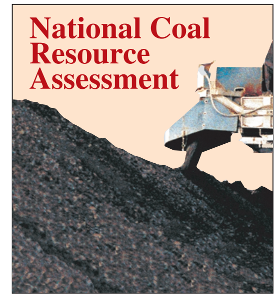
Chapter O

Investigations of the Distribution and Resources of Coal in the Southern Part of the Piceance Basin, Colorado



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By Robert D. Hettinger,[1] Laura N.R. Roberts, [1] and T.A. Gognat[2]

Chapter O *of*

Geologic Assessment of Coal in the Colorado Plateau: Arizona, Colorado, New Mexico, and Utah

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Investigations of the Distribution and Resources of Coal in the Southern Part of the Piceance Basin, Colorado

By Robert D. Hettinger, Laura N.R. Roberts, *and* T.A. Gognat

Abstract

This report on the southern part of the Piceance Basin, Colorado, is a contribution to the U.S. Geological Survey's (USGS) "National Coal Resource Assessment," a 5-year effort to identify and characterize coal beds and coal zones that could potentially provide fuel for the Nation's coal-derived energy during the 21st century. The report provides a geologic overview of the southern Piceance Basin and assesses its coal in terms of stratigraphic and geographic distribution, net accumulation, bed thickness, and overburden. Results are shown in maps, cross sections, and tables, and coal tonnage is reported by overburden, reliability, county, 7.5′ quadrangle, and ownership. These data provide useful information for future energy exploration and land-use planning and may help evaluate the basin's coal-bed methane potential.

Coal quantities reported as "resources" represent, as accurately as the data allow, all the coal in the ground that is in beds greater than 1 ft thick and less than 6,000 ft deep. Quantities of more deeply buried coal are reported as "other occurrences of non-resource" coal. Resources and non-resources of coal are differentiated into "identified" and "hypothetical" categories following the standard classification system of the USGS. Identified resources are those within 3 mi of a measured thickness value (data point), and hypothetical resources are farther than 3 mi from a data point. This study does not attempt to estimate coal "reserves" for the southern part of the Piceance Basin. Reserves are that subset of the resource that could be economically produced at the present time. Factors that effect the amount of coal that can be economically recovered include: (1) coal bed thickness, (2) the lateral discontinuity and inclination of coal beds, (3) coal that must be left in the ground for roof support, (4) coal beds that may be bypassed or destroyed while mining adjacent seams, and (5) coal that may not be mined owing to land-use or environmental restrictions. These factors may significantly reduce the amount of coal that could be recovered in the southern Piceance Basin, and the data used in the coal assessment are not sufficient to determine the proportion of the resource that is technologically and economically recoverable. For purposes of comparison, studies of coal resources in the Eastern United States have shown that less than 10 percent of the original coal resource, in the areas studied, could be mined economically at today's prices.

The study area occupies about 4,140 mi^2 of rugged terrain in the southern part of the Piceance Basin of west-central Colorado. The study area contains large quantities of coal and natural gas in the Upper Cretaceous Cameo-Fairfield coal group. The coal group is exposed along the basin's gently to steeply dipping flanks, and it is as much as 14,000 ft deep in the basin's interior region. The coal-bearing rocks are intruded by Tertiary dikes, sills, and laccoliths in the study area's southeastern region. The coal group is in the Williams Fork, Mount Garfield, and Mesaverde Formations, and it overlies the Rollins Sandstone Member of the Mesaverde, Iles, and Mount Garfield Formations. Coal beds in the Cameo-Fairfield accumulated in coastal-plain mires along the western edge of the Western Interior Seaway. These coastal-plain deposits intertongue to the southeast with marginal-marine strata that were deposited as the shorelines migrated back and forth during an overall regression to the southeast.

The Cameo-Fairfield coal group is 4 to 1,400 ft thick and contains as much as 140 ft of net coal in as many as 26 beds; coal-bed thicknesses range from 1 to 44 ft. The apparent rank of coal varies from subbituminous A to anthracite, and coal with coking properties has been identified in the southeastern part of the basin. The coal group contains (in ascending order) the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones. The Cameo-Wheeler coal zone is the most widespread of the three zones and it contains the thickest beds of coal; it is exposed along the southern and eastern margins of the study area and extends through the subsurface. The South Canyon and Coal Ridge coal zones are located only in the eastern part of the study area. About 176 million short tons of coal have been mined underground from the Cameo-Fairfield group in the Book Cliffs, Grand Mesa, Somerset, Crested Butte, Carbondale, and Grand Hogback coal fields. Most of the coal has been produced from the Cameo-Wheeler coal zone.

The Cameo-Fairfield coal group contains approximately 34 billion short tons of coal in beds that are more than 3.5

ft thick and less than 3,000 ft deep. Although some of this resource is currently feasible to mine economically, much of it may not be minable because of geological, technological, land-use, or environmental constraints. The coal group contains additional coal that is either too deep or in beds too thin to be mined economically in the foreseeable future. These include an estimated 13 billion short tons of coal that are less than 3.5 ft thick and under less than 3,000 ft of overburden, and about 170 billion short tons of coal that are under 3,000 to 14,000 ft of overburden. Although these thin or deep beds of coals are not likely to be mined, they may be an important source for coal-bed methane.

Introduction

Purpose and Scope

This report provides an assessment of coal resources in the southern part of the Piceance Basin, Colorado. Results of the study include a preliminary delineation and assessment of thick coal deposits and may serve as a baseline for other efforts to further assess the coal resource in terms of its availability and recoverability. The study also provides data that may help evaluate the basin's coal-bed methane potential. The Southern Piceance Basin assessment unit is part of the U.S. Geological Survey's National Coal Resource Assessment project that was initiated in 1994. The goal of the National Assessment is to characterize the resource potential and quality of coal for the entire Nation, with emphasis on those coals that may be of importance during the first quarter of the next century. The southern Piceance Basin contains significant resources of coal within the Mesaverde Group and Mesaverde Formation and is one of six priority areas within the Rocky Mountains and Colorado Plateau region. Resources in the southern part of the Piceance Basin represent about 3 percent of the Nation's total coal resource in the lower 48 States, if compared to the figures of Averitt (1975).

The assessment of the southern Piceance Basin is based primarily on data from oil and gas drill holes as well as data from coal test holes, outcrop measurements, and geologic mapping that has been conducted in the region since the early 1900's. Our interpretations from these data have been integrated with additional published geologic information to construct coal correlation charts and maps that show various aspects of coal distribution in the southern Piceance Basin. These data have been stored digitally and manipulated in a geographic information system to calculate coal resources within a variety of spatial parameters that are useful for land-use planning. Coal resources reported in this investigation are for total in-place coal and do not indicate the amount of coal that can be economically mined from the southern Piceance Basin.

Methods

In order to assess the coal resources of the southern part of the Piceance Basin, we created digital files for various geographic and geologic features within the region. These spatial data were stored, analyzed, and manipulated in a geographic information system (GIS) using ARC/INFO software developed by the Environmental Systems Research Institute, Inc. Spatial data that require gridding for the generation of contour and isopach maps were processed using EarthVision (Dynamic Graphics, Inc.). Contour lines generated in EarthVision were then converted into an ARC/INFO-generated format using a program called ISMARC and then converted into ARC/INFO polygon coverages using an Arc Macro Language (AML) program called CONVERT-ISM. We received both of the conversion programs from the Illinois State Geological Survey. We also collected and created additional coverages in ARC/INFO that define topographic features and various geographic boundaries within the vicinity of the study area such as counties, 7.5′ quadrangles, townships, and boundaries of surface and coal ownership. Integrating these various coverages allowed us to calculate coal resources and characterize coal distribution within a variety of geologic and geographic parameters that could be selected according to an individual's needs. The various digital files used in this report are available in the Colorado Plateau ArcView project (see Appendix 6), and they are explained by Biewick and Mercier (chap. D, this CD-ROM). The following paragraphs discuss procedures used to produce the various coverages used in the assessment.

