., Steam shovel mining of bituminous coal: Trans. A.I.M.E. vol. LVII, pp. 514-549, 1918.

[21]Stoek, H. H., op. cit., p. 537.

booms are more than 100 feet long, dipper sticks 70 feet long, and buckets to 32 cubic yards capacity. These machines can uncover coal to a depth of 60 feet in a cut 90 feet wide, although depths greater than 50 feet are avoided and cuts are commonly 60 feet wide. In 1929, the total coal mined by stripping in the United States had increased to approximately 22,000,000 tons[22] and that of Missouri had reached approximately 1,800,000 tons. Tonnage mined by stripping in Missouri reached a peak in 1944 when 4,031,356 tons were recovered by these methods, Figure 5.

Development of strip mining as a large contributor to the amount of coal recovered in Missouri and elsewhere has been given greatest impetus by two world wars. Demand for coal during the first world war was a powerful incentive to increased production. In addition to fuel requirements of war time industries during World War I, the navy and the merchant marine were large consumers of coal. Steam railways used coal, and railway cars were in such short supply that transportation of war goods had priority over coal. Labor shortages and difficulties occurred and wages increased, demanding a cheaper method of coal production. Stripping of coal increased to supply the domestic and industrial markets.

Following the boom days during and after World War I, a severe and prolonged depression developed. The influence of the depression on the coal industry was relieved temporarily in 1922 and early 1923 because of the shortages accumulated during a five-month strike. Except for this intermission, oversupply, low prices, and extreme competition permitted only those operations to survive which could produce at lowest cost. This economic condition persisted in the coal industry until after the general depression of the early 30's. Strip mining, however, was able to weather this ordeal and was, in fact, able to supply coal at the lower costs demanded; but the underground mines could not meet this competition.

In the increased demands for fuel brought about by the approach of World War II, strip mines expanded rapidly and underground mines in Missouri depreciated still further.

Improvements of machinery adapted to open pit mining and improved transportation techniques aided largely in maintenance and expansion of strip mining. Continued acceleration has been made possible by the successful introduction of the revolving shovel, caterpillar traction, walker traction, the increase in size of power shovels and draglines, loading shovels and equipment, counter-balanced shovels and draglines, electric drive, motor haulage, the highly improved drilling techniques for proving of areas, and pre-mining knowledge of thickness and quality of coal, thickness and character of overburden, drilling and blasting techniques, and the development of staffs of experienced and aggressive engineers. Flexibility of strip mining techniques, particularly in Missouri, have made it possible for the coal industry to pro-

[22]Kiessling, O. E., Tryon, F. G., and Mann, L., The economics of strip coal mining: U. S. Bur. Mines, Economic Paper 11, p. 3, 1931.

duce at lower costs when lower costs were necessary and to furnish a greater volume of production when more coal was required. The coal industry in Missouri could not have been maintained through the pre-World War II depression because of the competition of petroleum and natural gas, nor could the industry have been in a position to furnish the fuel so necessary for industry and for domestic use during and following World War II, if these developments and improvements had not been in operation.

COAL PREPARATION

In the mines of early days, particularly in underground mines, foreign materials such as shale, pyrite, and concretions were discarded at the working face. Cursory picking and rejection of noncombustibles in unloading at the tipple, loading for shipment, and unloading and transfer, completed the preparation for use. Sizing was done, if at all, by gravity screens, though these added little or nothing toward putting clean coal into the bin of the consumer. Strip-mined coal in particular was notoriously dirty and contained weathered and stained coal, impurities such as slate, and pyrite; and much of it was muddy. The coal consumers' greatest prejudices are those against the obvious impurities. With the development of stokers, particularly of the automatic devices, tramp iron, such as railroad spikes, pieces of gears and conveyors, nuts and bolts, lost tools and fragments of drill bits, came in for violent dislike.

Although coal preparation by cleaning and sizing has grown in all larger areas of coal mining, the strip mine operator in particular has been a leader in coal cleaning and sizing. By 1928, more than half of the strip-mine coal in the United States was marketed in prepared sizes or as screenings. In 1947, in Missouri nearly two-thirds (63 per cent) of the coal mined was washed and much of it was sized. All larger mines in Missouri maintain modern and highly efficient washing plants equipped with classifiers. In addition, many smaller producers crush, grade, and hand-pick their product.

COSTS OF PRODUCTION

Missouri coal competes on the market with that mined in all of the states which border it excepting Nebraska. The coal mining industry can flourish only as it meets competition from outside sources through relatively low mining costs and proximity to market. Chief competitors of Missouri are Illinois, Iowa, Kansas, Oklahoma, Arkansas, and the Applachian region of which the chief contributors to Missouri coal supplies are West Virginia and eastern Kentucky. Cost of production is the most important factor in the amount of coal produced in Missouri, if transportation costs are not considered. Costs of mining in Missouri compare favorably with those of other areas whose product competes with Missouri coal. In Table 1 the dollar values per ton of coal and the number of tons produced per day are presented for those

areas which are the chief competitors with the coal industry of Missouri. These data indicate that Missouri coal is mined at costs which compare favorably with its nearest producing neighbors, Kansas and Illinois, and that costs are conspicuously less than those of Iowa and Oklahoma.

TABLE 1

Value per ton and tons per man in Missouri and competitive fields in 1946.[23, 24]

State	Value per ton			Tons per man per day		
	High	Low	Average	High	Low	Average
Iowa	$5.51	$3.04	$3.69	7.18	1.87	4.55
Kansas	5.06	2.71	2.78	12.91	.69	8.16
Oklahoma	5.73	2.90	3.75	13.75	2.75	6.53
Missouri	5.73	2.20	2.79	19.96	1.55	9.64
Illinois	5.69	2.12	2.61	18.17	1.55	9.03

Although the table indicates that average cost of production in Missouri is somewhat greater than that of Illinois, yet Bates County ($2.63 per ton), Macon County ($2.60 per ton) and Henry County ($2.63 per ton) mine coal at somewhat less or only slightly greater costs than the Illinois average.

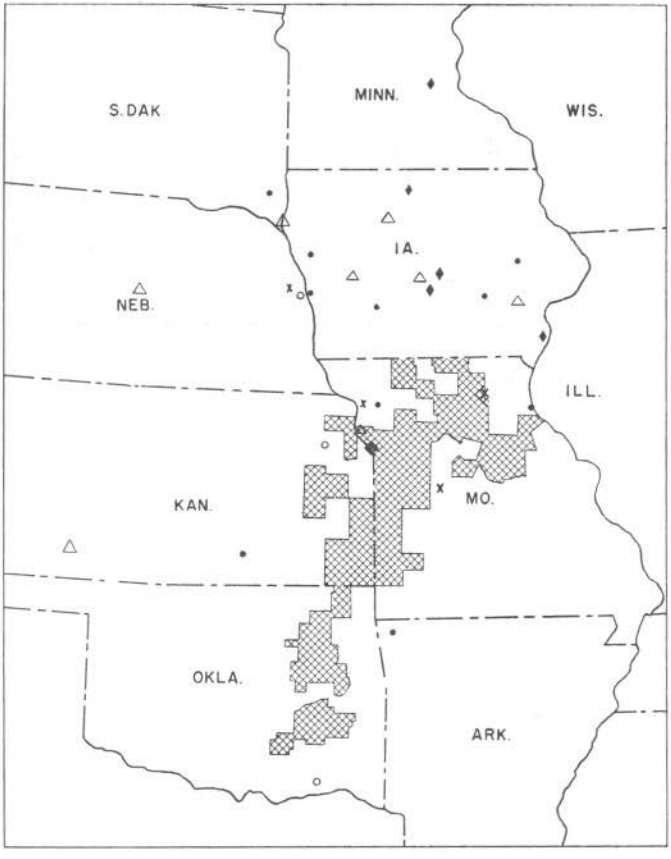
PROXIMITY TO MARKETS

Proximity to markets is not only one of the controlling factors in coal production but is the most important factor in Missouri. Centers of coal mining are in western and northern Missouri. Industrial centers of Missouri are St. Louis, Kansas City and St. Joseph, Joplin, Springfield and Sedalia. St. Louis is considerably nearer the coal mining areas of Southern Illinois than to the producing areas of Northern Missouri. Joplin is nearer the Kansas fields and Springfield is about equidistant from producing areas in Kansas and Missouri. Kansas City, St. Joseph, and Sedalia are nearer Missouri mining areas than to either Kansas or Illinois fields. Kansas City is the industrial heart of the Missouri coal mining industry. Most of the coal consumed northwest of a line drawn from Moberly in Randolph County through Lamar in Barton County is mined in Kansas and Missouri, and Missouri contributes an increasingly greater share toward the north. Missouri coal, supplemented by Kansas coal, competes successfully with Iowa mined coal, particularly in Omaha and Des Moines, Figure 6.

[23]Data from U. S. Bureau of Mines, Bituminous coal and lignite in 1946, Mineral Market Report, M. M. S. no. 1558, Dec. 22, 1947.

