U.S. Department of the Interior
U.S. Geological Survey

Assessing the Coal Resources of the United States

Introduction

In 1994, coal production in the United States reached the highest level in history (slightly more than 909 million metric tons or one billion short tons), continuing the upward trend of coal production and utilization that began 34 years ago. Previous assessments of the coal resources of the United States, which were completed as early as 1909, clearly indicated that the total coal resources of the Nation are large and that utilization at the current rate will not soon deplete them.

The Nation's coal resources are being reassessed by the U.S. Geological Survey (USGS). This assessment will not attempt to estimate the total coal endowment of the United States, but will instead identify and characterize the coal beds and coal zones that will provide the bulk of the nation's coal-derived energy during the first quarter of the twenty-first century, and, likely, well beyond.

Figure 1 outlines the major assessment activities of the USGS. For this study, the Nation has been divided into coal-producing regions. Teams of geoscientists, with expertise in each region, will carry out the coal assessments. Initially, five major coal-producing regions of the United States will be studied—the Appalachian Basin, the Illinois Basin, the Gulf Coast, the Northern Rocky Mountains and the Northern Great Plains, and the Rocky Mountains and Colorado Plateau (fig. 2). Additional regions having less potential for significant coal production during the next several decades will be studied in future years of the project. For each coal-producing region, the more important coal beds or coal zones will be identified, extent and thickness of the coals will be mapped, and information about resource parameters will be gathered. Special emphasis will be given to coal-quality parameters when characterizing the nature of the resource, principally calorific value, ash yield, and sulfur content. Chemical elements that can adversely effect coal utilization, as well as those of environmental concern, will also be delineated wherever possible. All data will be stored in digital form, and all products (such as text, tables, and maps) will be made available in digital form, thereby permitting geographic information system (GIS) technology to be used to manipulate and display the coal resource information.

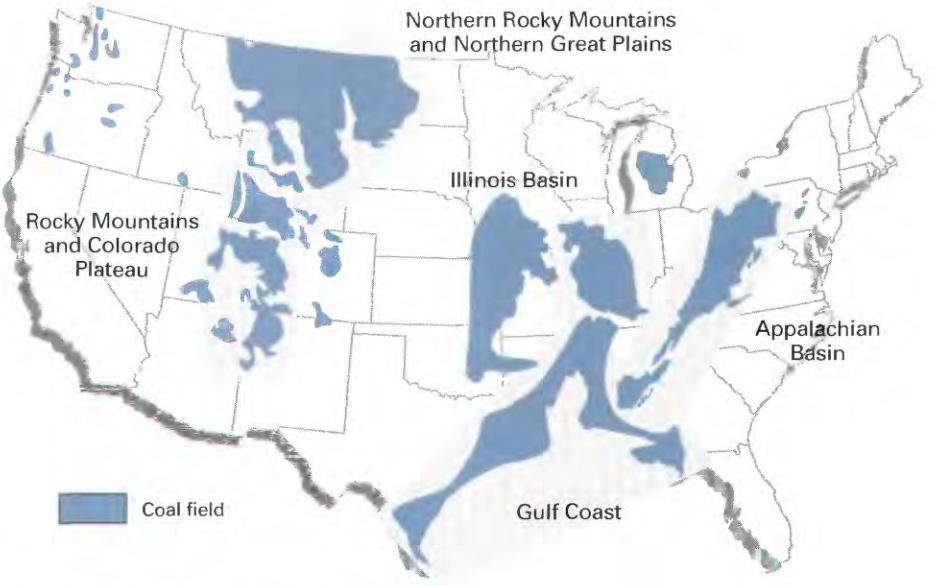

Figure 2. National Coal Resource Assessment regions.

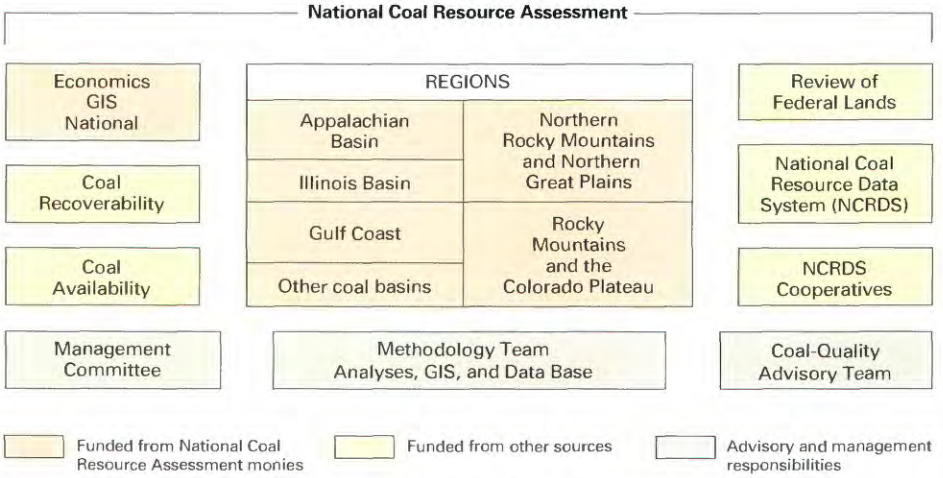

Figure 1. National Coal Resource Assessment activities of the U.S. Geological Survey.