Lithologic and Stratigraphic Data

Lithologic and stratigraphic data and the geographic distribution of coal are based on our interpretations of geophysical logs from 526 drill holes as well as published lithologic descriptions from 31 coal exploration holes and 70 published stratigraphic sections described from outcrops. At least one data point has been used in each square mile where data are available. Data point localities are shown on plate 1 (fig. A) and identified in Appendix 1; latitudinal and longitudinal coordinates of oil and gas holes were provided by the Colorado Oil and Gas Conservation Commission. Net-coal thicknesses and the elevation at the base of the coal resource interval (i.e., the top of the Rollins Sandstone Member) are also provided for each data point in Appendix 1. Stratigraphic interpretations are based on lithologic stacking patterns in each drill hole, as well as published outcrop descriptions and texts in geologic reports. Our complete database is available in ASCII format, DBF, and Excel spreadsheets in Appendix 5 on disc 2 of this CD-ROM—this database contains all lithologic and stratigraphic interpretations used in this assessment.

Lithologic interpretations from geophysical logs were generally made from a combination of natural gamma (gamma ray), density, resistivity, neutron, spontaneous potential, and caliper logs. Sandstone was interpreted from a moderate response on natural gamma and resistivity logs. Mudrock was interpreted from a high natural gamma and a low resistivity response. Coal was interpreted from a low natural gamma and density response and a high resistivity and neutron response. The thicknesses of coal beds were generally determined from density logs recorded at a scale of 1 inch to 40 ft. Coal-bed thicknesses were measured at the inflection points on the logs and reflected a specific gravity of 1.4 to 1.75 g/cm^3; thickness adjustments were made, if necessary, based on observations made from supplemental logs. The recorded thicknesses of coal beds were rounded off to the nearest 1 ft, and beds less than 1 ft thick were not included in the assessment; a minimum thickness of 1 ft was a modification from the 14-inch cutoff for coals of bituminous rank suggested by Wood and others (1983).

Coal-bed thicknesses and the net coal in a bed were determined according to Wood and others (1983). According to that methodology, a bed includes all coal and partings (noncoal material) that lie between the roof and floor, and the net thickness of coal in a bed does not include the thickness of partings that are more than 3/8 inch thick (Wood and others, 1983, p. 5, 31). Furthermore, according to Wood and others, (1983, p. 36), separate benches of coal are considered to be part of the same bed when the intervening parting is thinner than either bench; when the parting exceeds the thickness of either bench, the bed is considered to have split into two beds. Based on these criteria, we report the thickness of a bed to include the combined thicknesses of benches and partings; however, we report the net coal in a bed to include only the combined thicknesses of the coal benches.

Several quality-control procedures were used to detect and omit stratigraphic and data-entry errors. Down-hole depths of formations, coal zones, and lithologies were recorded on encoding sheets and hand-keyed into a StratiFact data-management system. Data entry errors were discovered and resolved by comparing the original geophysical logs to corresponding "strip logs" generated from the StratiFact database. Stratigraphic data were further evaluated by building numerous cross sections within the StratiFact graphics package, and stratigraphic interpretations were reevaluated when correlation problems were identified. Finally, structure contour and isopach maps were generated within the StratiFact package to reveal any anomalies.

Geologic and Geographic Coverages

ARC/INFO coverages for geologic and geographic boundaries were either created in-house or imported from existing public-domain databases by Tracey Mercier of the U.S. Geological Survey (USGS). The various coverages were made using common map projections, registered with common coordinates, and overlain to produce composite coverages used for figures and resource calculations presented in this report. Every effort was made to properly align spatial features in the composite coverages; however, some slight discrepancies could not be resolved because the original coverages had been digitized at different scales.

Geographic coverages include State, county, and township boundaries; cities and towns; highways; roads; railroad lines; rivers and streams; topography; coal mines; and areas of surface and mineral ownership. State and county lines were obtained from 1:100,000-scale Topologically Integrated Geographic Encoding and Referencing (TIGER) files produced by the U.S. Bureau of the Census in 1990. Township boundaries were modified in-house from 1:100,000-scale Digital Line Graph (DLG) files of the Carbondale, Delta, Douglas Pass, Grand Junction, Glenwood Springs, and Paonia quadrangles. Cities and towns were obtained from 1:2,000,000-scale DLG files produced by the USGS Global Land Information System (GLIS). Roads and highways were imported from a 1:100,000-scale National Transportation Atlas Databases produced in 1996 by the Bureau of Transportation Statistics. Railroad lines were imported from a 1:2,000,000-scale National Transportation Atlas Databases produced in 1996 by the Bureau of Transportation Statistics. Rivers and streams were imported from a 1:500,000-scale coverage entitled "Conversion of the U.S. Environmental Survey Research File 1 to an ARC/INFO coverage." Surface topography was obtained from 1:250,000-scale U.S. Geological Survey digital elevation models (DEM) of the Grand Junction, Leadville, Moab, and Montrose quadrangles. Areas of surface and coal ownership were digitized from 1:24,000-scale quadrangle maps by the Bureau of Land Management. Inactive coal mine locations were compiled onto 1:24,000-scale 7.5′ quadrangle maps by the Colorado Geological Survey and were digitized by the Colorado Geological Survey under contract by the USGS.

The bedrock and surficial geology was modified from a digital geologic map of Colorado (Green, 1992) that was compiled from the 1:500,000-scale geologic map of the State of Colorado (Tweto, 1979). In the eastern and southern part of the study area, the base of the coal resource interval is represented by the top of the Iles Formation and the base of the Mesaverde Formation, as depicted on this digitized map. In the western part of the study area, the base of the resource interval was digitized from the base of the Cameo coal zone as mapped by Erdmann (1934). The base of the resource interval was adjusted where necessary to match topographic features indicated on 1:250,000 digital elevation models constructed by the USGS.

Coal Resource Calculations

Coal resources were calculated using the methodology of Wood and others (1983) and Roberts and others (chap. C, this CD-ROM). Coal resources represent all coal beds greater than 1 ft thick and under less than 6,000 ft of overburden within specified coal zones. Coal beds deeper than 6,000 ft are not considered to be a resource according to Wood and others (1983). Coal resources were determined by multiplying the volume of coal by the average density of coal (Wood and others, 1983, p. 36). The volume of coal was determined by multiplying the net thickness of coal within a specified coal zone by the areal distribution of the coal zone. Coal density was estimated by its rank (Wood and others, 1983, p. 22). The density of coal in the southern part of the Piceance Basin varies from 1,700 short tons per acre-ft for subbituminous coal to 2,000 short tons per acre-ft for anthracite. This study used an average density of 1,800 short tons per acre-ft for bituminous coal.

Coal resources were reported within various maximum coal-overburden categories. Overburden was determined by subtracting elevations at the base of specified coal zones from surface elevations imported from 1:250,000 digital elevation models constructed by the USGS. Maximum overburden lines are shown on resultant maps at 500-; 1,000-; 2,000-; 3,000-; 6,000-; and 10,000-ft intervals. Coal resources are reported in overburden categories of 0–500; 500–1,000; 1,000–2,000; 2,000–3,000; and 3,000–6,000 ft by integrating the overburden and net coal isopach maps of each coal zone.

Reliability categories are based on the distance that the resource is calculated from a data point. Identified resources are located within a 3-mi radius of a data point, and hypothetical resources are located beyond a 3-mi radius from a data point (Wood and others, 1983). Although confidence levels have not been established for these categories, they reflect decreased levels of accuracy for calculated resources based on their distance from a data point.

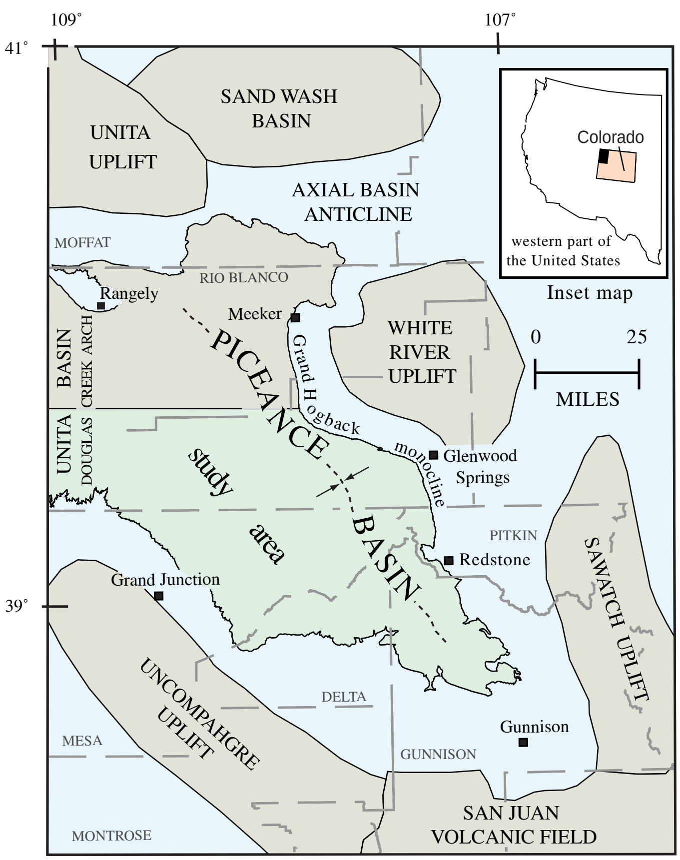


Figure 1. Location of the Piceance Basin and adjacent structural features (modified from Tweto, 1979). The study area (green) is in the southern part of the Piceance Basin. The inset map shows the location of these structural features (black area) in the State of Colorado and the western part of the United States.