[24]Arkansas production is omitted because Arkansas coal differs in rank from other competitive coals.

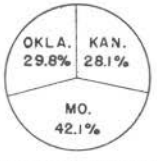
MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE 6



DISTRIBUTION OF COAL MINED IN THE 15th PRODUCTION DISTRICT*

15th PRODUCTION DISTRICT

	TONS
◆	1,000,000 — 1,500,000
○	500,000 — 1,000,000
x	100,000 — 500,000
△	25,000 — 100,000
•	5,000 — 25,000
♦	1,000 — 5,000

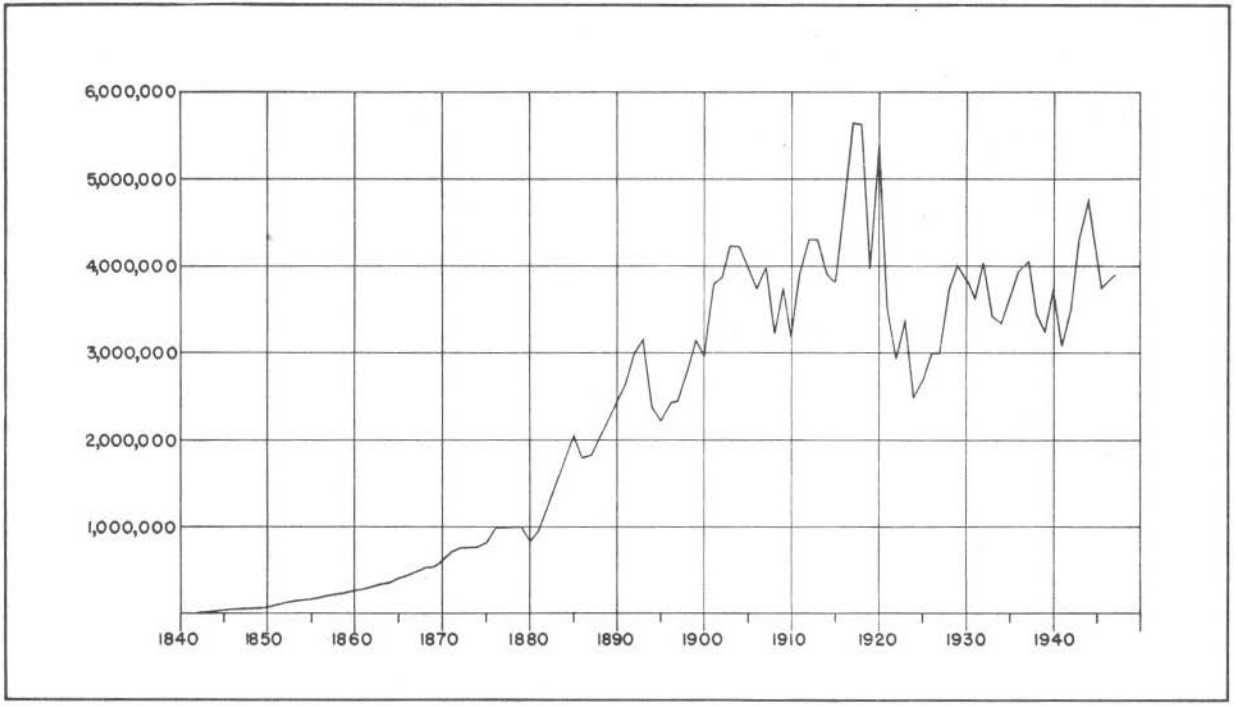


PER CENT MINED IN EACH STATE IN 1946

*SHIPMENTS OF LESS THAN 5,000 TONS REACHED WESTERN NORTH AND SOUTH DAKOTA, WESTERN MINNESOTA, NORTHWEST TEXAS AND NEW ORLEANS

DISTRIBUTION DATA FROM U.S. BUR. MINES, MINERAL MARKET REPT., M.M.S. NO. 1559 AND M.M.R. NO. 1558

MISSOURI COAL PRODUCTION IN TONS
1840-1947



HISTORY OF COAL PRODUCTION IN MISSOURI

Coal has been produced continuously in Missouri since before 1840, and records of the amounts of coal mined have been kept since that year.[25] From the time of earliest records in 1840 and through 1947, a total of 245,772,358 tons of coal have been mined, an average of 2,275,670 tons per year over a period of 108 years. In 1840 a tonnage of 9,972 was mined, and a decade later production had increased more than tenfold to 100,000 tons. By 1876 more than 1,000,000 tons of coal were mined and, except for the year 1880, more than that amount has been mined annually. Except for the year 1886, more than 2,000,000 tons have been mined yearly since 1882, and except for four years, more than 3,000,000 tons have been mined annually since 1899. During 1917, 1918, and 1919 more than 5,000,000 tons were mined each year.

A graph of coal production in Missouri, Figure 7, shows a gradual rise in production from 1840 to 1882 and a rapid rise by the coal mining industry from 1882 to 1893, interrupted in 1886 by loss of production from the "Great Strike." The upward trend in tonnage mined was seriously retarded by a depression in 1894 and 1895, but was followed by a renewal of mining activity which culminated in the high production of 1903 and 1904 to which added impetus was given by an anthracite strike in Pennsylvania. A slight decrease in the upward trend was occasioned by a sympathy strike of miners in Missouri with those of Indian Territory in 1900. From 1904 until 1915 tonnage mined was relatively high, but was erratic from year to year. A rapid rise in the amount of coal mined occurred after the beginning of World War I and culminated in the all-time record of coal mined in Missouri in 1917, almost equalled by production in 1918. Post-war readjustment resulted in a period of rapid decline in annual tonnage mined to the low of 1923, the most serious recession in Missouri coal mining history since the depression of 1904. Recovery does not appear to have been completed until 1928, eight years after the downward trend had begun. The depression of the early 30's caused a definite decrease in coal production in Missouri but it was probably less serious than in many other coal producing areas. A sharp business recession of 1938 is likewise reflected in a drop in coal production in 1938-39. A strike in 1941 cut production seriously. Activity due to World War II again brought coal production to a peak in 1944, the highest since 1920. Post-war readjustment appears to be the cause of a pronounced drop in production in 1945 but from which recovery to normal has been made in 1946 and 1947.

In summary, three periods of coal mining history may be noted: first, an initial stage of relatively small production with a gradual rate of increase in production which began before 1840 and appears to have continued nearly to 1880; second, one of rapid expansion which continued with significant

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[25]Reports of State Mine Inspector 1889-1946 inclusive. Mineral Resources U. S. for 1910, U. S. Geol. Survey, p. 154, 1911.

interruptions from 1881 to about 1900; third, one of relative stabilization which has continued with fluctuations common in coal mining from 1900 to the present.

COUNTY PRODUCTION

Coal, because of its wide geographic distribution in Missouri, has been mined in at least 55 counties. Before 1889, when compilation of complete statistics on county production was begun by the State Mine Inspector, several counties were mining important amounts of coal. In 1882 Bates, Putnam, Macon, and Randolph counties mined more than 100,000 tons each and Henry County mined 76,000 tons. Bates County produced 1,040,000 tons of coal in 1882 and Macon County 507,578 tons in 1884. By 1887, Bates, Macon, Lafayette, Randolph, Ray, Henry, Barton, and Putnam counties were mining more than 100,000 tons each per year, and Audrain, Caldwell, Carroll, Cooper, Grundy, Johnson, and Vernon counties were producing important amounts.

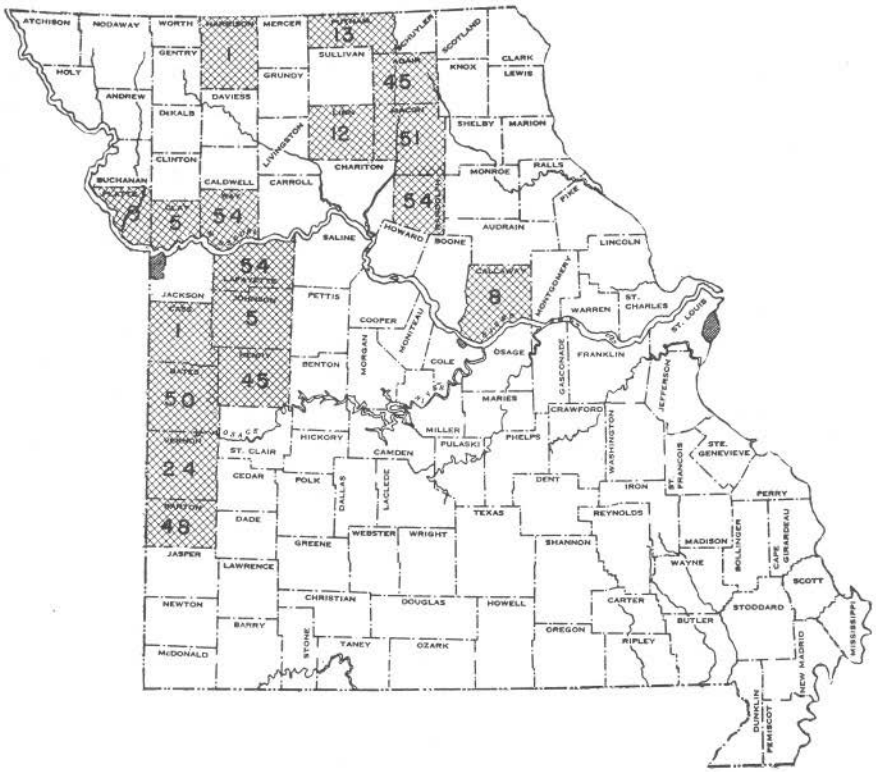
From 1889 to 1946, seventeen counties have mined more than 100,000 tons of coal per year. These counties and the number of years of production of more than 100,000 tons are indicated on the accompanying map, Figure 8. Two counties, Lafayette and Ray, have each mined more than 100,000 tons annually 54 out of 57 years, and Randolph has mined more than that amount for each of 53 years. Macon County has a half century of coal production above the 100,000-ton level annually, and Bates and Barton counties closely approach this record.