The success of the National Coal Resource Assessment will depend on the degree of cooperation between the USGS, other Federal agencies, State Geological Surveys, and coal producers in the major coal-producing States. These cooperators are a major source of data for the National Coal Resource Assessment and have local expertise to supplement that of the regional team. The results of the resource analyses within each region will be made available to the public as the studies are completed. A national summary of the entire assessment project is planned for 1999.

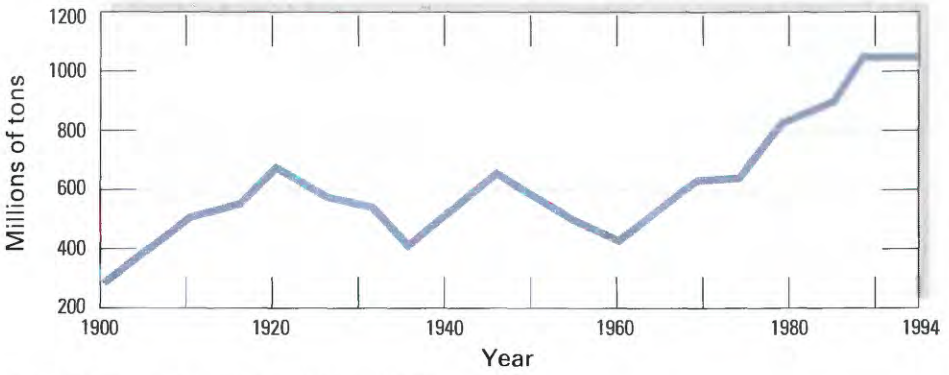

Figure 3. Coal production in the United States, 1900–94.

Economics of the National Coal Resource Assessment

Coal is an energy-producing commodity that is essential to the economic well-being of the world. The major use of coal in the United States is for the production of electricity. Other uses are residential and commercial, including production of coke for the steel industry. In 1994, the United States consumed a record 930 million short tons of coal (Energy Information Administration, 1995). Of these, electric utilities consumed about 817 million short tons, or about 88 percent of domestic production. The United States exported about 71 million tons of coal in 1994, chiefly for uses in metallurgical industries and for production of steam (electric utilities).

The economic viability of a coal deposit depends on several factors, including the overall quality and calorific value of the coal, mining costs, beneficiation costs, transportation to market, and the costs of disposal of the waste products of use. Like any other nonrenewable economic resource, coal deposits are discovered and evaluated, exploited if they are economic, and abandoned once they no longer can be produced at a profit, even though much of the resource may remain in the ground.

In a review of world energy resources, M. King Hubbert (1973) estimated that the coal resources of the United States and of the world will be depleted within 300 to 400 years. More recently, the Energy Information Administration (1995) estimated that the United States has enough coal to last 250 years. Clearly, there is a large amount of coal in the world. However, during the next few centuries, coal production rates will likely decline as mining thinner, deeper, and less desirable coal beds becomes necessary. Nevertheless, an overall decline in this Nation's coal production is not anticipated for many years. The National Coal Resource Assessment will provide coal-quantity and coal-quality data essential for determining the suitability of coal for various uses and for estimating future coal production rates for the various coal-producing States and coal-producing regions of the Nation.

In the United States, major changes in the coal industry and in the economy of the coal-producing regions are occurring. In general, production from eastern coal fields is steady or declining, and production from western coal-producing regions is increasing rapidly in response to the demand for low-sulfur steam coal (fig. 4).

The Appalachian basin is in a mature stage of development. Reserves in some Appalachian States are depleted, and residual coal production is low. In other Appalachian States, annual production rates, although considerable, are declining. Only in eastern Kentucky, West Virginia, and Alabama is coal production increasing or remaining steady in response to the high demand for steam coal. The relatively high sulfur content of coal from the Illinois basin is a serious impediment to the coal's use for steam production. Like the Appalachian basin, the Illinois basin has a long history of mining and is in a mature stage of development. In contrast, production from the very thick, subbituminous low-sulfur coal in the Powder River basin is increasing dramatically as a source for steam coal, even though its calorific value is lower than that of eastern coals. Impure lignites of low calorific value are being used for electric power generation in Texas, Louisiana, and North Dakota. The lower heat of combustion and quality of lignites preclude their transportation over significant distances, limiting their use to powerplants situated near mine sites.

Production of bituminous coal from Rocky Mountain States is increasing as demand for steam coal increases in western markets. In general, Rocky Mountain coal-producing regions are in a relatively early stage of development because transportation networks, as well as markets, are not fully developed.