Location

The area of investigation is located in west-central Colorado within the southern part of the Piceance Basin and includes a small part of the Uinta Basin (fig. 1). These adjoining structural and sedimentary basins developed as a single basin during Late Cretaceous time but were subsequently divided along the Douglas Creek arch (fig. 1) during the early Tertiary (Johnson and Finn, 1986). The Piceance Basin is bordered on the north by the Axial basin anticline, on the east by the White River and Sawatch uplifts, and on the south by the San Juan volcanic field and Uncompahgre uplift (fig. 1). The eastern flank of the Piceance Basin is defined by the Grand Hogback monocline, which extends approximately 90 mi from near Redstone north to Meeker, Colo. (fig. 1). The southern part of the Piceance Basin, or "study area" as defined in this report, includes those areas in Colorado that are within the Piceance and Uinta Basins that are south of lat 39°42′30″ and underlain by Upper Cretaceous rocks within the Mesaverde Group and Mesaverde Formation (this dual terminology is discussed in a later section on detailed stratigraphy) (figs. 1 and 2). The southeasternmost part of the study area is delineated along an inferred beveled edge of the Mesaverde Formation below Oligocene volcanics in the West Elk Mountains (Ellis and others, 1987).

The study area occupies approximately 4,140 mi^2 within parts of Delta, Garfield, Gunnison, Mesa, Pitkin, and Rio Blanco Counties (fig. 2). All or part of 99 7.5′ quadrangles cover the study area, and their names and locations are provided in Appendix 3. The towns of New Castle, Glenwood Springs, Carbondale, Redstone, Marble, and Crested Butte are located along the eastern margin of the study area, and the towns of Somerset, Paonia, Cedaredge, Delta, Palisade, and Grand Junction are located along the southern margin of the study area (fig. 2). Transportation through the study area includes Interstate 70, numerous State and local highways, and the Denver and Rio Grande Western Railroad (fig. 2).

Physiographic Features

The study area is characterized by rugged and variable terrain that has been produced by regional uplift, crustal folding, and subsequent erosion. Additionally, the terrain in the southeastern part of the study area, near the Elk and West Elk Mountains (fig. 2) has been further extensively influenced by numerous volcanic intrusions. The study area is drained by the

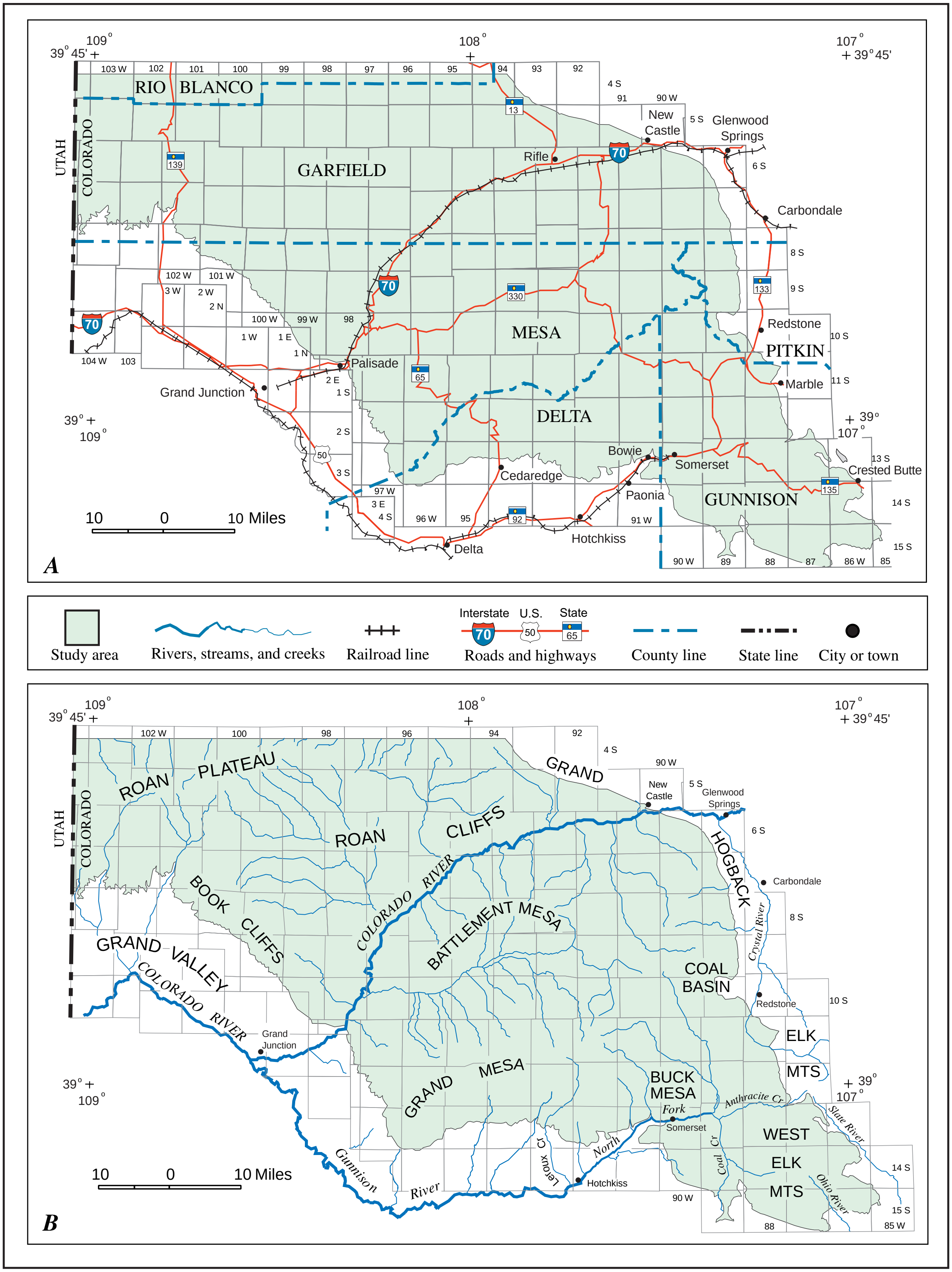


Figure 2. Location of study area in southern part of the Piceance Basin, Colorado. The study area includes areas south of lat 39°42′30″N. that are underlain by the Mesaverde Group or Mesaverde Formation. *A*, Geographic features in the vicinity of the study area. *B*, Physiographic features in the vicinity of the study area.

Colorado River, North Fork of the Gunnison River, and their tributaries (fig. 2), and tributaries to the Gunnison, Crystal, and White Rivers (fig. 2). The Colorado River flows southwesterly through the central part of the study area between the towns of Glenwood Springs and Grand Junction and proceeds westward through Grand Valley, which borders the southwestern part of the study area (fig. 2). The North Fork of the Gunnison River drains the southeastern part of the study area near Somerset and Paonia and joins the Gunnison River at the town of Hotchkiss; the Gunnison River then joins the Colorado River at the town of Grand Junction. Elevations on the Colorado River range from about 6,000 ft above sea level (asl) near Glenwood Springs to 4,400 ft (asl) near the Colorado-Utah State line, and elevations on the North Fork of the Gunnison River range from about 6,500 ft (asl) at its source to about 5,500 ft (asl) at its junction with the Gunnison River.