Counties which have ranked highest in annual coal production during the years 1889-1946 are shown graphically, Figure 9, and all counties which have in any year ranked first or second in coal production in Missouri are also shown. These include Adair, Barton, Bates, Henry, Lafayette, Macon, Randolph, Ray, and Vernon counties. Five counties, Macon, Barton, Bates, Lafayette, and Henry, have been of first rank in coal production. Macon County has been first in coal production during 23 production years. Barton County has been a leading Missouri producer 13 years and Bates 12 years.

In several counties more than 500,000 tons of coal have been mined annually. Macon County produced more than 500,000 tons of coal in each of 31 years. Barton and Lafayette counties have produced more than a half million tons during 21 years. Other counties which annually have produced more than that amount are Bates, Adair, Henry, Randolph and Ray. More than 1,000,000 tons of coal were mined in a year by each of Barton, Macon, and Bates counties. Barton County annually produced more than 1,000,000 tons of coal in 1926, 1927, 1928, 1929, 1930, 1931, and 1932. In Macon County more than 1,000,000 tons were mined in 1901, 1902, 1903, and 1907. During each of two years, 1944 and 1945, Bates County has produced more than 1,000,000 tons of coal.

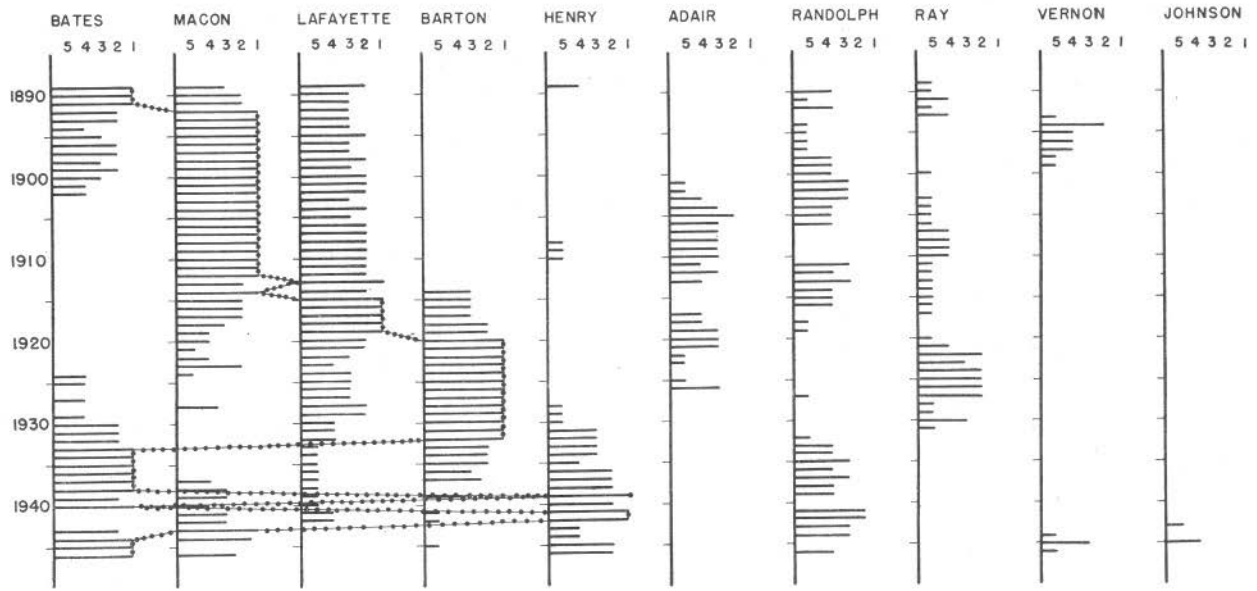
MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE 8