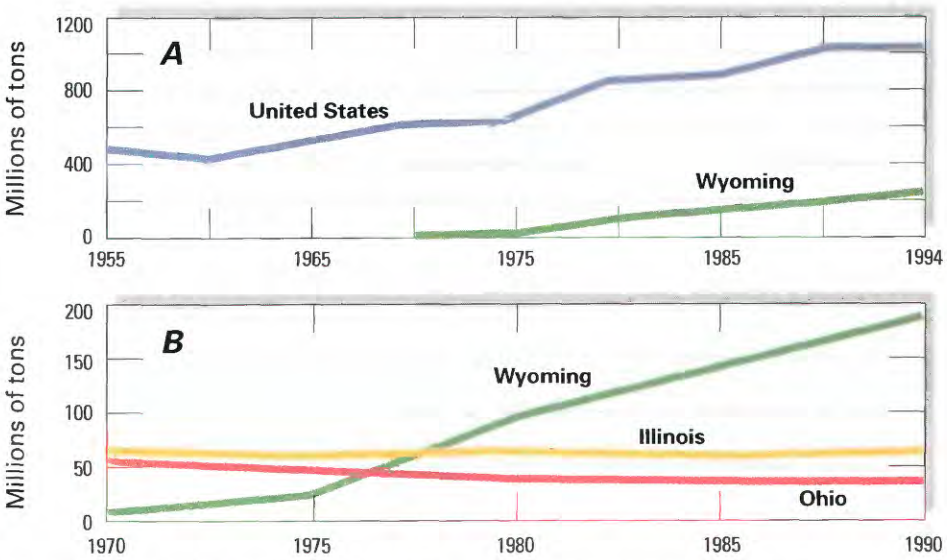

Figure 4. *A*, Coal production, United States and Wyoming; *B*, Coal production, selected States.

The Appalachian Basin

Approximately 40 percent of the Nation's coal is produced in the six States (Ohio, Pennsylvania, West Virginia, Maryland, Virginia, and Kentucky) that lie in the northern and central Appalachian basin (fig. 5). Coal is, and will continue to be, the primary energy commodity in the basin. More than 60 coal beds and coal zones are being mined. Fifty-six percent of the Appalachian total is produced from just 10 coal beds or zones (Energy Information Administration, 1995). Three of these beds, the Pittsburgh coal bed and Upper Freeport coal bed (Upper Pennsylvanian) and the Kittanning coal zone (upper Middle Pennsylvanian), are located in the northern part of the basin. The remaining six, the Fire Clay, the Hazard No. 5 (both Middle Pennsylvanian), the Upper Elkhorn No. 3, Alma, Pond Creek, and the Pocahontas No. 3 coal beds and (or) zones (all lower Middle Pennsylvanian), are located in the central parts of the basin. Each of these beds or zones produce more than 10 million short tons annually.

This study is designed to use the data and expertise existing within the USGS and the State Geological Surveys to produce bed-specific, digital coal resource assessments for most of the top producing coal beds and coal zones in the basin. Unlike past USGS assessments, this study will emphasize not only the quantity of coal but also the quality of the coal. Particular attention will be paid to the geochemical parameters that are thought to adversely affect combustion characteristics and the environment, including ash yield, sulfur content, calorific value, and the elements listed in the 1990 Clean Air Act Amendments. Geochemical data bases produced for the assessed beds will be augmented by new representative coal analyses of major, minor, and trace elements.

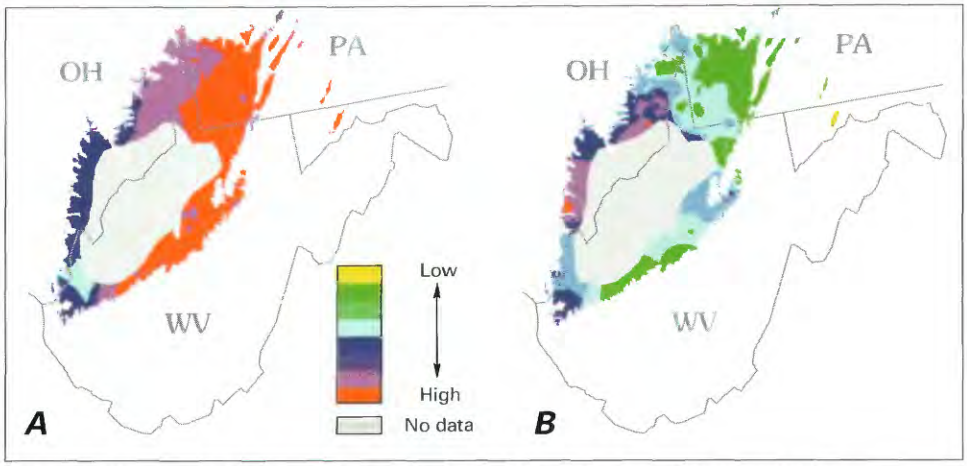

Figure 6. Preliminary Pittsburgh coal-bed quality maps. *A*, Preliminary mapping of chemical data points indicates higher calorific values (12,000–14,000 BTU/lb, as received) in the eastern part of the basin and lower values (10,000–12,000 BTU/lb) in the western part. This relation correlates with an increase in coal rank and higher total sulfur, as shown in *B*.

