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Kentucky's Coal Industry: Historical Trends and Future Opportunities

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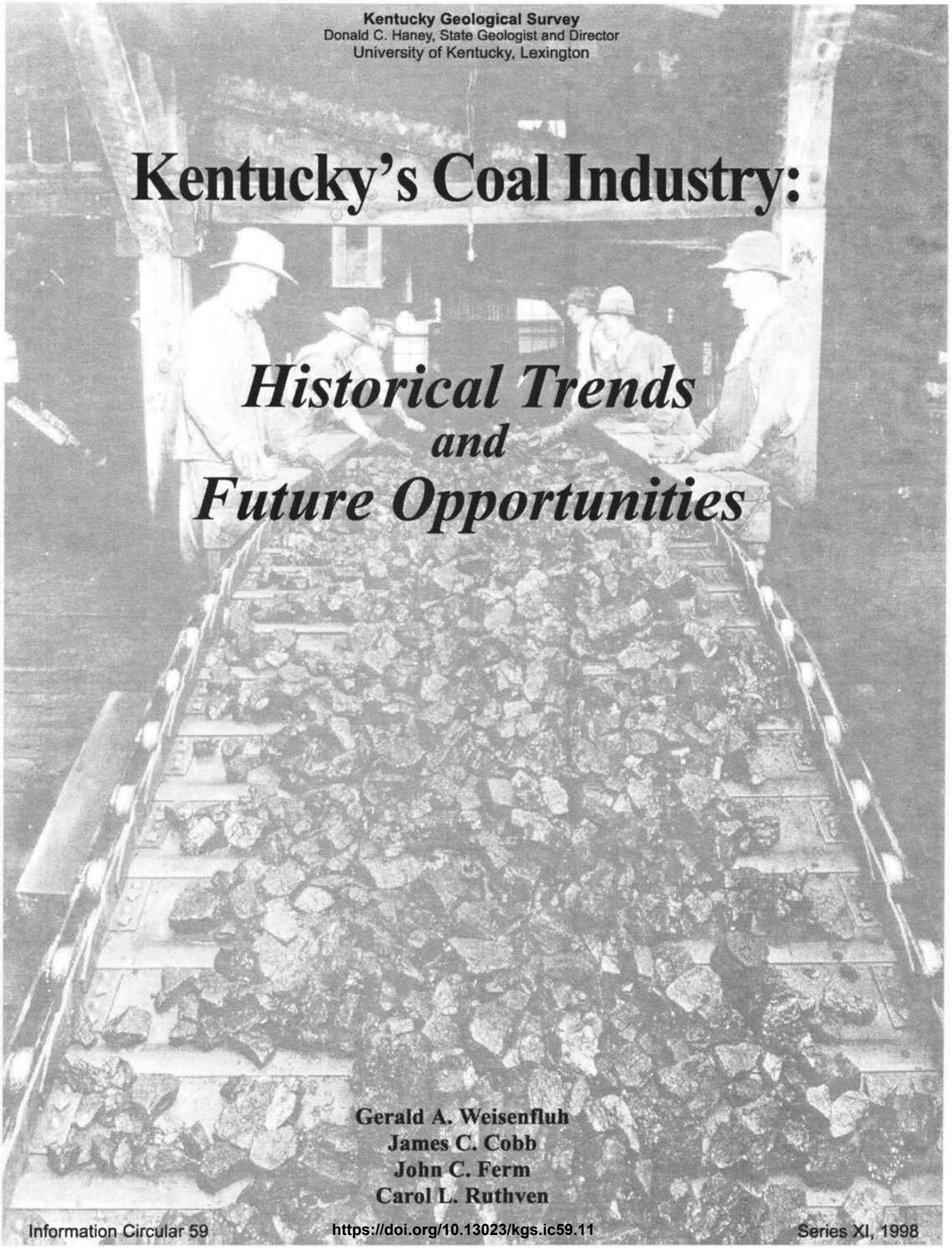

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The Kentucky Geological Survey at the University of Kentucky is a State-mandated organization whose mission is the collection, preservation, and dissemination of information about mineral and water resources and the geology of the Commonwealth. KGS has conducted research on the geology and mineral resources of Kentucky for more than 150 years, and has developed extensive public databases for oil and natural gas, coal, water, and industrial minerals that are used by thousands of citizens each year. The Survey's efforts have resulted in topographic and geologic map coverage for Kentucky that has not been matched by any other state in the Nation.

One of the major goals of the Kentucky Geological Survey is to make the results of basic and applied research easily accessible to the public. This is accomplished through the publication of both technical and nontechnical reports and maps, as well as providing information through open-file reports and public databases.

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Cover design by Collie Rulo. Historic photograph of miners sorting coal, Black Star Mine, Harlan County, eastern Kentucky, from the Kentucky Geological Survey archives.

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Kentucky's Coal Industry: Historical Trends and Future Opportunities

Gerald A. Weisenfluh[1], James C. Cobb[1], John C. Ferm[2], and Carol L. Ruthven[1]

Abstract

Coal has been produced in Kentucky since the late 18th century. In the early years, all mining was by underground methods, but surface mining became the dominant method during and after World War II. In recent years, surface-mine production in both fields has decreased while underground mining has increased.