The area north of the North Fork of the Gunnison River is characterized by steep hogbacks, cliffs, and dissected plateaus and high mesas. The Grand Hogback is one of the region's most prominent physiographic features; it rises 1,500 to 3,500 ft above the surrounding countryside and extends more than 60 mi from north of New Castle to Coal Basin (near Redstone) along the study area's eastern boundary (fig. 2). The Book Cliffs form an extensive escarpment that rises as much as 2,000 ft and forms the northern flank of Grand Valley (fig. 2). The Roan Cliffs form the southern flank of the broad and dissected Roan Plateau, which is about 8,500 ft (asl) in areas north of the Colorado River (fig. 2). Battlement Mesa, Buck Mesa, and the Grand Mesa are prominent features between the Colorado River and the North Fork of the Gunnison River (fig. 2). These mesas rises as much as 5,500 to 6,000 ft above the floors of nearby valleys and elevations are 10,500 ft (asl) on Grand Mesa and 10,973 ft (asl) on Battlement Mesa.

The area south of the North Fork of the Gunnison river is extremely rugged owing to high peaks, ridges, deep valleys, and gorges in the vicinity of the West Elk Mountains (fig. 2). Numerous peaks rise 2,000 to 5,000 ft above nearby valley floors, and summit elevations range from about 11,500 ft to 13,000 ft (asl). Many of these peaks are erosional remnants of large laccoliths that intruded during the Oligocene Epoch.

Coal Fields

The southern part of the Piceance Basin is in the Uinta coal region and contains the Book Cliffs, Grand Mesa, Somer-

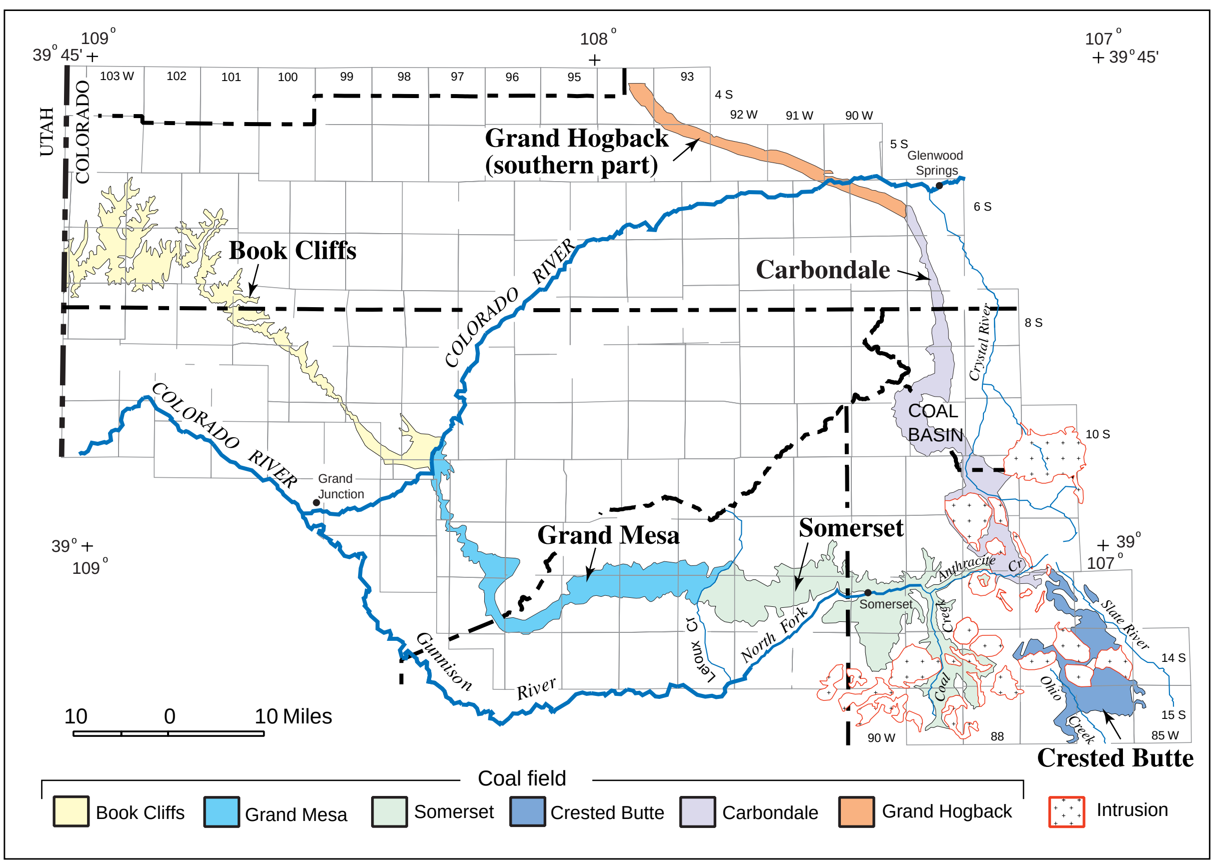


Figure 3. Location of coal fields in the southern part of the Piceance Basin, Colorado. Coal-field names are shown in bold type. Coal-field locations represent areas where the Mesaverde Group and Mesaverde Formation are exposed within the approximate field boundaries described by Landis (1959), Hornbaker and others (1976), and Tremain and others (1996). Laccoliths are also shown in the vicinity of the Somerset, Crested Butte, and southern part of the Carbondale coal fields.

set, Crested Butte, Carbondale, and Grand Hogback coal fields (Landis, 1959). Coal-field locations shown on figure 3 represent areas where the Mesaverde Group and Mesaverde Formation are exposed within the approximate coal-field boundaries that were described by Landis (1959), Hornbaker and others (1976), and Tremain and others (1996). The Book Cliffs coal field extends from the Colorado-Utah State line southeast to the Colorado River (Landis, 1959). The Grand Mesa coal field is located on the western and southern edges of Grand Mesa and extends from the Colorado River eastward to Leroux Creek (figs. 2, 3), which is the last major tributary to the North Fork of the Gunnison River. The Somerset field includes areas from Leroux Creek eastward through the valley cut by the North Fork of the Gunnison River and its tributaries (Tremain and others, 1996) and includes coal in the valley of Coal Creek (figs. 2, 3) located east of Mt. Gunnison (Landis, 1959). The eastern boundary of the Somerset field is in the western part of T. 13 S., R. 88 W. (Landis, 1959), and we have included areas where the Mesaverde Formation is exposed along North Fork of the Gunnison River in the southwestern part of T. 12 S., R. 88 W. The Crested Butte field has been vaguely defined to occupy the southeastern end of the Piceance Basin (Landis, 1959) near the Crested Butte ski resort (Tremain and others, 1996). For the purpose of this report, we have extended the Crested Butte field to include areas where the Mesaverde Formation is exposed along the valleys and tributaries of Slate River and Ohio Creek and to areas where the Mesaverde Formation is exposed along the headwaters of Anthracite Creek in T. 14 S., R. 87 W. (figs. 2, 3). The Carbondale field extends northward from the divide between the Crystal River and Slate River to the locality where the Grand Hogback swings to the northwest near Glenwood Springs (Landis, 1959). The Grand Hogback coal field extends northwestward along the Grand Hogback from near Glenwood Springs to about lat 40°N. (Landis, 1959); only the southern part of the Grand Hogback coal field is located in the study area.

Previous Geologic Investigations

Numerous geologic investigations have been conducted in the southern part of the Piceance Basin, and, although it is beyond the scope of this report to provide a complete bibliography, publications pertinent to our study are referenced.

Preliminary geologic and coal investigations were first conducted in the Piceance Basin by Hayden (1878) and Hills (1893). More detailed investigations followed in the early 1900's as Gale (1910), Lee (1909, 1912), and Erdmann (1934) provided 1:125,000 scale geologic maps, coal measurements, and stratigraphic frameworks for the Grand Hogback, Grand Mesa and West Elk Mountains, and Book Cliffs regions, respectively. Their work formed the basis for numerous stratigraphic studies that ensued. More recent investigations regarding the stratigraphy and depositional systems of Upper Cretaceous rocks in the Book Cliffs region include those of Young (1955), Fisher and others (1960), Gill and Hail (1975), Johnson and others (1980), Kirschbaum and Hettinger (1998), and Van Wagoner (1991a, 1991b, 1991c, 1995). Summaries of the stratigraphic nomenclature in the Book Cliffs region were provided by Young (1955, 1983) and Franczyk (1989). More recent studies of Upper Cretaceous rocks along the Grand Hogback and Coal Basin areas have been published by Horn and Gere (1954), Donnell (1962), Warner (1964), Collins (1970, 1976, 1977), Kent and Arndt (1980a, 1980b), Johnson (1982), and Madden (1989).