Cooperators

Geologists from the Kentucky Geological Survey, the Pennsylvania Bureau of Topographic and Geologic Survey, the West Virginia Geological and Economic Survey, the Ohio Division of Geological Survey, the Maryland Geological Survey, and the Virginia Division of Mineral Resources are providing vital expertise to the Appalachian basin portion of the National Coal Resource Assessment. Cooperative studies and information exchanges are also conducted with geologists and engineers in State permit and land-use agencies and private industry.

Products

Products will include stratigraphic and geochemical data bases, original and remaining resource calculations, and comprehensive bed-scale digital maps at a scale of 1:250,000 and 1:500,000 of geochemical, cropline, coal thickness, coal structure, overburden thickness, and mined-out areas for the assessed coal beds. The assessment for the Pittsburgh coal bed (fig. 6) will be completed in 1996; all products will be available digitally. Both stratigraphic and geochemical data for the assessment of the Pocahontas No. 3 coal bed and Kittanning coal zone will be compiled and verified from existing records already in the National Coal Resources Data System (NCRDS), and new publicly available data from mine permits, various State and Federal agencies, industry files, and published data.

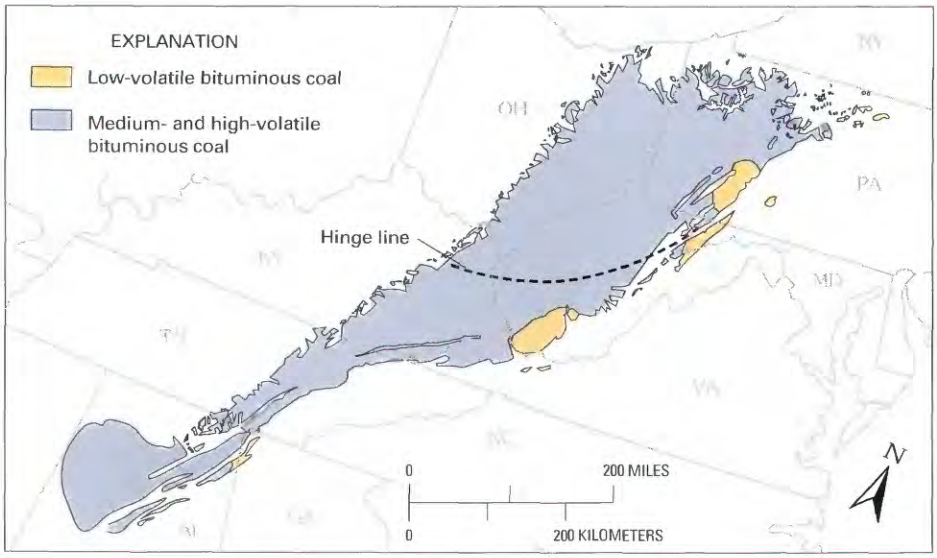

Figure 5. Coal-bearing formations in the northern and central Appalachian basin. Informal hinge line separates the high-sulfur (approximately 1.5–3.0 percent), northern part of the Appalachian basin from the low-sulfur (in general, less than 1.5 percent), central part.

The Illinois Basin

In terms of total coal resources, the Illinois basin (fig. 7) is one of the largest bituminous coal basins in the United States. Coal production in the basin in 1994 (fig. 8) was about 121 million short tons (Energy Information Administration, 1995). This production level is predicted to decline over the next 10 years as electric utilities change from high-sulfur Illinois basin coals to low-sulfur western coals.

This project will review previous assessments, facilitate the updating and merging of State digital data bases, and produce summaries of the tonnages and quality aspects for the major mined coal beds of Pennsylvanian age in the Illinois basin. The major beds are the Springfield (IL No. 5, IN V, KY No. 9) and the Herrin (IL No. 6, KY No. 11) coals.

Cooperators

The State Geological Surveys of the three States containing the Illinois basin—Illinois, Indiana, and Kentucky—are essential cooperators in this project. Each brings regional expertise and locally complete data bases to the study, without which the National Coal Resource Assessment would be much less complete.

Products

The main product of the project will be a digital data base that contains all publicly available point-source data on thickness, depth, and coal-quality for the major mined coals. From this data base, basinwide maps will be prepared for the principal coal beds; the maps will depict thickness, structure (elevation and depth), calorific value, moisture, sulfur, and other significant coal-quality parameters.

Summaries for additional beds will be provided if time permits. In order of priority (from highest to lowest), these beds are Danville (IL No. 7, IN VII, KY No. 14), Seelyville/Davis/ Dekoven (KY No. 6 & 7), Jamestown/ Hymera (IN VI, KY No. 12), Colchester (IL No. 2, IN IIIa), Survant (IL No. 2A, IN IV), Chapel (IL No. 8) and Womac, and Murphysboro coals.

Figure 7. The Illinois basin.