COUNTIES WHICH HAVE PRODUCED MORE THAN
100,000 TONS OF COAL IN ONE YEAR
1889–1947 INCLUSIVE



NUMBER OF YEARS IN WHICH 100,000 TONS OR
MORE WERE MINED SHOWN BY NUMBERS

YEARLY RANK OF LEADING COAL PRODUCING COUNTIES IN MISSOURI*

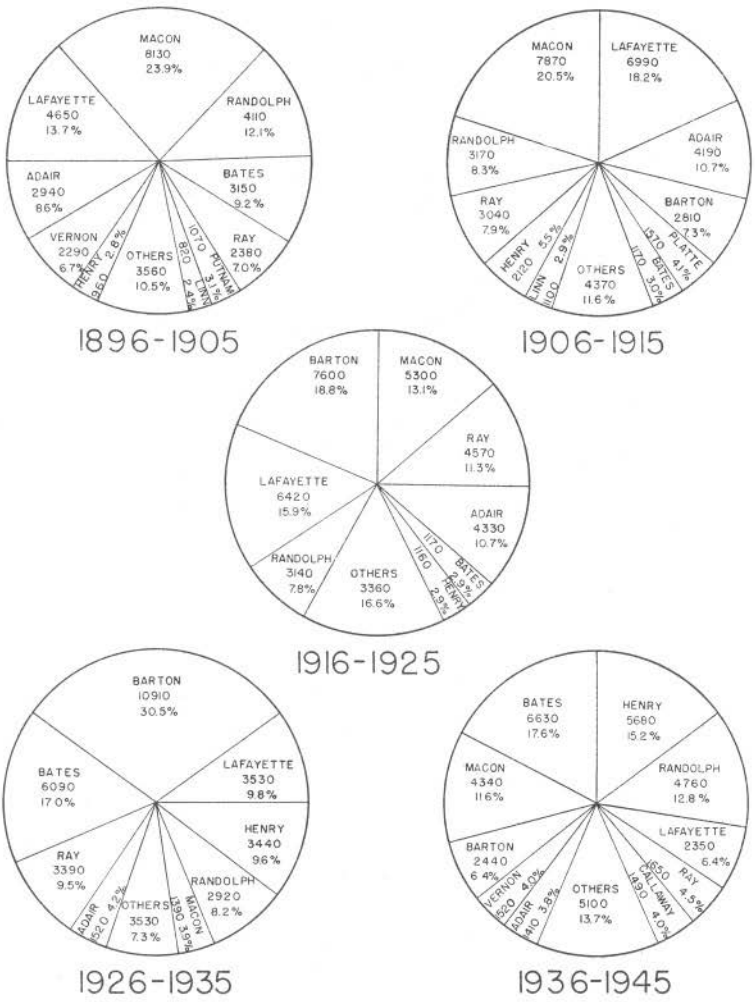


•••LEADING COUNTY FOR EACH YEAR

NOS. 1-5 INDICATE RELATIVE POSITION OF COUNTY AMONG THE FIVE LEADING COUNTIES

*PLATTE COUNTY RANKED FIFTH IN 1907

MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE 10



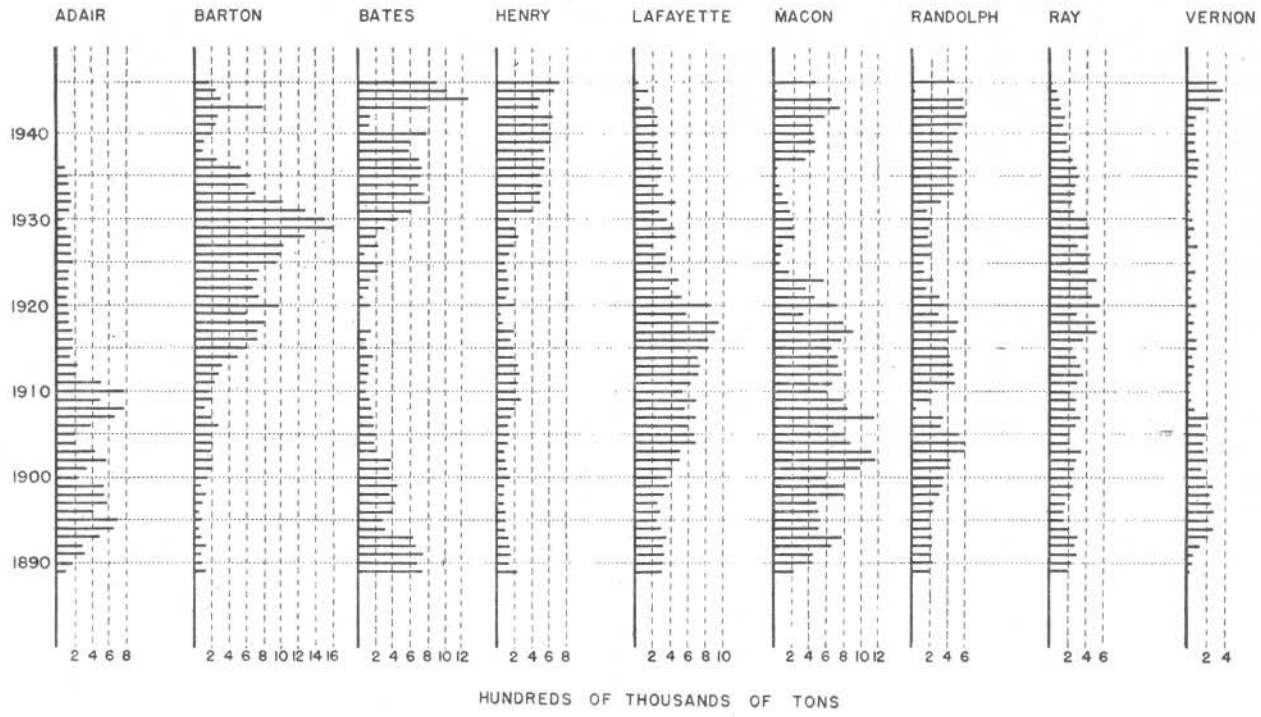
COAL PRODUCTION IN MISSOURI

IN THOUSANDS OF TONS

AND

PERCENT OF TOTAL

COUNTY COAL PRODUCTION OF LEADING COUNTIES



The coal production of important counties is shown graphically in Figure 11. It has also been summarized by decades, Figure 10, and is indicated in thousands of tons produced and the per cent contributed to total Missouri production during a ten-year period. Complete statistics of coal production for each county as recorded by the State Mine Inspectors from 1889 through 1947 are included in the Appendix at the end of this report. Although coal has been mined in 55 Missouri counties, three or four counties have yielded fully half of the coal in any decade and seven or eight counties have yielded three quarters of the total in a like period. From 1896-1905 northeast Missouri, including Macon, Randolph, Adair, Putnam, and Linn counties, produced half of the Missouri coal (50.1 per cent); northwestern Missouri, including Lafayette and Ray, produced more than one-fifth (20.7 per cent); and western Missouri including Bates, Vernon, and Henry counties produced nearly another fifth (18.7 per cent). In the next decade (1906-1915) northeastern Missouri produced considerably less than half of Missouri coal (42.4 per cent); northwestern Missouri, Lafayette and Ray counties with the addition of Platte County, produced nearly one-third of the total (30.2 per cent), a significant advance over the preceding decade. The advent of Platte County as an important producer is of interest, as coal mined in Missouri was brought up through shafts at Leavenworth, Kansas. Western Missouri, Barton, Henry, and Bates, maintained approximately the position of the preceding decade (1896-1905) with about two per cent less than previously (15.8 per cent of total State production). During the period of 1916-1925, northeastern Missouri mined less than one-third (31.6 per cent) of the total; northwestern Missouri dropped considerably, because of decreased production and the eventual cessation of mining of Missouri coal at Leavenworth, Kansas. Western Missouri mines became increasingly important, however, and with Barton County as leader, produced nearly one-fourth of the coal mined (24.6 per cent). In the decade of 1926-1935 western Missouri counties produced considerably over half of the total (57.1 per cent); in fact, Barton County alone mined almost as large a percentage (30.5 per cent) as northeastern Missouri in the preceding decade. Both northwestern and northeastern Missouri counties decreased in production of coal, northwestern Missouri producing 19.3 per cent and northeastern Missouri 16.3 per cent. Strikes following World War I, abandonment of mines, and changes in mining methods contributed to these pronounced shifts in areas of production. The decade of 1936-1945 shows further shifts in areas of production. Western Missouri counties mined considerably less than half the total (43.2 per cent); northeastern Missouri counties, Macon, Randolph, Adair, with the addition of Callaway County, produced nearly one-third (32.2 per cent) of the total; the important northwestern counties, Lafayette and Ray, produced little more than one tenth (10.9 per cent) of the total.

TABLE 2

Bituminous Coal and Lignite Consumption and Use in States Utilizing Missouri Coal*

State	Use				Total
	Industrial	Retail yards	By-product and water gas	Smithing	
Iowa	2,868,917	3,910,458	43,623	2,627	6,825,625
Kansas	590,016	848,676	.....	1,626	1,440,318
Minnesota	2,294,860	2,469,220	413,823	7,081	5,184,984
Missouri	2,728,097	3,645,562	324,257	7,303	6,705,219
Nebraska	574,045	1,240,800	.....	1,651	1,816,496
North Dakota	853,755	1,083,875	.....	961	1,938,591
South Dakota	355,530	550,558	1,097	1,026	908,211
Totals	10,265,220	13,749,149	782,800	22,275	24,819,444

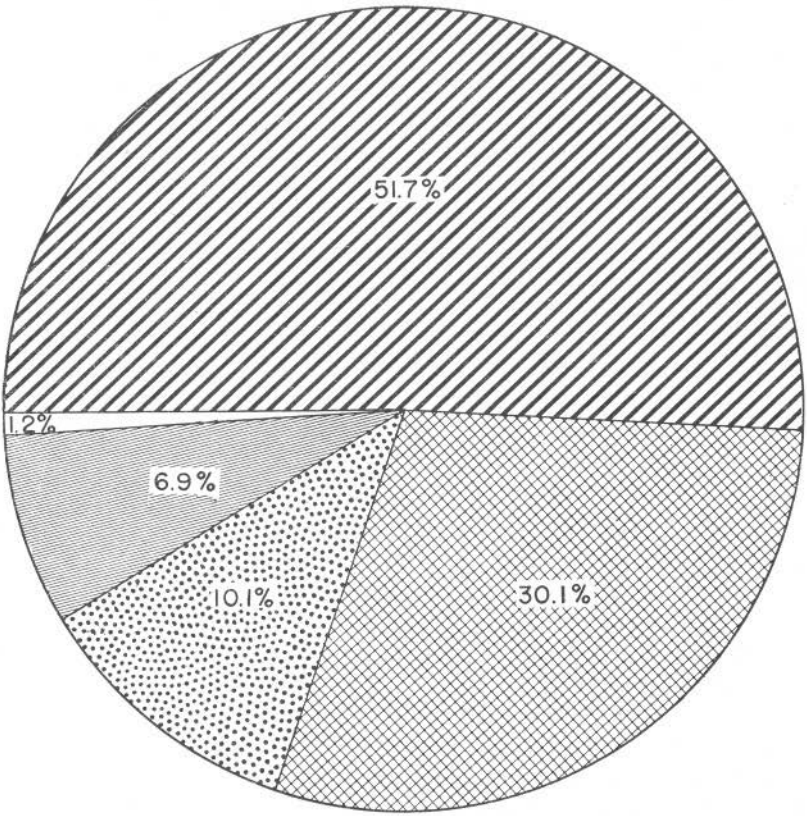
*For the year ending September 1946; Data from U. S. Bur. Mineral Market Report, M. M. S. no. 1557, Jan. 1948.

COAL CONSUMPTION IN MISSOURI

Missouri is a leading consumer of coal when compared with other west north central states (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) (Table 2). Iowa, Minnesota, and Missouri use more than two-thirds of the total consumed, regardless of source. More than half of the total consumed passes through retail yards. In the year ending September 30, 1946, 57.2 per cent of the consumption (data from Table 2) in Missouri was distributed through retail yards and 42.8 per cent was used for industrial purposes. A large but undetermined portion of the industrial coal was used for generation of power. Missouri and Minnesota each uses considerable amounts annually to produce water gas and by-products (Table 2).

Missouri mines much less bituminous coal than is consumed within the State, Figure 12. Although 6,705,219 tons were consumed in the State in the year ending September 30, 1946, less than half that quantity (3,185,929 tons) was mined in Missouri in 1946. Geographic factors, particularly the sources in relation to markets, permit competition from other fields to eliminate Missouri coal from the eastern and southeastern markets. Increased consumption of Missouri-mined coal can be accomplished only by lowering costs of production so that competition from other sources can be met.