In the last half of this century, the traditional steam coal market for locomotives has virtually disappeared, leaving electric power generation and coking coal for the steel industry as the principal markets. More than half of all coal produced in the State has been produced in the last 25 years. Whether this level of production can be profitably sustained is questionable.

More than 50 percent of the coal in eastern Kentucky is less than 28 in. thick, while more than 69 percent of the coal in western Kentucky is greater than 42 in. thick. Although eastern Kentucky's resources are thinner, they have a lower sulfur content and higher calorific value than western Kentucky's.

Traditional resource estimates have overestimated the amount of coal that can actually be mined because they have not taken into account factors such as competing land uses and geologic and engineering constraints. KGS is participating in national programs to estimate coal availability and recoverability. Results of selected study areas suggest that as little as 50 percent of the original resource is available for mining, whereas only 20 percent is economically recoverable. It is uncertain yet whether these averages are indicative of all of Kentucky's coal resources. Regional assessments of Kentucky's most important coals, which incorporate coal availability methods, are under way.

A number of regulatory and taxation issues will have an impact on the coal industry in Kentucky, but how much of an impact is uncertain. These issues include the Clean Air Act Amendments, liability for unreclaimed surface mines, regulatory flexibility to permit changes in postmine land use, and changes in the State's workers' compensation law.

Advances in thin-seam and remote-mining technology will be crucial, particularly in eastern Kentucky, where most of the remaining coal occurs in thin seams. Improvements in coal-preparation technology could make Kentucky's higher sulfur coals more attractive. There may be potential for extraction of methane gas from coal beds, as an energy by-product.

Detailed knowledge of the physical and chemical character of Kentucky's coal beds will be vital in their development. Acquisition of this knowledge could be facilitated by cooperation among private industry, public agencies, and research institutes.

Introduction

Coal has been produced in Kentucky's two coal fields (Fig. 1) since the beginning of the 19th century and has been the State's most important mineral resource since that time. In 1994, the coal industry employed more than 24,000 miners, and tax revenues generated from all economic activity related to the industry provided more than 11 percent of General Fund receipts in Kentucky (oral commun., Kentucky Department of Employment Service). Today, more than 50 percent of the Nation's electricity is generated in coal-fired power plants, and 95 percent of the electricity generated in Kentucky comes from coal. Clearly, demand for coal is strong and will remain so well into the future. Many factors affect Kentucky coal production: the size and quality of the reserve base, market demand and competition, transportation infrastructure, mining and processing technology, and government regulation. Understanding the complex relationships among these factors will help identify future opportunities for continued development of coal resources and realization of the associated economic benefits for coal-producing counties and the State.

Contrasts in eastern and western Kentucky coal resources present different challenges and opportunities for future development. Coal beds in western Kentucky are more uniformly thick compared to those of eastern Kentucky, but have

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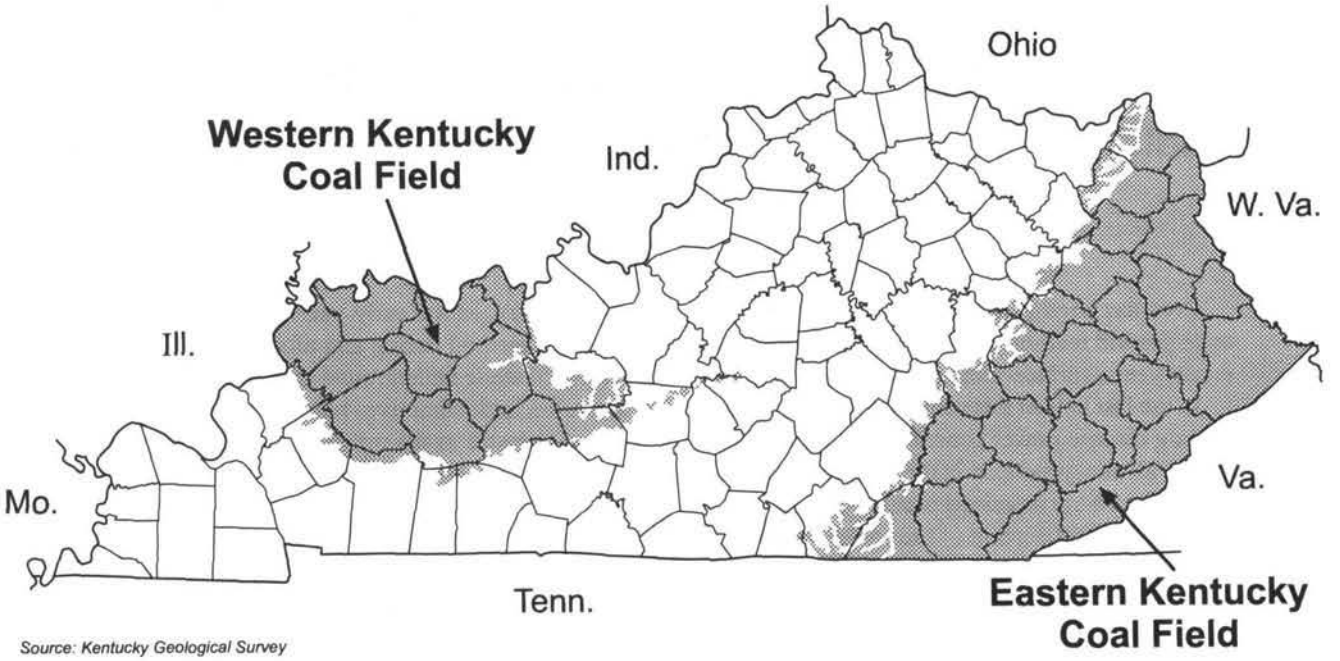

Figure 1. Kentucky's bituminous coal fields.

higher average sulfur content. Surface access to western Kentucky coal is limited, and more costly underground mines will be the primary method of future extraction. Eastern Kentucky coals are more variable in thickness than those of western Kentucky, but are of higher average quality. Higher physiographic relief in the east has provided greater accessibility for near-surface mining. Decisions regarding regulation of emissions from power plants and taxation levels are likely to affect Kentucky's coal fields in different ways, but as of this writing the outcomes of these issues are not known.