Although the investigations of Lee (1909, 1912), Gale (1910) and Erdmann (1934) still provide the only geologic maps for some areas of the southern Piceance Basin, more recent geologic maps have been made for much of the study area. These include maps within (1) the Grand Hogback and Coal Basin areas by Donnell, (1962), Collins (1976), and Madden (1989); (2) the Elk and West Elk Mountains by Hanks (1962), Gaskill and Godwin (1966a, 1966b), Godwin (1968), Gaskill and others (1967, 1986), Gaskill and DeLong (1987); (3) the Paonia and Gunnison areas by Johnson (1948) and Dunrud (1989a); and (4) the Cedaredge and Hotchkiss areas by Hail, (1972a, 1972b) and Dunrud (1989b). Geologic maps from published and unpublished source maps were compiled and referenced on 1:250,000-scale geologic maps of the Grand Junction, Montrose, Leadville, and Moab 1°×2° quadrangles by Cashion (1973), Tweto and others (1976), Tweto and others (1978), and Williams (1964), respectively. Larger scale maps were compiled at a 1:100,000 scale for the Carbondale 30′×60′ quadrangle (Ellis and Freeman, 1984), parts of the Grand Junction and Delta 30′×60′ quadrangles (Ellis and Gabaldo, 1989), and the Gunnison and Paonia area (Ellis and others, 1987). Areas of geologic mapping used in this report are shown in figure 4.

Previous subsurface geological investigations in the Piceance Basin include cross sections of Upper Cretaceous and Tertiary strata by Johnson (1979a, 1979b, 1979c, 1989b), Johnson and others (1979a, 1979b, 1979c), Ellis and Kelso (1987), and Nowak (1991). Subsurface coal-bed correlations have also been made along several cross sections in the southeastern part of the basin by Ellis and others (1988), Dunrud (1989a, 1989b), and Tyler and McMurry (1995). Results of exploratory coal drilling in the Grand Mesa, Coal Basin, and Book Cliffs areas have been reported by Eager (1978, 1979), Kent and Arndt (1980a, 1980b) and Gualtieri (1979), respectively. Core of coal-bearing rocks in the Book Cliffs area was collected and described by Hobbs and others (1982) and McPhillips (1980), and core of coal-bearing rocks in the Paonia area was collected and described by Johnson (1948) and Toenges and others (1949, 1952).

Coal resources were evaluated for each coal field in the Piceance Basin by Landis (1959), and coal-bed methane and natural gas potential have been evaluated by Johnson and others (1987), Johnson (1989a) and Tyler and McMurry (1995). Coal quality has been summarized for each coal field in the southern part of the Piceance Basin by Hornbaker and others (1976), Murray and others (1977), and Tremain and others (1996). Additional coal-quality data was reported by

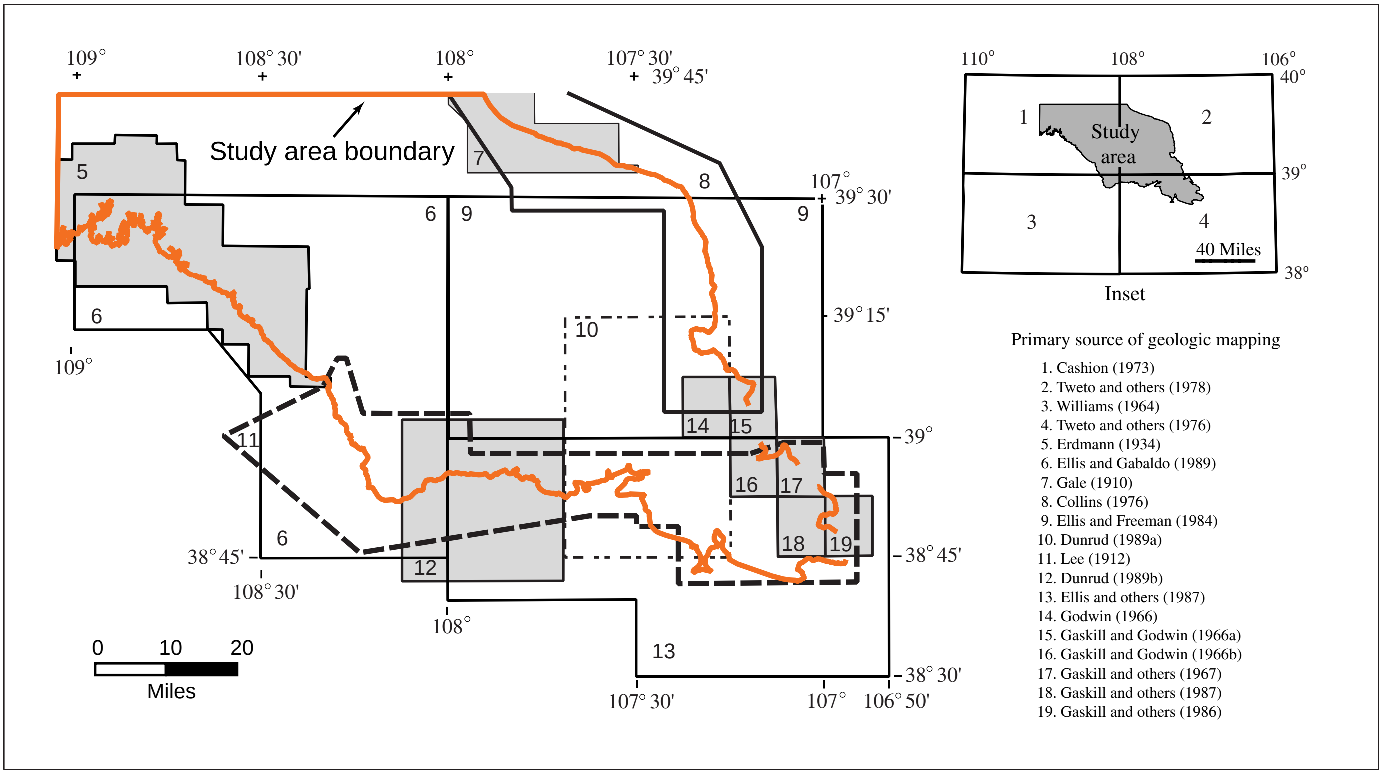


Figure 4. Index map showing primary sources of geologic data in relation to the study area. Inset shows location of 1°x2°quadrangle maps in which geology was complied at a scale of 1:250,000.

Toenges and others (1949, 1952) for the Somerset coal field and by Collins (1976) for the Carbondale and Grand Hogback coal fields.

Acknowledgments

We thank the Colorado Oil and Gas Conservation Commission for providing latitude and longitude locations for oil and gas holes used in this assessment and Wynn Eakins (Colorado Geological Survey) for providing some coal data used in the Somerset coal field. We thank Gary Stricker (U.S. Geological Survey) for a creating a computer program to query data in the StratiFact database; Tracey Mercier (contractor) for compiling various geologic, physiologic, and geographic GIS coverages; Marin Popov, Allen Heinrich, and Jon Haacke (contractors) for their technical assistance using StratiFact software; and Bill Everham and Cindy Steuben for their technical support. We also thank William Keefer, Doug Nichols, Ron Johnson, Mark Kirschbaum, Rick Scott, and Katharine Varnes for their thorough reviews of the manuscript.

Geologic Setting

Paleogeography of the Southern Part of the Piceance Basin During the Late Cretaceous and Tertiary

During the Late Cretaceous (approximately 95–67 Ma) the region now occupied by the Piceance Basin was located at a paleolatitude of about 42°N. within the Cretaceous Rocky Mountain Foreland basin. Sediment was sourced from the Sevier highlands and deposited along the western margin of the Western Interior Seaway (fig. 5). Structural development of the Piceance Basin began near the end of the Cretaceous Period as the Laramide orogeny partitioned the foreland basin into numerous smaller sedimentary basins and continued until the end of the Eocene Epoch (Johnson, 1989a). A detailed summary regarding sedimentary infilling and structural development of the Piceance Basin is provided by Johnson (1989a).