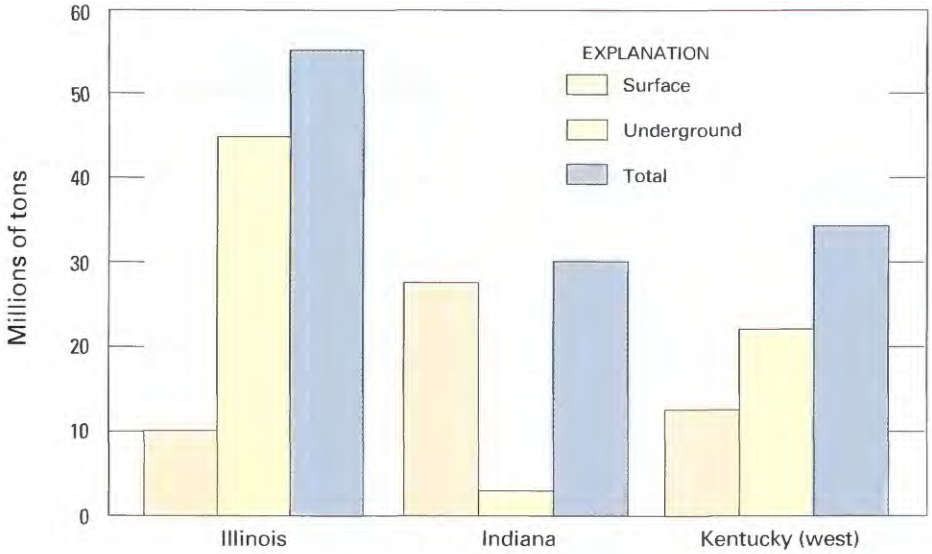

Figure 8. Coal production in the Illinois basin, 1994.

The Gulf Coast

The Gulf Coast region (fig. 9) produces about 57 million short tons of coal annually. Texas ranks sixth in coal production in the United States. Most coal in the region is produced from the Wilcox Group (Paleocene-Eocene) (fig. 10) and is used as fuel for mine-mouth electric power-generating plants. Gulf Coast coal quality is generally below that of other major coal-producing regions of the United States. The objectives of this project are to provide high-quality, organized information and interpretations on the location, quality, and quantity of the coal to be mined in the Gulf Coast area during the next several decades to meet the needs of the region and the nation for reliable, low-cost, environmentally compatible energy.

The primary interval of study is the Wilcox Group. In addition, selected coal-producing intervals (such as the Jackson and Claiborne Groups, Eocene) that are producing or have potential for producing coal in the near future, will be investigated. Particular emphasis will be given to the characterization of the Hazardous Air Pollutants identified by the 1990 Clean Air Act Amendments.

Work will include the collection of mine permit data, State survey data, and petroleum data base information and the review and organization of the USGS's National Coal Resources Data System (NCRDS) stratigraphic and geochemical data. New coal samples for geochemical characterization, mine maps, and other data will be collected. Palynological studies will continue to improve stratigraphic control in areas to be assessed.

Cooperators

The Gulf Coast area cooperators include the Arkansas Geological Commission, the Geological Survey of Alabama, the Louisiana Geological Survey, the Mississippi Office of Geology, the Tennessee Division of Geology, and the Texas Bureau of Economic Geology.