Increasing competition from the western United States in the steam coal market will present a significant challenge for Kentucky coal mines. Innovations in mining, processing, marketing, and transportation can position companies for future success. One such opportunity in eastern Kentucky may be identification of specialty steel and chemical markets, which attract significantly higher prices for coal with desirable quality characteristics. In order to better prepare for future needs, an understanding of factors affecting past coal production is essential.

Historical Trends in Coal Production

Coal was first produced in eastern Kentucky in 1790 and by 1820 in western Kentucky. Early mines produced small tonnages, mainly for local use. Early production levels were primarily a function of low demand and lack of efficient transportation routes. Regional use of coal was primarily for steam locomotives, manufacturing, and domestic fuel. One of the earliest commercial markets was for cannel coal, a high-Btu product used for domestic heating. Cannel mines were developed in western Kentucky and in the outlying counties of the Eastern Kentucky Coal Field, but there were no efficient transportation routes to outside markets from cannel-coal deposits in the main part of this field.

The first large production increase occurred in the early 1920's as a result of penetration of commercial rail lines into the eastern coal fields and increased demand for coal for steam locomotives. During the economic depression of the 1930's, demand for coal declined, and with diminished coal production there was little impetus for technological improvement. Until the beginning of World War II, almost all mining in Kentucky was by underground methods, as the technology for efficient surface mining had not yet been developed (Fig. 2).

The next significant production increase occurred during the industrial expansion associated with World War II. Large-area surface-mine machines (draglines) were used to develop the relatively flat terrain of the Western Kentucky Coal Field, and would be the dominant method of mining in this region until the mid-1980's. Surface-mine production for western Kentucky, however, has steadily decreased from 1970 to the present (Fig. 2). This trend may be due to diminished surface-mineable reserves, because access to near-surface mineable coals in western Kentucky is limited to the periphery of the coal field, and much of this area has been previously mined.

In eastern Kentucky, growing demand for coal in the 1940's resulted in increased underground mining (Fig. 2), but the steep slopes of this mountainous area prevented de-

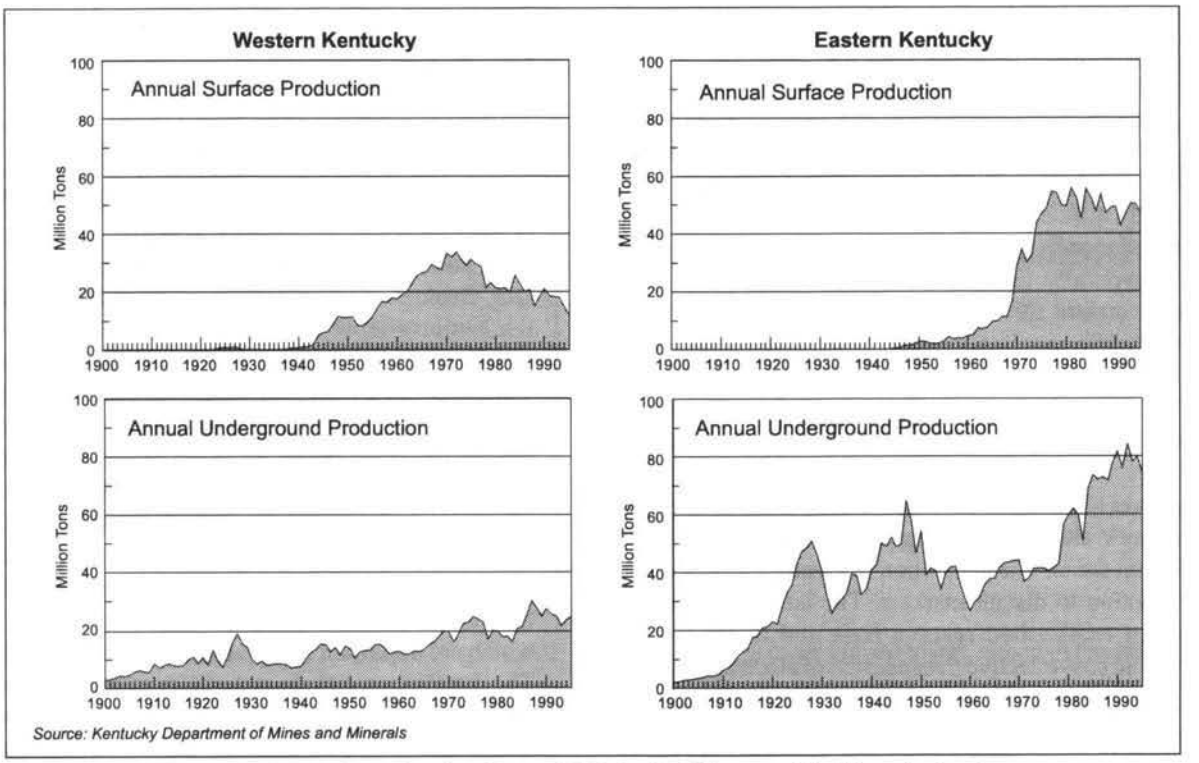

Figure 2. Annual production from 1900 to 1995 by coal field and mine type.