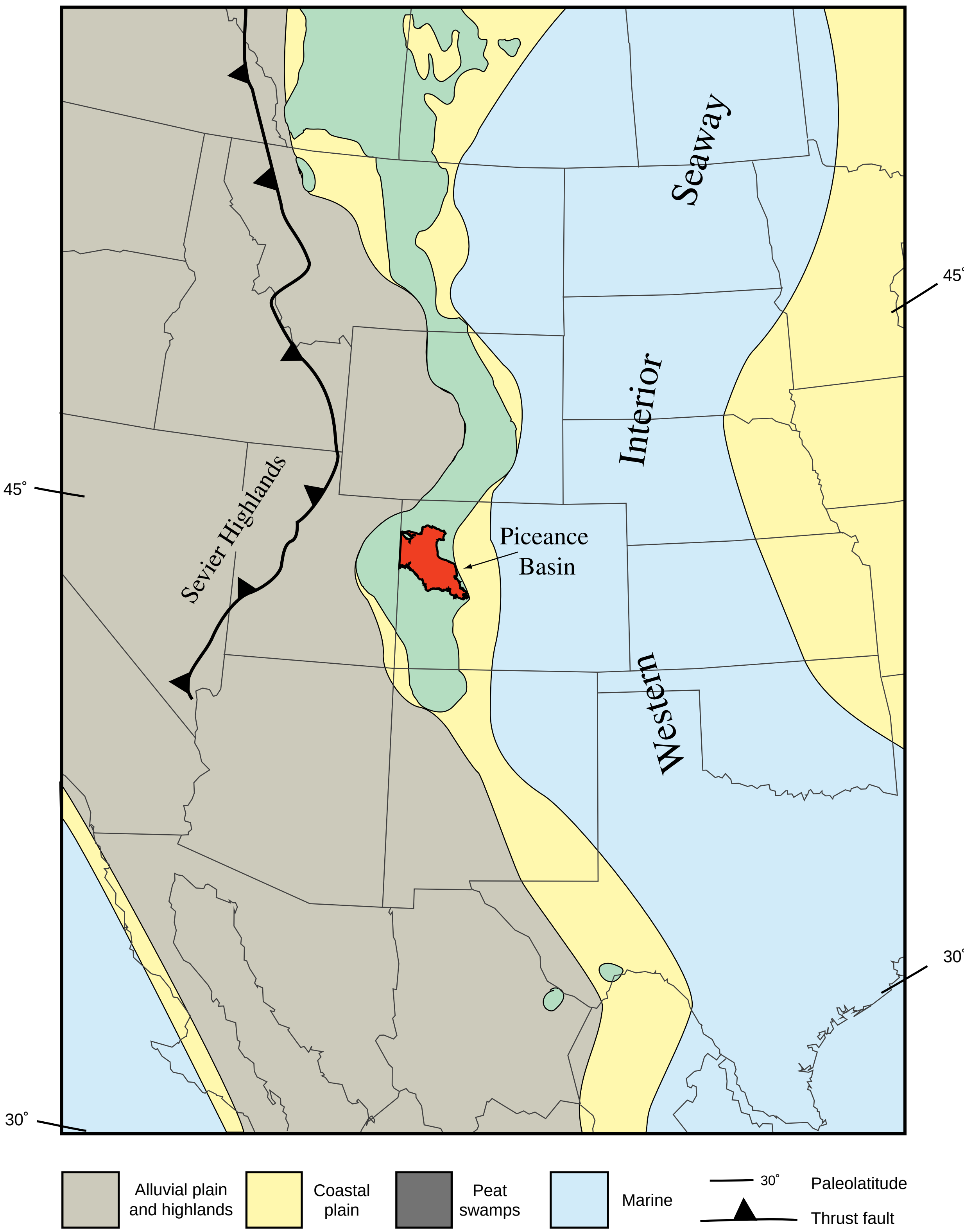


Figure 5. Paleogeographic map of the central part of North America during the late part of the Campanian Stage (79–72 Ma) of the Cretaceous Period. The Piceance Basin is shown in relation to shorelines, coastal plains, and peat swamps associated with the Western Interior Seaway; deposits from these depositional systems are preserved in the Mesaverde Group and Mesaverde Formation. Map is modified from Roberts and Kirschbaum (1995).

During the Late Cretaceous, fluvial systems prevailed between the Sevier highlands and Western Interior seaway and coal-forming mires occupied the coastal plain. Fluctuations in sea level and sediment supply caused the shorelines to migrate back and forth throughout the Late Cretaceous. Shoreline positions and depositional systems of the Late Cretaceous are summarized in paleogeographic maps of North America by Roberts and Kirschbaum (1995). The seaway initially expanded westward across the study area during the Cenomanian Stage and reached its maximum size during the Turonian Stage. Paleoshorelines were located about 50 to 100 mi east of the Sevier highlands during the Turonian Stage and remained relatively stable until the beginning of the Campanian Stage, when the seaway began to retreat eastward. Shorelines slowly shifted eastward during the early Campanian and then rapidly shifted about 300 mi to the southeast during the late Campanian. Shorelines were oriented about N. 60° E. to N. 15° W. and migrated back and forth as they crossed the study area during the late Campanian (Johnson, 1989a).

Continental fluvial and lacustrine conditions prevailed throughout the study area from the latest part of the Cretaceous Period to the middle part of the Eocene Epoch of the Tertiary Period. As tectonic activity increased during the Laramide orogeny, coarse-grained clastics were deposited in mountain-front environments along the basin's margins, and finer grained sediment was deposited in lower energy fluvial and flood-plain environments within the basin's interior (Roehler, 1974; Johnson, 1985). By the middle Eocene, the area of the Piceance Basin was inundated by Lake Uinta, and sediment accumulated in saline to freshwater lacustrine environments (Donnell, 1961; Roehler, 1974; Johnson, 1985). During the late Eocene, Lake Uinta was filled in by volcaniclastic sediment from the Absaroka volcanic field in Wyoming and by locally derived sediment (Johnson, 1985).

The later part of the Tertiary Period was characterized by intrusive and extrusive volcanic activity. In the vicinity of Coal Basin and in the Elk and West Elk Mountains, Cretaceous and Tertiary strata were intruded by igneous stocks, dikes, sills, and laccoliths of Miocene and Oligocene age. Finally, during the Pliocene, basalt flowed across areas of the Battlement and Grand Mesas.

General Stratigraphy of Upper Cretaceous and Tertiary Strata in the Southern Part of the Piceance Basin

Isopach maps presented by Johnson and Finn (1986) indicate as much as 11,000 ft of Upper Cretaceous strata are preserved in the Piceance Basin. Cretaceous strata are assigned (in ascending order) to the Dakota Sandstone, Mancos Shale, Mesaverde Group and Mesaverde Formation (table 1). These rocks are exposed along the southern and eastern margin of the basin and are deeply buried in the basin's interior (fig. B on pl. 1). The Dakota Sandstone is Cenomanian in age (Johnson, 1989a) and may be as old as Albian in age (Molenaar and Cobban, 1991; Molenaar and Wilson, 1993). The Dakota consists of about 40 to 225 ft of strata that were deposited in continental, coastal-plain, and nearshore marine environments during the initial expansion of the Western Interior Seaway. North of the study area, near the town of Rangely, the Dakota is overlain by about 300 ft of marine sandstone and shale that are within the Mowry Shale and superposed Frontier Formation (Molenaar and Wilson, 1993); these rocks thin and pinch out to the southeast in the basin's subsurface. The Mancos Shale is about 4,000 to 5,000 ft thick and was deposited in offshore marine environments that prevailed during the Cenomanian through late Campanian Stages. The upper part of the Mancos Shale intertongues with and divides the overlying Mesaverde Group into its various formations and members (Warner, 1964). Prominent tongues of the Mancos include the Buck Tongue and Anchor Mine Tongue. The Mesaverde Group and Mesaverde Formation contain about 2,100 to 5,600 ft of strata that were deposited in a complex system of fluvial, coastal-plain, paludal, estuarine, and shoreface environments that were associated with the shoreline regression during the late Campanian and Maastrichtian Stages; thicknesses were estimated from isopach maps in Johnson and Finn (1986, fig. 8). In the study area, the upper part of the Mesaverde Group and Mesaverde Formation consists primarily of continental strata that was deposited after the seaway had completely withdrawn from the region.