MISSOURI GEOLOGICAL SURVEY I.C. No. 3 FIGURE 12



SOURCE OF COAL CONSUMED
IN MISSOURI
(During year ending September 30, 1946)*

- Illinois, excluding east. Illinois
- 15th Production Dist. (Mo. Kans. Okla.)
- East. Pennsylvania, west. Virginia, east. Kentucky & Alabama
- Arkansas
- Others, west. Ky, east Ill., Ind., Ia., Wyo., Colo.

Data from U.S. Bur. Mines, Mineral Market Rept. M.M.S. NO. 1557, Table I, 1946

COMPETITION OF OTHER FUELS AND OTHER SOURCES OF ENERGY

Missouri coal must compete with petroleum products, natural gas, and hydroelectric power. During recent years there has been a pronounced trend toward oil and gas consumption, both industrially and domestically. Since 1945 the conversion to oil-burning furnaces from coal-burning devices has been prevalent. In the United States, electric power utilities used four per cent less bituminous coal and 79 per cent more fuel oil in 1946 than in 1945.[26] Railroads have made increasing use of diesel-powered locomotives during recent years. Although factory sales of domestic stokers for burning bituminous coal nearly doubled in 1946 over 1945, shipments of domestic oil burners, boiler-burner units, and furnace-burner units more than tripled during the same time.

The effect of the proximity of gas and oil fields of Kansas and Oklahoma to the coal fields is to drive Oklahoma and Kansas coal farther north from the areas of gas recovery, where the coal, as well as the oil and gas, further competes with the Missouri coal. Thus Kansas in 1946 mined 2,493,388 tons of coal,[27] but only 1,080,738 tons[28] from all of Production District 15, which includes Oklahoma, Kansas and Missouri, were used in Kansas during the year ending September 1946. Likewise Oklahoma used only 336,949 tons of coal from Production District 15 during the year ending September 1946, but mined 2,647,380 tons of bituminous coal in that year.

TECHNOLOGY AND ECONOMIES AND THEIR EFFECTS ON COAL CONSUMPTION

The efficiency of coal as a fuel has steadily increased. In 1899 a kilowatt-hour of electricity required about 7.05 pounds of coal, whereas in 1919, 3.2 pounds and in 1945 only 1.3 pounds were required. In 1945 one pound of coal produced the same amount of electricity as did 5.4 pounds in 1899.[29] One hundred and seventy pounds of coal were required to move 1000 tons a mile by railway in 1919-20, but in 1945 only 116 pounds were required to perform the same work with an increased efficiency of 31.8 per cent.[30] A passenger train car required 18.5 pounds of coal to move it one mile in 1919-20, whereas 14.9 pounds were required in 1945, an increased efficiency of 19.5 per cent.[31]

Research is being currently conducted by various agencies to increase further not only the efficiency of coal in various devices as stoves, furnaces, locomotives and power plants, but to reduce and eliminate smoke and otherwise increase cleanliness in the use of coal. Smokeless, coal-burning, hand-

[26]U. S. Bur. Mines, Mineral Market Report, M. M. S. no. 1558, Dec. 22, 1947.

[27]Bituminous coal and lignite in 1946. U. S. Bur. Mines, M. M. S. no. 1558, 1947.

[28]Bituminous coal distribution year ended Sept. 30, 1946. U. S. Bur. Mines, M. M. S. no. 1557, Jan. 1948.

[29]U. S. Bur. Mines, Minerals Yearbook, pp. 842-844, 1945.

[30]U. S. Bur. Mines, Minerals Yearbook, p. 842, 1945.

[31]U. S. Bur. Mines, Minerals Yearbook, p. 842, 1945.

fired stoves, furnaces, boilers, water heaters, and cooking ranges have been perfected. Study of the use of pulverized coal for gas-turbine locomotives has reached an advanced stage, and gas-turbine locomotives have been developed. Stokers of improved performance for domestic use, which will use coals not suitable for use in stokers of current design, are being developed.[32] Studies for control of fly ash are being made. Ash removal in domestic stokers is being investigated by various agencies.

In addition, new fields of utilization of coal in the United States are being opened by intensive research and experimentation in the production of gas and liquid fuels. After a study of more than two hundred proposed sites, the government-owned synthetic-ammonia plant at Louisiana, Missouri, has been taken over by the United States Bureau of Mines as a demonstration plant to be used in development of processes leading to commercial production of oil and gasoline from coal.

FUTURE OF MISSOURI COAL

Coal is the great reservoir of reserve power and energy in the United States. Large reserves remain in Missouri. It has been mined in important amounts for well over a century. Since the beginning of the century, in spite of great increases in the use of gas, oil and power from hydroelectric sources, and despite increased competition of coal from other fields, coal mining has been as stabilized in Missouri as the industry has been elsewhere. Other sources of energy have been additions to that from Missouri coal, rather than replacements of heat and energy previously derived from coal. In order to maintain this relative stability, and to meet competition, areas of production among Missouri fields have shifted gradually from one area to another. Mining methods in stripping operations have kept pace with competition.

The duration of the practice of strip mining methods may be prolonged by improvement of techniques, possibly the increased use of draglines and shovels of greater depth capacity. To what extent stripping ratios can be increased in areas where thick coals are under deep overburden cannot be stated. Discoveries of new areas are to be expected. Finding of areas where two relatively thin coal beds lie sufficiently close together to be mined in one operation may permit successful tandem operations. Few undeveloped areas are known, however, and removing increased depths of overburden and development of new areas will delay but not prevent the exhaustion of coal areas which can be stripped.

If underground mining methods are eventually to supply markets with Missouri coal at rates commensurate with those of the past, they can do so only by adopting the most advanced methods of underground mining, underground loading, and development of preparation plants, because Missouri coal competes with fields from which thicker coal is and will be mined, loaded, and prepared by the most advanced modern methods.

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[32]Sherman, R. A., Combustion research at Battelle: Ohio State University, Experiment Station News, pp. 29-32, April, 1948.

APPENDIX I

COAL PRODUCTION OF MISSOURI (1889-1947) BY COUNTIES[1]

[1]Data from State Mine Inspector's Reports, except as noted.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Adair	Audrain	Barton	Bates	Benton
1889	16,522	22,298	122,664	729,633	.....
1890	14,840	22,813	65,097	671,373	.....
1891	16,110	19,569	63,626	726,273	.....
1892	14,820	29,792	108,784	659,924	.....
1893	20,957	42,262	61,301	627,514	.....
1894	20,744	43,910	55,767	291,271	.....
1895	24,540	40,918	76,242	252,231	.....
1896	23,510	37,511	37,570	375,300	.....
1897	27,078	35,167	70,554	410,304	.....
1898	62,215	36,498	104,233	343,878	.....
1899	104,868	40,759	67,844	441,983	.....
1900	181,577	43,530	141,520	363,577	.....
1901	347,047	44,066	183,983	347,047	.....
1902	312,403	33,435	200,433	359,061	.....
1903	516,267	39,009	185,257	176,877	.....
1904	658,558	42,578	199,973	152,495	.....
1905	708,388	52,434	196,175	178,246	3,700
1906	428,037	39,940	267,344	160,014	3,297
1907	584,371	25,463	191,106	166,512	3,106
1908	568,446	31,391	103,765	136,531	.....
1909	564,328	33,336	217,001	117,674	.....
1910	250,230	34,546	161,228	69,600	.....
1911	352,486	25,003	207,830	79,140	.....
1912	590,234	26,188	273,670	106,379	.....
1913	426,490	10,630	308,891	103,115	.....
1914	216,622	11,611	493,970	151,946	.....
1915	211,126	12,971	591,680	80,868	.....
1916	328,528	7,660	721,707	66,692	.....
1917	682,004	31,402	726,987	116,285	.....
1918	789,034	12,117	817,975	40,896	.....
1919	511,878	12,515	588,332	14,074	.....
1920[a]	777,986	18,626	965,757	115,621	.....
1921[a]	527,804	10,538	726,347	39,690	.....
1922[a]	221,703	17,526	658,092	147,047	.....
1923[a]	251,783	15,959	704,090	119,934	.....
1924[a]	154,295	16,920	739,854	207,847	.....
1925[a]	188,828	22,300[b]	947,844	263,710	.....
1926	194,647	9,751	1,120,048	67,050	.....
1927	182,485	11,375	1,132,539	206,915	.....
1928	144,244	6,348	1,265,881	190,555	.....
1929	148,498	9,215	1,594,245	272,249	.....
1930	137,949	7,478	1,495,563	429,212	280
1931	110,912	6,131	1,273,399	596,995	20
1932	139,950	4,861	1,126,432	812,464	.....
1933	136,814	8,059	688,668	741,807	.....
1934	148,105	5,227	591,289	680,348	.....
1935	182,885	4,441	640,727	701,220	.....
1936	162,143	3,293	526,636	724,151	.....
1937	163,787	3,178	269,700	684,251	.....
1938	159,069	145	92,805	586,747	5,200
1939	100,500	.....	80,062	587,369	.....
1940	71,151	1,416	174,951	797,426	.....
1941	136,471	3,243	232,485	114,286	.....
1942	167,063	1,424	257,497	134,561	.....
1943	171,848	1,571	253,018	733,676	.....
1944	147,390	.....	309,962	1,260,889	.....
1945	129,482	.....	242,910	1,005,661	.....
1946	96,333	.....	171,674	897,619	.....
1947	105,455	.....	472,274	671,602	.....
	14,833,838	1,130,347	26,367,258	22,307,615	15,603