velopment using the early surface-mining equipment. A shift toward surface-mine production did not occur until the 1970's. This was a response to developments in contour surface mine technology, unusually high demand for coal as a result of the OPEC oil embargo, and the increasing costs of underground mining. However, the trend toward increasing surface-mine production quickly reversed, as extensive production diminished high-quality surface reserves and the regulatory costs of surface mining increased in 1977 after passage of the Federal Surface Mine Control and Reclamation Act. Since that time, eastern Kentucky surface mine production has shown a slight decline, whereas underground mining has increased significantly (Fig. 2).

Changes in coal utilization within the last half of this century have had a significant impact on the production and marketing of coal from Kentucky. First, traditional fuel markets and coal for steam locomotives virtually disappeared, leaving electric power generation and coking coal for the steel industry as the principal markets. Eastern Kentucky underground mine production was especially influenced by large-scale replacement of coal-fired locomotives by diesel engines between 1950 and 1960 (Fig. 2). This was followed by a shift of markets from northern industrial fuels to southern utilities. In addition, the market for coking coal was greatly diminished by downsizing in the steel industry in the 1970's. Existing and anticipated clean air legislation has also affected the marketing of both high- and low-sulfur coal. Initially, demand for high-sulfur coal diminished, but as electric power-generating facilities with scrubbing technology became available and low-sulfur credits were accumulated, this demand partially returned. More recently, Kentucky coal has been faced with strong competition from inexpensive low-sulfur coal from the Powder River Basin in Wyoming and Montana. This western U.S. coal is now capturing some traditional utility markets for Kentucky coal located in the midwest and southeastern United States.

As a result of higher productivity and lower mining costs effected by major technological advances in mining techniques, more coal is being mined in Kentucky than ever before, and this is being accomplished with a smaller number of mines and fewer employees. Over half of all coal produced in the State has been extracted within the last 25 years (Fig. 3), and the question arises whether or not this level of production can be profitably sustained in the future. The answer will depend on a thorough understanding of the current reserve base; mining, transportation, and processing technologies; the nature of future markets; and the impact of regulations. The socioeconomic impact of these changes in Kentucky coal mining will also require careful assessment because of the economic impact that mining jobs have for the State (Geroyan and others, 1994; Straus and others, 1996).

Transportation and Marketing

Two modes of coal transportation dominate Kentucky's supply infrastructure and represent a substantial portion of

the cost of delivered coal. More than three-fourths of mined coal is transported by truck from the mine site to either preparation or loading facilities. This is true for both coal fields, but direct rail shipment is more practical in western Kentucky because there are fewer mines and the infrastructure is better developed. Coal transportation to the end user (principally utilities) is approximately two-thirds by railroad and the balance by barge or truck. Rail access for specific areas is typically limited to a single carrier, and where multiple carriers serve a region, rates are reported to be somewhat different. Deregulation of rail rates, implemented by the Federal Staggers Rail Act of 1980, is generally believed to have been disadvantageous for eastern U.S. coal producers, because the resulting reduction in rail shipping rates has selectively favored low-cost mines in the western United States. Over the long term, Kentucky's coal producers may have to seek alternative transportation methods or expand uses of coal for on-site generation of electricity for local use or distribution to distant markets. The latter approach will require an established reserve base and technology for efficient and cost-effective transmission of electricity. In-place burning or gasification may also be a viable alternative to transporting coal to markets.

The impact of transportation costs is exacerbated by the low average sales price for steam coal. Low profit margins have forced companies to increase production and, at the same time, reduce employment of miners and support staff. Alternative marketing strategies to target higher profit margins have been successful for a few companies, but they require detailed knowledge of coal quality characteristics and typically result in low-volume contracts in the steel and chemical industries. Alternative markets do, however, have sales prices 2 to 10 times the value of the steam coal market. The advantage of this marketing strategy is that mining and transportation costs are reduced because fewer tons are required to generate an acceptable profit margin. Unfortunately, little information is known about these markets and whether they have the potential to reduce the current reliance on the steam coal market.

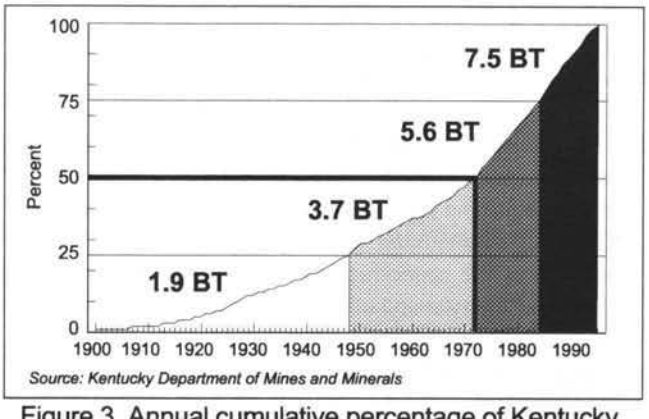

Figure 3. Annual cumulative percentage of Kentucky coal production.