More than 10,000 ft of lower Tertiary strata have been deposited in the Piceance Basin (Johnson, 1985, fig. 4). Tertiary strata in the study area are assigned (in ascending order) to the Wasatch, Green River, and Uinta Formations (table 1) and are exposed throughout the interior of the Piceance Basin (fig. B on pl. 1). The Wasatch Formation is as much as 5,800 ft thick (Tweto and others, 1978) several miles north of the study area (in T. 2 S., R. 95 W.) and includes rocks deposited in fanglomerate, fluvial, and flood-plain environments during the early and early middle Eocene (Roehler, 1974). Cross sections in Roehler (1974, figs. 1 and 2) indicate that the Green River Formation is about 1,500 to 3,000 ft thick in the study area and consists of strata that were deposited in lacustrine environments of Lake Uinta during the early and middle Eocene. The Green River Formation contains vast quantities of oil shale and is preserved in the central region of the Piceance Basin. Rocks of middle Eocene age in the Uinta Formation are the youngest strata preserved in the Piceance Basin (Roehler, 1974). The Uinta Formation intertongues with the Green River Formation and has a maximum preserved thickness in the study area of about 1,000 ft on Battlement Mesa (Tweto and others, 1978); and it is 1,600 ft thick north of the study area in T. 1 N., R. 98 W. (R.C. Johnson, oral commun., 1999). The Uinta is comprised of volcaniclastic sedimentary rock that was deposited in Lake Uinta (Johnson, 1985).

Table 1. Stratigraphic summary of Cretaceous and Tertiary strata in the southern part of the Piceance Basin, Colorado.

[Lithologic descriptions and depositional interpretations are compiled from Hail (1972a, 1972b), Cashion (1973), Roehler (1974), Gill and Hail (1975), Collins (1976), Tweto and others (1978), Kent and Arndt (1980a, 1980b), Johnson (1982), Ellis and Freeman (1984), Ellis and others (1987), Dunrud (1989a, 1989b), and Ellis and Gabaldo (1989). Stratigraphy of the Upper Cretaceous Mesaverde Group and Mesaverde Formation are provided in table 2]

Age	Group or Formation	Thickness (ft)	Description and depositional interpretation
Pliocene and or Miocene	Extrusive igneous rock	5-4,000	Black basalt in lava flow layers (5-250 ft thick and as much as 800 ft thick on Grand Mesa). Includes andesitic breccia, lava, and volcaniclastic debris of the West Elk breccia in the West Elk mountain area which are as much as 4,000 ft thick. Volcanic.
Pliocene, Miocene, and Oligocene	Intrusive igneous rock	tens to thousands of ft	Rhyolite and basaltic stocks, plugs, and sills; and granodioritic and quartz monzonite stocks, dikes, sills, and laccoliths. Volcanic.
Eocene	Unita Formation	1,000 (max.)	Sandstone, mudstone, siltstone, and marlstone.
Eocene	Green River Formation	3,400 (max.)	Gray and yellow-brown marlstone, oil shale, siltstone, and sandstone, with minor tuff and limestone. Fluvial and lacustrine.
Eocene and Paleocene	Wasatch Fm	5,800 (max.)	Variegated mudrock with local lenses of sandstone, volcanic sandstone, and basal conglomerate. Separated from underlying strata by an unconformity. Fluvial and lacustrine.
Late Cretaceous	Mesaverde Group and Mesaverde Formation	2,150-5,600	In the Book Cliffs coal field, the Mesaverde Group is divided into the Hunter Canyon Formation, Mount Garfield Formation, Sego Sandstone, and Castlegate Sandstone. In the Grand Hogback and Carbondale coal fields, the Mesaverde Group is divided into the Iles and Williams Fork Formations. Coeval strata are assigned to the Mesaverde Formation and upper part of the Mancos Shale in the Grand Mesa and Crested Butte coal fields. Details are provided in table 2.
	Mancos Shale	4,000-5,000 (max.)	Dark-gray shale with minor sandstone and siltstone; includes thin lenses of limestone, sandy limestone, and limy shale. Intertongues with the lower part of the Mesaverde Group or Formation. Marine.
Early(?) to Late Cretaceous	Dakota Formation	40-225	Light-gray and tan, fine- to coarse-grained sandstone or quartzite; minor interbeds of dark gray shale, shaley sandstone, conglomeratic sandstone, and thin lenticular beds of coal. Fluvial and marginal marine.

Detailed Stratigraphy of Upper Cretaceous Mesaverde Formation and Mesaverde Group in the Southern Part of the Piceance Basin

In the southern part of the Piceance Basin, the Upper Cretaceous Mesaverde Group and Mesaverde Formation were deposited in continental, nearshore, and offshore environments as shorelines migrated back and forth during an overall regression to the southeast. Paleoshorelines were oriented about N. 60° E. to N. 15° W. during the late Campanian (Johnson, 1989a), and the associated shoreface strata rise stratigraphically to the southeast and pinch out into offshore marine strata. The shoreface strata grade into continental beds to the northwest. Nomenclature used for these rocks is complex and has been used inconsistently by previous investigators. The Mesaverde has been assigned Group status in the Book Cliffs, Grand Hogback, and Carbondale coal fields but is considered a Formation in the Crested Butte and Grand Mesa coal fields. Lithologic descriptions and nomenclature for the Mesaverde Group and Mesaverde Formation are summarized in table 2 and stratigraphic correlations are shown in figure 6.

The Mesaverde Group in the Book Cliffs coal field is divided into (from oldest to youngest) the Castlegate Sandstone, Sego Sandstone, Mount Garfield Formation, and Hunter Canyon Formation (Erdmann, 1934; Fisher and others, 1960). The lower part of the Mount Garfield Formation is divided into the Corcoran, Cozzette, and Rollins Sandstone Members (Young, 1955; Gill and Hail, 1975). In the Grand Hogback and Carbondale coal fields, the Mesaverde Group was split into the Iles and Williams Fork Formations by Collins (1976). Warner (1964) demonstrated that the Iles Formation along the Grand Hogback includes the equivalent of the Sego, Corcoran, Cozzette, and Rollins Sandstone Members in the Book Cliffs