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[b]Includes Ralls County.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Boone	Caldwell	Callaway	Carroll	Cass
1889	9,944	26,074	12,633	.....	.....
1890	21,302	17,074	18,355	.....	.....
1891	23,577	22,661	15,581	.....	.....
1892	21,058	38,333	16,551	1,380	.....
1893	25,602	29,020	23,961	1,088	.....
1894	19,038	22,869	23,223	920	.....
1895	21,090	17,876	16,771	2,664	.....
1896	20,428	19,780	22,182	2,304	1,000
1897	14,127	20,000	20,152	2,225	1,206
1898	16,780	23,000	21,281	803	1,558
1899	29,665	28,000	22,356	2,397	1,321
1900	19,179	26,000	15,120	1,575	2,745
1901	21,549	19,021	21,562	1,430	.....
1902	23,609	11,853	24,483	1,985	1,350
1903	22,216	11,485	28,882	1,570	3,316
1904	35,865	11,866	19,754	604	4,173
1905	39,152	15,000	37,645	164	1,882
1906	28,132	11,419	39,660	717	3,422
1907	35,495	11,656	34,748	4,850	3,400
1908	26,842	10,800	50,719	1,581	5,340
1909	19,726	7,815	32,491	1,210	7,500
1910	18,651	7,300	34,278	560	9,938
1911	19,288	3,130	34,054	332	9,971
1912	19,436	2,267	23,480	160	.....
1913	18,214	4,200	48,821	144	.....
1914	17,380	1,821	40,694	660	500
1915	13,595	982	28,926	690	.....
1916	10,467	.....	35,227	173	.....
1917	22,155	.....	54,432	64	.....
1918	25,419	.....	45,738	.....	.....
1919	17,406	1,636	44,861	.....	.....
1920[a]	18,950[c]	86,617[d]	58,462	.....	.....
1921[a]	16,128[c]	91,646[d]	32,191	.....	.....
1922[a]	13,557[c]	88,113[d]	41,255	.....	.....
1923[a]	12,200[c]	95,292[d]	26,602	.....	.....
1924[a]	19,338[c]	99,625[d]	.....	.....	.....
1925[a]	15,527[c]	.....	28,389	.....	.....
1926	22,187	1,103	30,501	.....	.....
1927	24,471	2,127	28,250	.....	.....
1928	39,103	1,800	34,893	.....	.....
1929	48,335	2,413	34,813	.....	.....
1930	39,875	2,298	25,388	.....	.....
1931	32,257	1,100	25,530	.....	.....
1932	52,401	3,053	27,606	125	.....
1933	47,282	1,769	41,872	1,265	.....
1934	53,676	120	31,399	.....	.....
1935	42,275	670	40,200	488	.....
1936	34,603	.....	53,320	.....	.....
1937	28,471	.....	87,602	.....	.....
1938	13,930	342	110,867	.....	.....
1939	12,438	.....	134,287	.....	.....
1940	17,327	.....	151,895	.....	.....
1941	18,642	.....	160,230	727	.....
1942	33,458	.....	192,518	2,255	.....
1943	55,879	.....	210,171	250	.....
1944	43,053	.....	199,764	.....	.....
1945	51,410	.....	189,413	62	.....
1946	45,586	.....	170,160	.....	.....
1947	58,414	.....	165,888	.....	.....
	1,587,160	901,026	3,242,087	37,422	58,622

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[c]Includes Chariton and Moniteau counties.
[d]Includes Clay, Platte, and Dade counties except Dade not included in 1920.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Cedar	Chariton	Clark	Clay	Clinton
1889					
1890		120		5,036	
1891	1,264	1,170		8,289	
1892	4,181	2,312			
1893	890	1,136		7,139	
1894	730	185		19,371	
1895	1,590	1,859		4,000	
1896	1,863	355		6,500	
1897	2,178	1,573		9,000	
1898	1,244	3,488		1,500	
1899	2,116	4,517		8,000	
1900	1,095	2,940		12,800	
1901	1,730	1,447		16,681	
1902	3,107	2,025		8,052	
1903	1,554	956		18,000	
1904	330	625		32,400	
1905	408	10,651		34,317	
1906		29,044		42,002	
1907		36,474		40,590	
1908	165	879		37,786	
1909		1,007		44,500	
1910	185	925		22,994	
1911		400		41,770	
1912		2,640		27,826	
1913		5,641		22,990	
1914		4,464		22,093	
1915		3,472		17,498	
1916		2,100		24,021	
1917		22,000		29,094	
1918		22,250		22,042	
1919		2,473		12,835	3,063
1920[a]		[g]		[h]	
1921[a]		[g]		[h]	
1922[a]		[g]		[h]	
1923[a]		[g]		[h]	
1924[a]		[g]		[h]	
1925[a]		[g]		[h]	
1926		8,546		69,314	
1927	1,006	7,721		58,435	
1928	462	7,665		49,484	
1929	2,500	5,125		75,091	
1930	255	4,785		77,255	
1931	600	4,846		78,989	
1932		1,360		70,264	
1933		1,110		87,617	
1934	958	1,133		72,109	
1935	673	2,010		95,560	
1936	511	1,110		115,791	
1937	68	1,405		102,716	
1938	85	1,000	490	81,928	
1939		1,644	6,324	96,204	
1940	264	5,928	7,860	146,271	
1941	469	5,442		141,560	
1942	403	4,857		133,630	
1943	365	970	1,496	71,742	
1944	441	618	913	63,852	
1945	372	570		39,892	
1946	32			16,239	
1947		230		11,699	
	34,094	237,203	17,083	2,354,768	3,063

[a] Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[g] Included with Boone County.
[h] Included with Caldwell County.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Cole	Cooper	Crawford	Dade	Daviess
1889		1,027		2,290	
1890		1,594		1,400	
1891	2,000	2,200		3,402	
1892	1,548	3,666		6,881	
1893	1,200	2,892		6,695	
1894	2,000	2,639		2,327	
1895	1,120	2,492		5,066	
1896		750		4,570	
1897	3,794	250		2,980	
1898	3,704	514		4,495	
1899	8,600	320		4,930	
1900		1,000		2,350	
1901	2,280	1,265		5,393	
1902	1,045	945		5,180	
1903	1,440	315		8,260	
1904	1,600	500		2,286	
1905	5,080			1,646	
1906	2,720			2,151	
1907	2,401			1,912	
1908	500			4,654	
1909	2,466			5,592	
1910	3,100		7,231	4,436	
1911	3,650			5,650	
1912	3,925			5,000	
1913	2,942			5,750	
1914	1,400			4,080	
1915				4,001	
1916				5,760	
1917				5,348	
1918		2,303		3,651	
1919		607		3,317	
1920[a]		29,300[c]		6,342	
1921[a]		4,514[c]		[b]	
1922[a]				[b]	
1923[a]				[b]	
1924[a]				[b]	
1925[a]				[b]	
1926					
1927		80			
1928		76			
1929		160		2,500	
1930				1,220	
1931				790	
1932				470	
1933		364		3,417	
1934		136		2,251	132
1935		17		6,660	
1936	11			4,135	7,264
1937	326	224		5,219	16,316
1938	366			4,101	14,373
1939	242			4,940	17,878
1940	112			8,286	21,897
1941	1,262			9,017	20,000
1942				12,339	20,538
1943				10,698	13,916
1944				8,636	10,226
1945				7,484	
1946				8,102	7,873
1947				8,078	7,566
	60,834	60,150	7,231	246,138	157,979