Coal Resource Estimates

The basis of current estimates of Kentucky coal resources is the 1:24,000-scale geologic mapping conducted between 1960 and 1983 by the Kentucky Geological Survey and the U.S. Geological Survey. These maps and coal data represent the Nation's most complete and accurate geographic and stratigraphic information about coal and have established Kentucky as a leader in coal-resource characterization. Tonnage estimates for 100 eastern Kentucky coal beds suggest original in-place resources of 64 billion tons (BT) (Brant, 1983a–b; Brant and others, 1983a–d). Western Kentucky has 33 coal beds that amount to 40 BT (Smith and Brant, 1978). The larger eastern resource results from its greater area and number of coal beds. The resource estimates are categorized by bed thickness and, in some cases, overburden thickness, which are important factors in determining mining methods. The distribution and characteristics of coal resources among individual coal beds and geographic areas are not uniform, and this has had a definite impact on coal production trends for specific areas. Kentucky's two coal fields are distinctly different in terms of the thickness and quality of coal resources and their accessibility for mining. These factors will play an important role in future coal development.

Although Kentucky's potentially mineable beds are numerous, only a relatively few have significant coal resources. Furthermore, these resources are not uniformly distributed throughout the coal fields. In eastern Kentucky, 25 percent of the original resource is associated with the Upper Elkhorn Nos. 1, 2, and 3 beds and 67 percent with the top 10 coal beds (Fig. 4). In western Kentucky, 91 percent of the resource occurs within six coal beds (Fig. 5). These 16 coal beds have also been the leading producers throughout the State's history. Not all areas of each coal field are favored with abundant coal. Of the 35 coal counties in eastern Kentucky, the southeastern 10 counties contain 75 percent of the resource, and Pike and Harlan Counties have 30 percent of the estimated coal. In western Kentucky, only 8 of the 17 coal counties have more than 1 BT, and 70 percent of the resource is located in four counties.

Eastern Kentucky has more resources in thin beds than western Kentucky does. In eastern Kentucky, more than 50 percent of the coal is estimated to be less than 28 in. thick. Only two beds are believed to contain more than 1 BT of coal having a thickness greater than 42 in., the Lower Elkhorn and Fire Clay (Fig. 4). The total amount of coal greater than 42 in. in thickness comprises only 17 percent of the entire estimate for eastern Kentucky (Fig. 6), and much of this is associated with the top 10 beds. In contrast, only 5 percent of western Kentucky's estimate is less than 28 in.

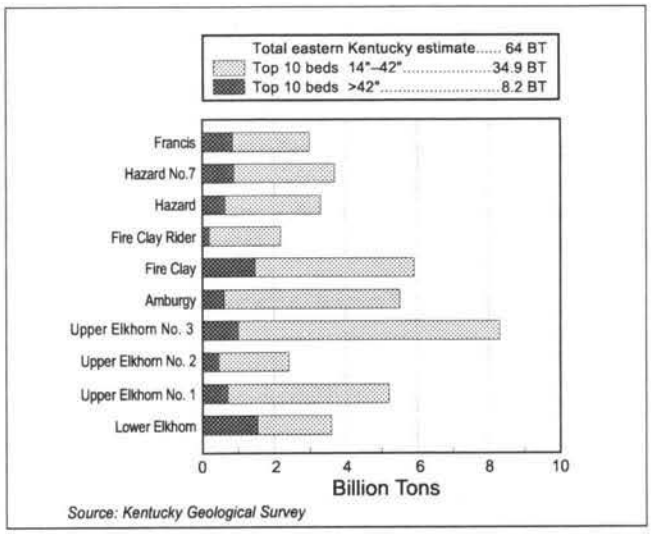

Figure 4. Distribution by thickness for the top 10 coal beds in eastern Kentucky.

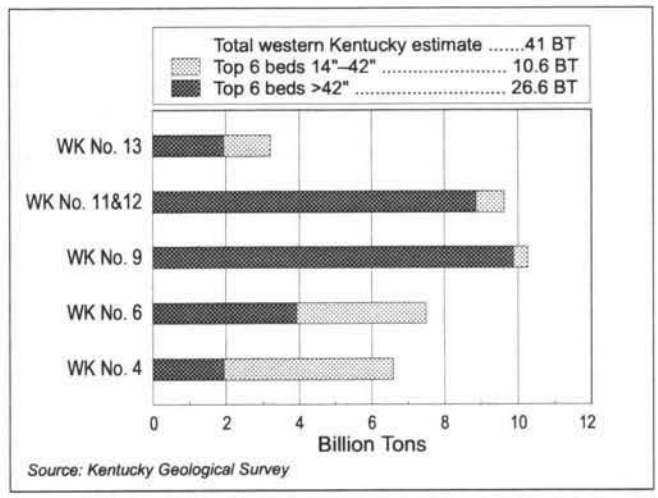

Figure 5. Distribution by thickness for the top six coal beds in western Kentucky.

thick, and 69 percent is greater than 42 in. thick (Fig. 7). All six of the commonly mined coals in western Kentucky contain more than 1 BT of resources (Fig. 5). These differences in coal bed thickness in the coal fields are important because they have implications for the type of technology necessary to expand the economic resource base.