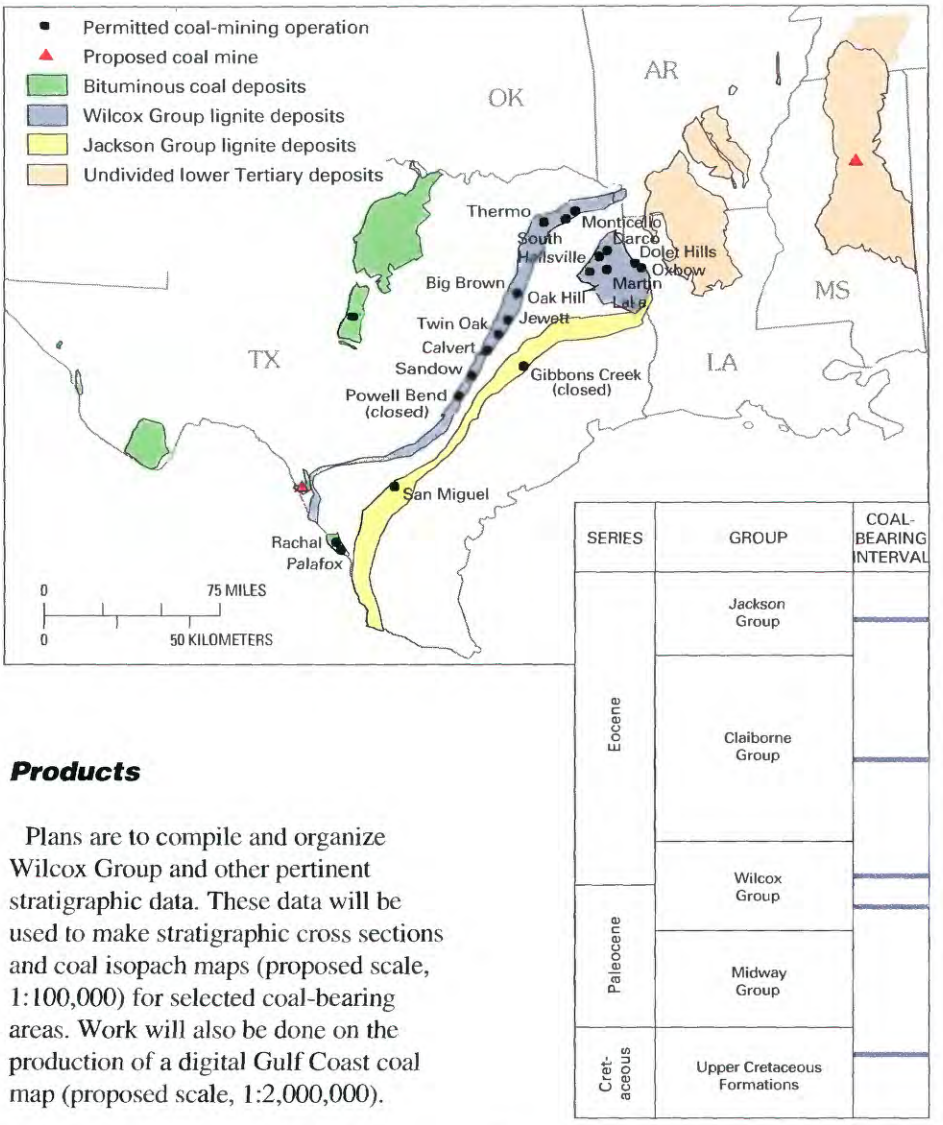

Figure 10. Locations of coal mines in the Gulf Coast region. Stratigraphic column shows position of coal-bearing intervals.

Products

Plans are to compile and organize Wilcox Group and other pertinent stratigraphic data. These data will be used to make stratigraphic cross sections and coal isopach maps (proposed scale, 1:100,000) for selected coal-bearing areas. Work will also be done on the production of a digital Gulf Coast coal map (proposed scale, 1:2,000,000).

Project Personnel

This project team consists of sedimentologists, stratigraphers, coal resource specialists, palynologists, geochemists, computer specialists, and physical science technicians.

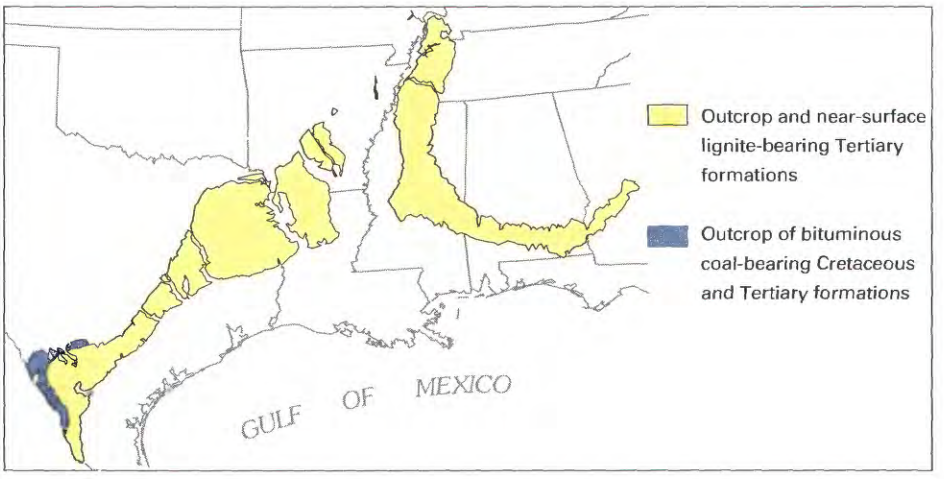

Figure 9. Major coal-bearing areas in the Gulf Coast region.

The Northern Rocky Mountains and the Northern Great Plains

The northern Rocky Mountain region and the Northern Great Plains of Wyoming, Montana, and North Dakota contain vast amounts of strippable coal within the Paleocene Fort Union Formation (fig. 11). Fort Union coal beds currently being mined are as much as 140 feet thick. About 30 percent or 300 million short tons of the 1.03 billion short tons of coal produced in the United States in 1994 is from Fort Union coal beds in this region. This region includes the 14 largest coal mines in the United States, each having production of over 10 million short tons. Production is from 14 beds or zones—the Wyodak-Anderson, Anderson-Dietz, and Rosebud of the Powder River Basin, the Beulah-Zap, Hagel, and Harmon of the Williston basin; and the Ferris Nos. 23, 24, 25, 31, 38, 39, Hanna No. 80, and Deadman seam of the Hanna-Greater Green River basin. More than 25 percent of the Nation's coal production is from 25 mines developing the Wyodak-Anderson, Anderson-Dietz, and Rosebud coal beds or zones in the Powder River Basin. These coals are relatively clean, containing less sulfur and ash than coals produced from other regions in the conterminous United States. Accordingly, mining of these compliance coals increased from less than 25,000,000 million short tons to more than 250,000,000 million short tons, and replaced, in part, noncompliance coals from other regions as fuel demand for electric power generating plants grew during the past two decades. Coal resources of Tertiary age in other parts of the Northern Rocky Mountains will be assessed also, although not as rigorously.