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[c]Includes Howard, Moniteau, Morgan, and Pettis counties.
[b]Included with Caldwell County.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Franklin	Grundy	Harrison	Henry	Howard
1889	.....	18,000	.....	210,376	.....
1890	.....	23,593	.....	127,281	4,000
1891	.....	28,983	.....	144,139	.....
1892	.....	28,670	.....	137,258	.....
1893	.....	35,770	.....	125,962	.....
1894	.....	35,000	.....	84,473	.....
1895	.....	37,200	.....	99,058	3,460
1896	.....	41,000	.....	78,551	3,220
1897	.....	35,402	.....	76,023	2,240
1898	.....	39,974	.....	68,261	.....
1899	.....	39,633	.....	81,373	456
1900	.....	42,371	.....	129,902	2,944
1901	.....	42,361	.....	103,267	3,685
1902	.....	34,936	.....	91,612	4,350
1903	.....	25,563	.....	87,203	9,051
1904	.....	13,647	.....	113,987	2,694
1905	.....	500	.....	132,619	11,954
1906	.....	7,990	.....	122,718	14,949
1907	.....	11,040	.....	166,928	13,456
1908	.....	10,822	.....	216,152	7,438
1909	.....	9,869	.....	279,754	611
1910	.....	12,640	4,700	209,528	644
1911	.....	7,020	32,810	243,691	240
1912	.....	10,000	93,140	267,088	100
1913	.....	10,000	149,108	245,671	.....
1914	.....	10,000	91,139	189,274	8,000
1915	.....	10,000	89,472	180,470	.....
1916	.....	10,542	73,259	148,946	.....
1917	.....	12,948	78,746	197,957	458
1918	.....	11,643	67,755	56,470	.....
1919	.....	8,419	23,308	47,487	.....
1920[a]	.....	23,080[f]	[i]	203,200	[i]
1921[a]	.....	11,654[f]	[i]	95,279	[i]
1922[a]	.....	31,259[f]	[i]	115,374	[i]
1923[a]	.....	12,210[f]	[i]	115,094	[i]
1924[a]	.....	10,191[f]	[i]	111,731	[i]
1925[a]	.....	11,565[f]	[i]	66,458	[i]
1926	.....	6,000	5,937	125,159	.....
1927	.....	5,631	5,846	180,133	53,998
1928	.....	5,970	5,200	238,275	67,344
1929	250	5,281	5,491	255,526	.....
1930	.....	5,800	4,812	231,421	1,647
1931	600	4,050	7,361	406,775	1,950
1932	.....	5,055	5,677	489,131	1,200
1933	.....	4,861	3,560	496,608	4,700
1934	.....	6,323	4,354	510,947	4,001
1935	.....	7,416	11,753	506,458	2,639
1936	.....	6,267	14,015	547,326	3,865
1937	.....	6,244	16,488	552,999	2,136
1938	.....	3,880	12,575	525,787	662
1939	.....	4,000	22,907	613,266	4,588
1940	.....	3,887	23,710	619,130	10,358
1941	.....	3,485	22,426	584,441	838
1942	.....	3,005	20,693	628,190	168
1943	.....	916	12,969	458,020	185
1944	.....	.....	8,283	490,317	.....
1945	.....	.....	4,969	657,345	.....
1946	.....	.....	7,056	721,158	.....
1947	.....	.....	4,977	489,645	.....
	850	853,566	934,496	15,498,672	254,229

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[f]Includes Harrison and Schuyler counties.
[i]Included with Grundy County.
[j]Included with Cooper County.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Jackson	Jasper	Johnson	Lafayette	Lewis
1889			12,803	320,448	
1890			13,187	329,845	
1891		633	10,530	352,603	
1892			10,485	347,600	
1893	4,819		12,101	371,928	
1894	6,720		15,427	299,931	
1895	14,632		8,873	256,761	
1896	14,532		3,961	307,285	
1897	21,028		3,770	284,448	
1898	15,000		4,318	347,857	
1899	25,125		4,710	392,608	
1900	20,900		8,455	377,892	
1901	20,000		9,695	439,217	
1902	21,000		8,500	539,612	
1903	8,500		3,847	539,612	
1904	3,348		4,139	713,677	
1905			32,221	705,917	
1906			23,853	648,015	
1907			66,403	712,981	
1908			7,888	571,908	210
1909			6,556	724,110	123
1910			7,360	559,426	
1911			4,267	658,587	
1912			5,517	743,288	
1913			16,214	754,907	
1914			74,116	743,396	
1915			3,940	869,740	
1916			2,480	868,005	
1917			9,268	942,653	
1918			147,216	962,893	
1919			67,522	614,017	
1920[a]			45,434	885,569	
1921[a]			15,240	540,421	
1922[a]			44,201	416,383	
1923[a]			58,500	511,277	
1924[a]				326,497	
1925[a]				355,419	
1926			11,878	359,948	
1927			58,489	209,310	
1928			44,580	494,531	
1929		5,674	46,264	466,024	
1930			42,323	375,670	
1931			5,288	297,628	
1932			5,637	421,519	
1933			8,785	325,333	
1934			6,174	284,200	
1935		10,020	6,410	309,859	
1936		8,523	3,021	334,166	
1937		7,944	7,005	321,237	
1938		4,793	8,948	265,205	
1939		3,675	5,348	258,527	
1940		5,072	5,117	255,383	
1941		9,880	5,426	252,188	
1942		9,406	54,797	260,450	
1943		8,231	337,218	193,673	
1944		7,064	294,741	161,257	
1945		4,505	269,592	49,141	
1946		2,914		41,039	
1947		4,988	238,775	44,912	
	175,604	93,322	2,238,813	26,317,933	333

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Lincoln	Linn	Livingston	Macon	Miller
1889		2,136		223,660	
1890		13,403	1,100	457,886	87
1891		28,036	200	454,029	130
1892		35,588	1,000	685,335	127
1893		48,302	1,000	788,563	
1894		61,807	800	511,566	
1895		100,179	1,050	539,120	
1896		92,022	1,155	519,648	
1897		67,895	1,468	490,601	
1898		83,041	1,817	720,999	
1899		72,081	800	739,293	
1900	270	81,130	3,813	595,297	
1901		85,459	1,177	1,025,213	
1902		79,221	800	1,198,133	
1903		64,206	2,068	1,119,646	
1904		102,205	1,539	899,963	
1905		91,593	2,810	817,093	
1906		97,879	2,150	782,948	
1907		124,068	2,270	1,159,233	
1908		104,240	1,010	851,130	
1909		132,810	735	816,306	
1910		86,774	725	610,166	
1911		123,279	175	672,258	
1912		117,550		795,526	
1913		102,386		737,869	
1914		110,185		752,965	
1915		96,899		674,870	
1916		103,797		797,192	
1917		128,654		935,300	
1918		144,691		817,570	
1919		89,238		392,450	
1920[a]		142,290		720,227	
1921[a]		89,747		473,985	
1922[a]		53,807		352,137	
1923[a]		27,964		571,350	
1924[a]		21,829		181,598	
1925[a]		15,739		60,766	
1926		49,769		78,953	
1927		29,871		96,568	
1928		28,400		240,112	
1929		34,392		221,463	
1930		25,944		212,398	
1931		27,893		186,890	
1932	158	45,893	398	164,112	
1933	800	48,536		85,432	
1934	1,216	31,210		62,384	
1935	1,803	67,852		42,497	
1936	1,852	88,066		35,087	
1937	1,472	101,616		381,677	
1938	1,971	76,594		476,303	
1939	81	73,531		484,214	
1940	2,554	86,961		474,041	
1941	1,417	52,366		443,956	
1942		71,860		583,052	
1943		61,423		777,204	
1944		23,538		657,534	
1945		6,193		22,832	
1946		6,678		498,182	
1947		12,603		577,456	
	13,594	4,073,319	30,060	31,744,238	344

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Moniteau	Monroe	Montgomery	Morgan	Nodaway
1889			10,003		
1890		108	14,744	240	
1891	476	36	12,124	488	2,222
1892			16,039		1,850
1893			15,923		2,548
1894			12,175		2,804
1895			10,900		1,802
1896			10,736		6,065
1897			15,200	6,000	2,769
1898		1,810	2,740	1,440	1,000
1899		960	2,670		2,350
1900		822	2,670	300	2,371
1901	480	1,445	1,680	1,674	2,000
1902	143	1,980	2,400	446	1,590
1903		2,451	2,880	4,183	
1904	576	1,682	2,371	4,200	
1905	1,146	730	4,000	1,500	2,063
1906	3,550		1,840	600	731
1907	3,552		2,990	2,640	120
1908	3,100	800	1,382	1,683	
1909	1,792	450	2,828	1,680	
1910		600	1,500		
1911			1,000		
1912	1,500				
1913	2,000	400	795		
1914		1,040		665	
1915		2,480	350	1,000	
1916		1,000	400		
1917		1,400	500	4,430	
1918		570		1,975	
1919		275			
1920[a]	[k]			[j]	
1921[a]	[k]			[j]	
1922[a]	[k]			[j]	
1923[a]	[k]			[j]	
1924[a]	[k]			[j]	
1925[a]	[k]			[j]	
1926					
1927		1,202			
1928		4,459			
1929		1,548	104		
1930		1,345	600		
1931		1,927	635		
1932		800	100		
1933		1,768			
1934		2,214	412		
1935		1,010	158		
1936		725	88		
1937		794	1,592	1,656	
1938		10,325	1,818	4,724	
1939		4,445	459	3,750	
1940	279	5,493	162	6,287	
1941	1,317	9,011	211	3,236	
1942	906	633	35		
1943	1,283	5,121			
1944	2,080	5,371			
1945	1,067	6,484			
1946		6,192			
1947		6,156			
	25,247	98,062	159,214	54,797	32,285