All coal mined in Kentucky is of bituminous rank, but the two coal fields differ in other quality parameters. Western Kentucky coals tend to be of moderate to high sulfur content and moderate Btu value. Eastern Kentucky is believed to contain one of the largest resources of low-sulfur, high-Btu coal in the United States, although moderate- to high-sulfur coals are also mined there. Ash contents vary greatly, and recent experience in eastern Kentucky suggests that the remaining resource will have higher levels of ash than that previously mined.

Coal Availability

A National Coal Council report (Blackmore and Ehrenreich, 1987) outlined a number of weaknesses in traditional resource and reserve base estimates. Foremost among these was a lack of accounting for regulatory and technological factors that limit resource development. The council concluded that the existing estimates overstate the amount of coal that can actually be mined. Examples of factors that may restrict mining include competing land uses (e.g., state and national parks, municipal areas, cemeteries,

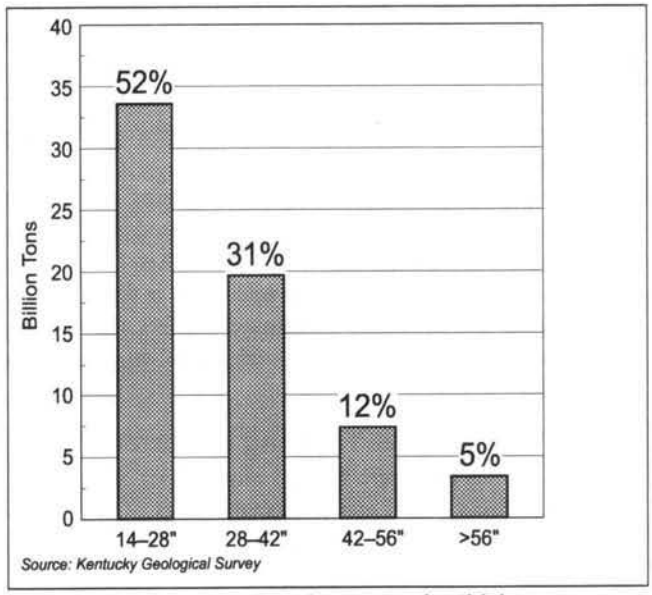

Figure 6. Proportional coal tonnage by thickness categories for all eastern Kentucky coal beds.

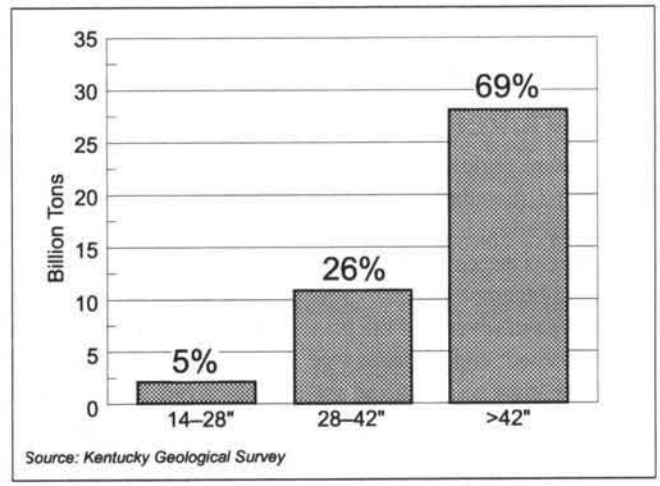

Figure 7. Proportional coal tonnage by thickness for all western Kentucky coal beds.

and streams) and geologic and engineering constraints (e.g., coal of insufficient thickness, unstable roof conditions, proximity to adjoining underground mines). In order to estimate the impact of mining restrictions, a national coal availability program was established, and the U.S. Geological Survey and Kentucky Geological Survey developed the original pilot project (Eggleston and others, 1990). The former U.S. Bureau of Mines developed similar methods to evaluate the recoverability of coal that is characterized as available for mining.

Although these studies are not yet complete, a number of observations can be made. Land-use (regulatory) restrictions may be locally important, but their impact on a regional scale is small in Kentucky. One reason is that the coal fields are in rural areas, and mineable coals tend to be remote from most competing land uses. Many of the restrictions that do apply have been dealt with to minimize loss of reserves. Technological limitations have a significant impact on mineability, and the principal factor is the inability to profitably extract thin coal seams with available underground equipment. This is particularly important in eastern Kentucky, where a large proportion of the resource is less than 28 in. thick. Western Kentucky has areas that may be too deep to mine or are too structurally complex, and there are some mine blocks with insufficient acreage for economic development. Both regions have some resources that have been sterilized because of mining of adjacent beds, but this is not a widespread occurrence. Together these technological limitations may affect more than 50 percent of the original resource.

Results of coal recoverability investigations suggest that as little as 20 percent of the resource within the study areas is economically recoverable. Important factors for recoverability are coal preparation costs and engineering considerations for vertically adjacent mines. A key finding in both studies is that most of these constraints are actually economic factors rather than technological and legal issues. Most of the mining that is precluded reflects the costs associated with overcoming these constraints.