Coals from the Powder River Basin analyzed for Hazardous Air Pollutants named in the 1990 Clean Air Act Amendments indicate lower Hazardous Air Pollutants content than other coals from within this region and other regions in the United States. Thus, the unique chemical characteristics and thickness of these Fort Union coals make them an important resource for continued and expanded use within current and future environmental constraints.

The objectives of this project are to focus on the resource assessment of these and other coal beds or zones that are potentially mineable during the next several decades, to build a relational digital data base (geographical, stratigraphical, and analytical) that can be accessed rapidly and analyzed by a variety of customers, and to provide critical geological information for immediate coal development and for future mining.

Cooperators

State cooperators include the North Dakota Geological Survey, the Montana Bureau of Mines and Geology, and the Wyoming State Geological Survey. Federal and private cooperators include the Office of Surface Mining (Denver office), the Bureau of Land Management in Wyoming (Casper and Cheyenne offices) and Montana (Billings office), and 15 mining companies in Montana, North Dakota, and Wyoming.

Products

Anticipated digital products of this project include (1) maps showing data distribution, outcrops and subcrops of coal-bearing rocks, and mine permit and lease boundaries, (2) maps of thickness and chemical concentrations of coal beds or zones, (3) overburden and coal strippability maps, (4) stratigraphic and coal bed or zone correlation charts, and (5) tabulated resource estimates. Data and products will be available in the USGS National Coal Resources Data System (NCRDS) and on CD–ROM.

Project Personnel

The project consists of a multidisciplinary team of sedimentologists, stratigraphers, geochemists, palynologists, coal-resource specialists, and computer specialists.

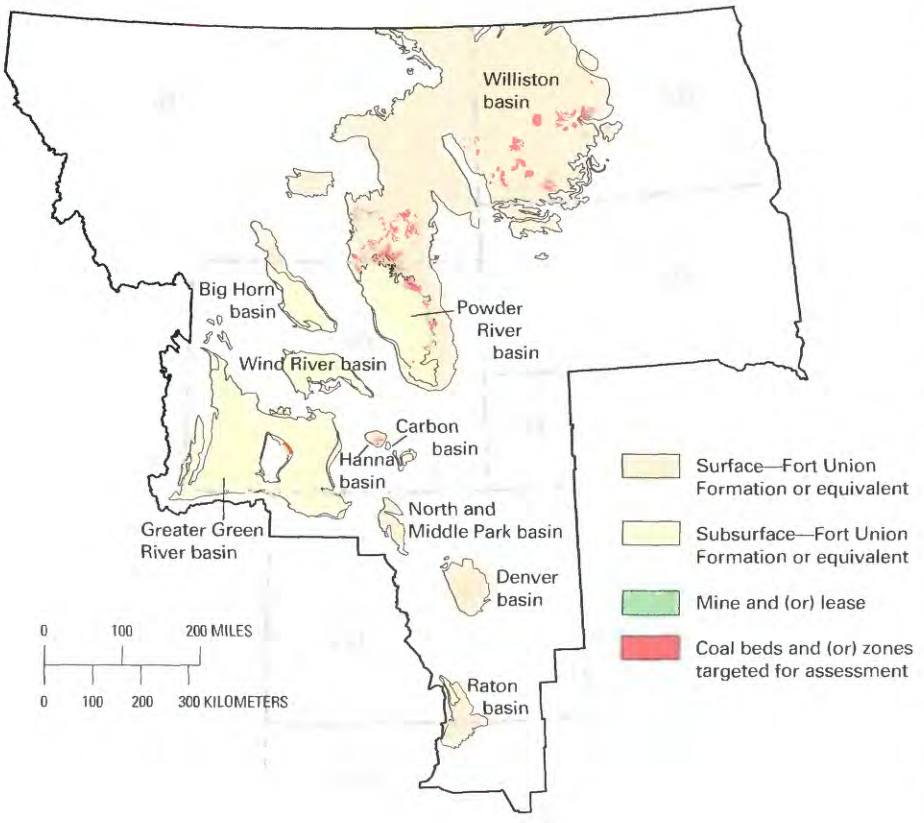

Figure 11. Paleocene coal-bearing basins, the lateral extent of the Fort Union and equivalent formation, mine lease areas, and targeted coal beds or zones.

The Rocky Mountains and Colorado Plateau

This project will provide information on the distribution and quality of coals of the Colorado Plateau and adjoining areas. Emphasis is placed on coals that have a high potential for being mined over the next few decades and on coals administered by the Federal Government. The study region, which includes parts of Arizona, Colorado, New Mexico, Utah, and Wyoming (fig. 12), encompasses approximately 40 active mines that produce a total of more than 80 million short tons of coal each year. The amount of coal mined in this area has risen steadily over the last 30 years. The coal supplies the fuel for many of the region's electrical powerplants, and some of the coals contain significant methane resources.