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[j]Included with Cooper County.
[k]Included with Boone and Cooper counties.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Pettis	Phelps	Platte	Putnam	Ralls
1889				75,877	
1890				91,584	675
1891				123,526	614
1892	433			134,984	280
1893	181			145,641	2,160
1894	1,738			119,832	4,400
1895				111,572	8,489
1896				85,032	9,644
1897	1,470			101,330	7,843
1898	5,400			121,952	7,768
1899	3,200			126,673	16,014
1900				106,203	20,956
1901				139,456	25,238
1902				125,543	20,150
1903				114,008	18,085
1904			126,217	70,118	16,902
1905			205,535	84,240	14,961
1906			210,197	102,973	17,073
1907			259,849	58,999	16,768
1908			190,306	54,505	14,415
1909			204,098	51,770	15,237
1910			136,934	60,645	17,658
1911			136,264	21,259	15,600
1912			157,143	26,287	13,799
1913			107,547	24,875	15,022
1914			79,580	10,548	14,900
1915			89,981	6,787	13,703
1916			91,394	5,614	12,496
1917			100,807	21,304	13,570
1918				49,724	26,491
1919				29,554	14,812
1920[a]	[i]			30,867	
1921[a]	[i]			13,921	
1922[a]	[i]				
1923[a]	[i]			12,869	
1924[a]	[i]			8,547	
1925[a]	[i]			15,737	[1]
1926			15,902	10,789	17,482
1927			18,304	34,419	12,347
1928			30,974	28,416	14,415
1929			34,443	51,606	16,464
1930			30,226	23,853	27,108
1931			25,016	13,045	11,524
1932			27,586	23,836	10,349
1933			24,765	23,789	15,413
1934			24,631	29,898	13,053
1935			25,490	45,130	17,775
1936			25,027	28,831	4,677
1937	731		16,278	63,124	26,340
1938				39,101	15,128
1939				42,973	15,823
1940				55,784	16,509
1941				38,897	11,956
1942				53,115	13,322
1943				39,737	4,455
1944				25,895	9,109
1945				15,233	1,062
1946				21,493	590
1947		213		24,218	2,851
	13,153	213	2,394,494	3,217,538	673,475

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.
[i]Included with Cooper County.
[1]Included with Audrain County.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Randolph	Ray	St. Clair	Saline	Schuyler
1889	184,609	207,829	.....	832	.....
1890	245,898	240,462	.....	660	300
1891	224.758	282,247	3,866	7,981	280
1892	296,011	272,948	5,405	4,440	766
1893	219,762	319,405	6,517	1,865	962
1894	209,566	196,852	5,337	1,875	3,556
1895	218,774	150,998	1,000	3,682	1,620
1896	230,194	149,093	4,058	432	2,440
1897	243,012	157,652	5,452	1,281	2,022
1898	314,842	215,348	3,599	740	2,921
1899	354,830	252,683	4,210	1,320	5,304
1900	303,133	248,591	3,892	500	4,253
1901	432,655	264,900	4,539	942	3,800
1902	432,655	280,162	3,139	205	3,373
1903	605,716	356,424	3,963	.....	9,077
1904	578,895	225,485	1,229	.....	21,860
1905	544,118	226,369	2,559	1,410	5,292
1906	342,497	280,156	13,220	900	2,094
1907	97,702	349,180	2,360	845	4,840
1908	31,266	294,230	812	150	2,425
1909	205,909	301,383	1,360	100	2,300
1910	207,067	232,971	1,500	.....	1,943
1911	481,731	309,554	2,310	.....	21,950
1912	483,459	378,502	2,028	.....	22,556
1913	478,488	335,267	1,055	.....	17,824
1914	434,651	304,815	1,791	.....	.....
1915	408,421	250,338	6,419	.....	883
1916	399,722	379,133	1,128	.....	3,647
1917	497,487	515,834	589	.....	3,448
1918	543,915	518,558	667	.....	2,034
1919	311,562	297,289	586	.....	2,440
1920[a]	422,903	578,694	.....	.....	[i]
1921[a]	324,836	476,117	.....	.....	[i]
1922[a]	158,692	423,881	.....	.....	[i]
1923[a]	233,529	518,633	.....	.....	[i]
1924[a]	138,224	408,202	.....	.....	[i]
1925[a]	113,752	449,931	.....	.....	.....
1926	187,925	462,075	1,094	.....	5,028
1927	203,244	317,665	799	305	10,859
1928	181,361	391,069	885	.....	3,948
1929	182,041	428,060	1,300	.....	2,840
1930	180,438	422,227	16,195	.....	535
1931	167,699	262,658	866	.....	638
1932	343,379	246,836	.....	.....	1,049
1933	465,932	287,245	.....	.....	779
1934	476,520	278,631	.....	373	857
1935	528,948	293,673	217	.....	357
1936	466,397	291,634	1,200	.....	2,720
1937	539,731	246,050	3,292	15	1,705
1938	458,028	207,354	3,506	.....	1,511
1939	458,680	151,370	5,393	.....	1,428
1940	506,428	186,734	3,697	.....	248
1941	572,688	148,383	7,472	.....	302
1942	597,876	151,996	9,072	.....	.....
1943	576,484	107,965	22,204	.....	.....
1944	577,880	99,352	15,005	.....	.....
1945	21,930	60,746	650	.....	.....
1946	481,003	23,035	180	.....	.....
1947	517,504	25,927	25,835	.....	.....
	20,647,357	16,740,801	213,452	30,853	191,014

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly. Included with Grundy County.

COAL PRODUCTION OF MISSOURI BY COUNTIES

	Shelby	Sullivan	Vernon	Warren	Worth
1889			13,313		
1890	40		33,292		
1891	8	560	64,303		
1892		8,800	119,036		
1893		1,000	234,376		
1894		6,600	297,599		
1895		5,487	237,965		
1896			303,886		
1897			281,894		
1898			252,134		
1899			298,382		
1900			229,343		
1901			164,972		
1902			207,126		
1903			175,221		
1904			173,571		
1905		1,666	206,772		
1906			155,427		
1907		3,000	221,194		
1908		3,263	52,197		
1909		4,972	31,472		
1910		7,200	24,032		
1911		1,000	6,289		
1912		1,000	30,219		
1913		2,424	50,556		
1914			46,147		
1915			72,832		
1916			80,001		
1917			43,525		
1918			54,840		
1919			36,529		
1920[a]			74,771		
1921[a]			42,026		
1922[a]			30,648		
1923[a]			7,824		
1924[a]					
1925[a]					
1926			4,700		
1927			86,587	107	
1928			9,761		
1929			68,453		
1930			40,345		
1931			16,253		
1932			21,300	150	
1933			28,707	1,592	
1934			34,003	726	1,080
1935			100,582	1,213	
1936			115,291	1,555	
1937		90	118,906	1,897	
1938			63,426	1,157	
1939			61,168	1,042	
1940			69,154	619	
1941			69,828	655	
1942			85,101	1,057	
1943			178,751	346	
1944			360,903		
1945			396,924		
1946			322,555		
1947			419,409		
	48	47,062	7,025,821	12,116	1,080

[a]Figures from Missouri Geological Survey, Biennial Report of 55th General Assembly.

APPENDIX II

TOTAL PRODUCTION OF COAL IN MISSOURI

Years	Production in Tons	Years	Production in Tons
1889	2,222,971	1920[a]	5,369,565
1890	2,437,389	1921[b]	3,551,621
1891	2,648,494	1922[c]	2,942,750
1892	3,016,285	1923[d]	3,403,151
1893	3,190,442	1924[e]	2,480,880
1894	2,383,052	1925[a]	2,694,215
1895	2,281,081	1926	2,865,786
1896	2,416,577	1927	2,981,088
1897	2,429,388	1928	3,530,211
1898	2,838,152	1929	4,022,368
1899	3,192,351	1930	3,864,445
1900	3,001,016	1931	3,570,265
1901	3,788,356	1932	4,053,151
1902	4,046,042	1933	3,588,649
1903	4,167,108	1934	3,360,090
1904	4,241,912	1935	3,699,086
1905	4,381,956	1936	3,613,301
1906	3,889,659	1937	3,784,282
1907	4,422,502	1938	3,254,244
1908	3,400,731	1939	3,258,556
1909	3,850,871	1940	3,742,391
1910	2,809,215	1941	3,084,213
1911	3,521,988	1942	3,505,277
1912	4,229,907	1943	4,311,785
1913	4,010,236	1944	4,784,073
1914	3,840,453	1945	3,185,929
1915	3,744,394	1946	3,545,693
1916	4,181,091	1947	3,896,675
1917	5,198,649		
1918	5,188,437	Total Production	208,062,930
1919	3,148,485		

[a] Includes 164,869 tons produced but not allocated to counties in Appendix I.
[b] Includes 19,537 tons produced but not allocated to counties in Appendix I.
[c] Includes 129,075 tons produced but not allocated to counties in Appendix I.
[d] Includes 108,041 tons produced but not allocated to counties in Appendix I.
[e] Includes 36,182 tons produced but not allocated to counties in Appendix I.
[f] Includes 138,250 tons produced but not allocated to counties in Appendix I.

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