Directions for Future Coal Resource Studies

Future regional coal resource studies should consider the unequal distribution of coal resources and the effects of technological limitations on mining. Most of the State's coal resources are contained in a small number of beds, and these should be emphasized in new studies. There is evidence that reserves in several of the principal beds may be significantly diminished, and if this is true, new resources of comparable quality must be identified and characterized. The availability of coal for mining is greatly affected by the geological variability of the coal beds. The data necessary to document this variability are, for the most part, not publicly available for regional resource studies, and as a result the impact of technological limitations may be underestimated. An effort must be made to acquire sufficient data to define the limits of mining for specific coal bodies. Finally, public data concerning the quality of mineable coals, particularly trace element chemistry, are insufficient to prepare detailed estimates of coal quality for beds to be mined in the future. The latter information will be crucial for the successful development of Kentucky's remaining resources.

Impacts of Regulation and Taxation

Regulations at the local, State, and Federal levels have an impact on the mining, transportation, and use of Kentucky coal. A number of regulatory and taxation issues are particularly important, and their future impact is uncertain. These include the effects of Clean Air Act Amendments on demand for Kentucky coal, liability for unreclaimed surface mines, regulatory flexibility to permit changes in postmine land use, and the outcome of changes in the State's workers' compensation law.

The Clean Air Act Amendments of 1990

Title III of the Federal Clean Air Act Amendments of 1990 concerns hazardous air pollutants (HAP's). A total of 189 substances are classified as hazardous air pollutants, and 15 of these occur in trace amounts in coal. Industrial companies generating these substances who are deemed to be "significant emitters" are required to use available technology to the fullest possible extent to reduce emission of HAP's. At the present time, coal-burning power plants are not considered to be significant emitters. However, a study has been under way by the Federal Environmental Protection Agency (EPA) for a number of years to collect information to address this issue. A 2-year extension is being sought to allow more data collection, particularly with respect to arsenic and mercury. At the time of the writing of this paper, no official position had been taken by the EPA with regard to additional regulation of coal burning.

Some utilities are reported to be consuming coal with sulfur contents substantially below the regulated levels in order to exceed the requirements of the Clean Air Act and accumulate credits for sulfur dioxide emissions in the future. This trend, if it continues, will ultimately affect the long-term availability of low-sulfur, high-value coal in eastern Kentucky for other uses.

Regulatory Issues Relating to Surface Mines

Most areas that were surface mined prior to the Federal Surface Mine Control and Reclamation Act of 1977 contain unreclaimed surface mines. Some companies are considering remining such areas because of increased capabilities for overburden removal. However, reclamation liabilities, and their associated costs, of the preexisting mines will be a fac-

tor. It has been suggested that this has been a deterrent to development of a significant amount of reserves adjacent to these unreclaimed surface mines. The magnitude of this problem, however, has not been quantified on a statewide basis.

Postmine land-use changes can greatly enhance the long-term economic development of the coal fields. This is particularly true in eastern Kentucky where flat land suitable for development is scarce. Examples of land-use changes include sport and wildlife sites, development areas for industry, government and residential facilities, airports, and agricultural uses. In Kentucky, all of these applications have proven to be successful alternatives to restoration of mine sites to the original slope of the land. Moreover, in many cases, they result in an environment that is more stable than premine conditions. Design of the sites must be carefully planned to account for the physical and hydrologic conditions of the area. When this is accomplished, postmine land uses help provide a means of sustaining local economies after mining has been completed.

Workers' Compensation

The high costs of workers' compensation levees are cited by many coal companies as a major impediment to the mining industry in Kentucky. The State's assessment of this tax is reported to be significantly higher than that of surrounding states. Recent legislative changes in the workers' compensation law will also clearly affect the coal industry.

Extraction and Processing Technology

Underground Mining

Recent trends in coal production suggest that underground mining will be an increasingly important recovery method for Kentucky coal. Currently, about 60 percent of underground mines in the State use continuous mining systems. Longwall systems, which are more productive and efficient, account for less than 10 percent of production. Low usage of longwalls in western Kentucky is probably because of the high capital investment for the equipment, combined with lower sales prices for the higher sulfur coal. In eastern Kentucky, low usage is mainly a function of smaller mine blocks and more variable and thinner coal beds. Another method, highwall mining, requires surface-mine access, but is actually a remote underground mining system. Highwall miners have had mixed success at Kentucky mines, but may be effective under proper geologic conditions. Each of these mining systems will have continued use in the future, but should be used with appropriate geologic and engineering planning.

The technological challenges for underground mining differ for the two coal fields. A substantial portion of western Kentucky's reserves are in beds greater than 42 in. thick, but at depths greater than 1,000 ft. Existing mining equipment is probably adequate to extract this resource, but ground control and mine planning methods should be enhanced to allow for safe mine development at greater depths. In contrast, thinner, more variable coal beds will be crucial in future coal mining in eastern Kentucky, where improvements in thin-seam and remote-mining technology will be important for converting resources into reserves. These thinner resources may also become targets for in situ gasification as an alternative to extractive technologies.

Surface Mining

Substantial evidence in both coal fields indicates that extensive mining of surface reserves has affected production, but it is uncertain whether technological advances in surface mining equipment will have a major impact in the future. Regulatory constraints associated with surface mining are thought to have reduced the feasibility of mining some reserves. Few would want environmental standards relaxed, but flexibility in postmine land use could have a beneficial effect on the coal fields.