Coals in the Colorado Plateau are entirely of Cretaceous age. The coals are generally subbituminous to bituminous in rank, low in sulfur content (424 samples average 0.7 percent), and low in ash content (average 12.3 percent). Six high-priority areas have been identified for detailed study (1) southern San Juan basin—Menefee and Crevasse Canyon Formations, (2) northern San Juan basin—Fruitland Formation, (3) southern Piceance basin—Mesaverde Formation, (4) northwest Colorado (Danforth, Yampa, and Lower White River coalfields)—Williams Fork Formation, (5) Wasatch Plateau and Book Cliffs area—Blackhawk Formation, and (6) Kaiparowits Plateau—John Henry Member of the Straight Cliffs Formation.

The study will concentrate on the six high-priority coal-bearing areas. The Kaiparowits Plateau is virtually unmined and has an untapped original coal resource. Resources will be estimated by using technical restrictions such as thickness and depth and will be categorized by landownership. The remaining five studies are in areas of active (and historical) mining. Each study will follow the basic plan developed for the Kaiparowits study. These studies also will show areas where coal mining is restricted because of land-use, industrial, social, or environmental factors.

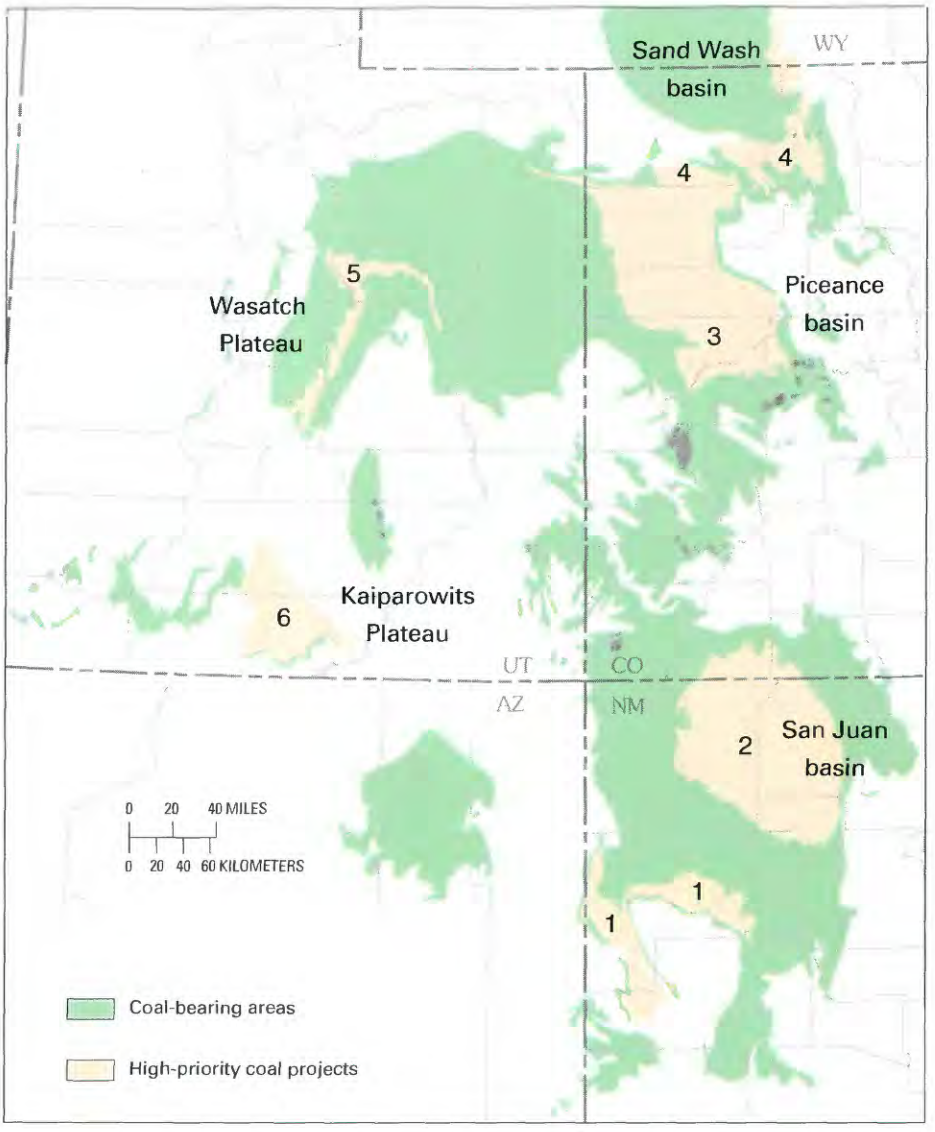

Figure 12. Coal-bearing areas in the Colorado Plateau region.

Cooperators

Cooperative studies are in progress with the U.S. Bureau of Land Management, the U.S. Forest Service, and the State Geological Surveys of Colorado, New Mexico, and Utah.

Products

The report on the John Henry Member in the Kaiparowits Plateau will be the first to be completed and will include detailed stratigraphic cross sections, structure contour and overburden maps, and seven coal isopach maps. Also, a geographic information system is being developed that will integrate coal stratigraphy, coal resources, and coal geochemistry data bases.

Project Personnel

This project team consists coal geologists, stratigraphers, geochemists, sedimentologists, and computer specialists.

References

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