Coal Preparation Technology

Some of the most important advances affecting coal marketing involve processing. Many modern preparation facilities are equipped with in-line analyzers that constantly monitor the quality of coal entering and leaving the plant. Sophisticated distribution systems permit the separation, by size and quality, of coal products destined for a variety of customers with specific needs. These methods are not without costs, and improvements in processing technology should focus on achieving cost efficiency. In addition, inexpensive preprocessing for ash removal from high-ash beds will be important in eastern Kentucky.

Coalbed-Methane Extraction

Potential may exist in Kentucky for extraction of methane gas from coal beds that could be used as an energy by-product of the coal resource. Methane (CH_4) is a naturally occurring gas associated with coal beds and has been economically recovered from coal in some coal basins. Significant commercial production of coalbed methane occurs in Alabama and New Mexico. In areas adjoining the Eastern Kentucky Coal Field (i.e., Virginia), methane has long been extracted from coal beds prior to mining for safety reasons, and there are current activities for commercial development. The possibility of coalbed-methane production in Kentucky is supported by the existence of some mines with histories of methane problems and successes of recent test holes.

Directions for Future Technology

New technologies are vital for the future extraction of Kentucky's coal resource. A detailed knowledge of the physical and chemical character of the beds that will be mined will be critical in the development of these resources. The value of sophisticated processing techniques is enhanced if

the variability in quality of the feedstock can be predicted and controlled. Acquisition of this knowledge could be facilitated by cooperation among private industry, public agencies, and research institutes. Industry has extensive data and a solid understanding of mining and processing problems, but often lacks the financial resources to undertake detailed geologic and engineering studies and to invest in development of new technology. Public agencies and universities have expertise and technology that could be used in a cooperative effort with industry to address these issues.

Summary

The Kentucky coal industry during fiscal year 1994–95 produced 162 million tons of coal with a gross value of $3.9 billion (Kentucky Coal Marketing and Export Council and the Kentucky Coal Association, 1995; Straus and others, 1996). Employment and revenue generated by industries supporting or servicing coal mining are vital to the coal-producing counties. The coal industry directly employed 24,133 miners earning $942.8 million in wages and salaries in 1994 (oral commun., Kentucky Department of Employment Services, 1996). All economic activity related to the coal industry generated $544 million in State tax revenues, representing more than 11 percent of the fiscal year 1994–95 General Fund receipts of $4.6 billion (Straus and others, 1996). Of the $544 million in State taxes, $180 million was severance taxes. Under provisions of the Local Government Economic Assistance Fund established by the General Assembly in 1980, a portion of coal severance taxes is returned to counties.

The economic contribution to coal counties and the State economy and General Fund are clearly substantial. In order to ensure the long-term economic stability of these counties and continued State revenues from the coal industry, a careful assessment of factors affecting production should be undertaken. Historical trends are instructive—production rates have fluctuated as a result of changes in demand for coal, availability of reserves, access to transportation infrastructure, and development of new mining and processing technology. These factors will continue to affect the economic strength and competitiveness of the industry in the future.

Kentucky contains sufficient coal resources to support mining well into the future, but whether these resources can be economically mined at competitive coal prices will depend on other factors. Most of the resource base is associated with relatively few coal beds. Some of these coal beds have been extensively developed in specific areas, and this may affect employment demographics in the near future. The resources that remain are more likely to be thinner, of poorer quality, or more challenging in terms of mining conditions. At the same time, surface mining will continue to decline in importance relative to more costly underground methods, and this will have an impact on the competitiveness of Kentucky's mines.

Future mining of less accessible and more complex coals and highly sophisticated processing and utilization cannot be achieved without an improved understanding of Kentucky's coal resources. Knowledge of the geologic characteristics associated with thin and deep seams will be essential to develop the necessary technology to extract and process these resources. Detailed chemical characterization of coals will provide the data necessary to assist industry to develop strategies for compliance with future regulation of combustion emissions. Perhaps of greater importance, characterization will provide valuable information about new techniques required to further process coal for specialty, high-value markets and will help identify the coal reserves with the greatest potential for value-added processing.

Most of the coal mined in Kentucky is sold out of state for electric power generation. Since 1970, competition in this market has begun to shift from a regional to a national basis as a result of new low-cost mines in the western United States. This added competition has further depressed coal prices and resulted in low profit margins. Profitability has become increasingly dependent on producing larger quantities of coal with fewer personnel. An alternative to this marketing strategy is to identify specialty uses of coal, existing and novel, which may generate significantly higher prices. While such efforts will not likely replace dependence on the steam coal market, they can be used to position companies for success in an increasingly competitive market and may also provide international market opportunities.

The coal resource base in Kentucky is substantial. It has supported extensive mining throughout this century, but sustainable production rates in the future are uncertain. The technology used to mine and process the resource, the commodities produced, and the markets pursued in the future will likely be different from those in the past. Over time, emphasis will likely shift toward mining thin coal beds and deeper coal deposits. Less emphasis will be placed on surface mining and more emphasis will be placed on underground mining. Coal may be viewed not only as a vital source of energy for electric power generation and combustion, but also as a valuable upgraded product that can be used in high-value, specialized markets in the chemical and other industries. As new market opportunities are identified and new technology employed in the mining and processing of coal, there should be significant opportunities to capture the full economic benefits of the substantial remaining coal resources in Kentucky.

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