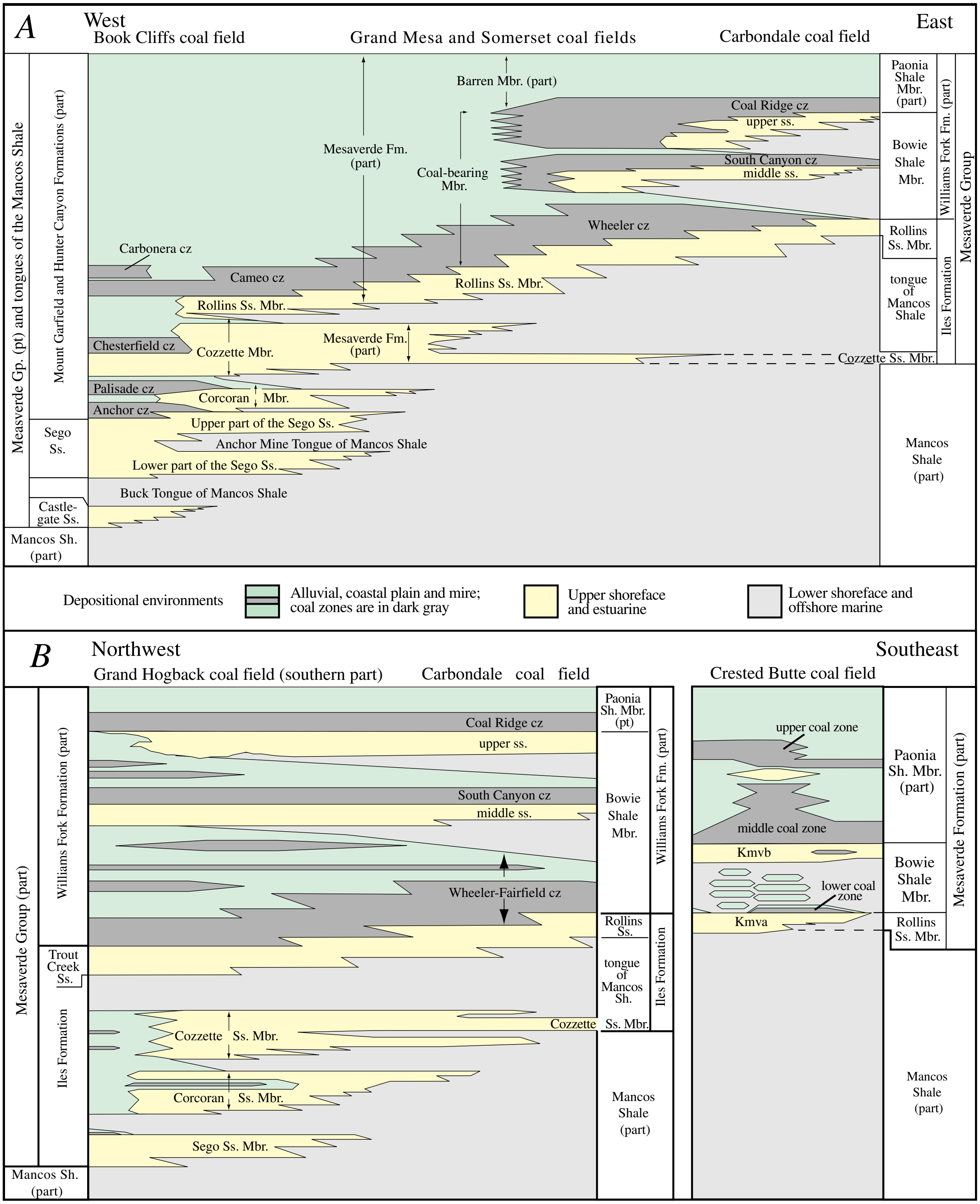


Figure 6. Stratigraphic correlations and facies relationships in the Mesaverde Group and Mesaverde Formation, southern part of the Piceance Basin, Colorado. *A*, Line of section drawn perpendicular to depositional strike; stratigraphy is based on Gill and Hail (1975), Dunrud (1989a, 1989b), and Kirschbaum and Hettinger (1998). *B*, line of section subparallel to depositional strike; stratigraphy in the Grand Hogback and Carbondale coal fields is based on Collins (1976), and in the Crested Butte coal field it is based on Gaskill and Godwin (1966b) and Gaskill and others (1967, 1986, 1987); coal zone nomenclature in the Crested Butte area refers only to its usage in this report. Abbreviations include: Sandstone (Ss), sandstone (ss.), Member (Mbr.), coal zone (cz), Shale (Sh.), Group (Gp.), Formation (Fm.), and part (pt.).

area. The Rollins Sandstone was traced north along the Grand Hogback into the Trout Creek Sandstone near the town of Meeker (Warner, 1964; Collins, 1976). The overlying Williams Fork Formation has been divided into (in ascending order) the Bowie Shale Member (which contains the informally named middle and upper sandstones), Paonia Shale Member, and upper "undifferentiated" Williams Fork Formation by Collins (1976).

The Mesaverde Formation in Grand Mesa coal field has been divided (from oldest to youngest) into the Cozzette Member, Rollins Sandstone Member, and an unnamed upper part (Gill and Hail, 1975). The Cozzette Member pinches out into the Mancos Shale to the southeast and only the Rollins Sandstone Member and unnamed upper part remains in the western part of the Somerset field (Hail, 1972a, 1972b). Dunrud (1989a, 1989b) subsequently divided the upper part (from oldest to youngest) into the informally named coal-bearing and barren members and the formally named Ohio Creek Member of the Mesaverde Formation. The Mesaverde Formation in the Crested Butte coal field was initially undivided, although a basal marine sandstone (Kmva) and second marine sandstone (Kmvb) were mapped throughout the area by Gaskill and Godwin (1966a, 1966b) and Gaskill and others (1967, 1986, 1987). Later, Gaskill and DeLong (1987) divided the Mesaverde Formation into the Rollins Sandstone, Bowie Shale Member, Paonia Shale Member, and an undifferentiated upper part; the previously named Kmva sandstone was correlated to the Rollins Sandstone Member, and the top of the Bowie Shale Member was placed at the top of the Kmvb sandstone.

The Castlegate, Sego, Corcoran, Cozzette, and Rollins have been interpreted as successively higher stratal units that were deposited during successive regressive marine cycles (Johnson, 1989a). Each regressive cycle was separated by a marine tongue of the Mancos Shale that had a basal transgressive component and regressive upper component that graded into the overlying regressive cycle. The transgressive limits of the marine shale tongues and the regressive limits of the Castlegate, Sego, Corcoran, and Cozzette are shown by Johnson (1989a); the regressive limit of the Rollins Sandstone was mapped in the vicinity of Crested Butte by Gaskill and others (1986). The Castlegate Sandstone is a complex fluvial and deltaic deposit that reached its seaward limit in the western part of the Piceance Basin (Johnson, 1989a). The Sego, Corcoran, and Cozzette Members are also complex and consist of marginal-marine and continental strata, whereas the Rollins Member simply consists of nearshore marine strata (Johnson, 1989a). Although stratal successions in the Mesaverde Group and Mesaverde Formation have been associated with regressive marine cycles, the more recent identification of estuarine valley-fill complexes in the Castlegate and Sego Sandstones (Van Wagoner, 1991a, 1991b, 1991c) and Corcoran, Cozzette, and Rollins Sandstone Members (Kirschbaum and Hettinger, 1998) indicates that these formations and members contain transgressive deposits as well.

Coal-bearing coastal-plain and continental strata above the Rollins Sandstone Member in the Mount Garfield and Mesaverde Formations in the Book Cliffs and Grand Mesa coal fields intertongue to the southeast with coal-bearing coastal-plain and marine rocks in the coal-bearing member in the Somerset coal field and Bowie Shale Member of the Mesaverde Formation in the Grand Hogback, Carbondale, and Crested Butte coal fields. The Bowie Shale Member contains two thick tongues of nearshore marine strata in the Grand Hogback and Carbondale coal fields (Collins, 1976); however, only one thin tongue of nearshore marine strata has been described in the Crested Butte coal field (Gaskill and DeLong, 1987), and precise correlations of these marine facies have not been resolved. Shoreface deposits at the top of each marine tongue in the Grand Hogback and Carbondale coal fields were named the middle and upper sandstone, respectively (Collins, 1976), and the shoreface deposit at the top of the only marine tongue in the Crested Butte area was named the Kmvb sandstone (Gaskill and DeLong, 1987). The upper sandstone and Kmvb sandstone mark the last episode of marine deposition in the study area and overlying Cretaceous strata were deposited in coastal-plain, fluvial, and alluvial-plain environments.

Structure

The Piceance Basin is an elongate basin that has gently dipping western and southwestern flanks and a steeply dipping eastern flank. The synclinal axis of the basin trends to the northwest from near Redstone to near Meeker, and although strata are gently inclined toward the axis, dips of strata are locally steep on the limbs of folds and near laccoliths located along the southern and eastern flanks of the basin. Steeply dipping strata are particularly common in the West Elk Mountains and along the limb of the Grand Hogback monocline (figs. 2; 7*A*). Strata are generally not faulted at the surface except at localities along the Douglas Creek arch and in the West Elk Mountains (figs. 2, 7*A*). However, a system of blind thrust faults has been identified beneath the Divide Creek and Wolf Creek anticlines and Grand Hogback monocline (fig. 7*A*) by Grout and Verbeek (1992).

Outcrops of Upper Cretaceous coal-bearing strata are inclined from less than 5° to more than 90° within the various coal fields (fig. 3) of the study area. Upper Cretaceous coal-bearing rocks in the Book Cliffs and Grand Mesa coal fields generally dip less than 6° to the north and northeast but are inclined by as much as 9° to 18° along the southwest limb of the Garmesa anticline, and 10° to 27° on the northeast-dipping limb of the Book Cliffs monocline (fig. 7*A*) (Lee, 1912; Erdmann, 1934; Hail 1972a, 1972b). Cretaceous beds in the western part of the Somerset coal field are also inclined less than 5° in northerly directions but are more steeply inclined (14° to 55°) along the eastern margin of the coal field, where they are folded over the flanks of laccolith intrusions (fig. 7*A*) (Lee, 1912; Dunrud, 1989a, 1989b). The Crested Butte and southern part of the Carbondale coal fields are structurally complex and the reader is referred to the geologic maps of Godwin

Table 2. Stratigraphic summary of the Upper Cretaceous Mesaverde Group and Mesaverde Formation in the Book Cliffs, Grand Mesa, Somerset, Crested Butte, Carbondale, and Grand Hogback coal fields in the Piceance Basin, Colorado.

Age	Group or Formation	Thickness (ft)	Description and depositional interpretation
			Book Cliffs coal field
The Mesaverde Group in the Book Cliffs coal field is divided (in descending order) into the Hunter Canyon Formation, Mount Garfield Formation, Sego Sandstone, and Castlegate Sandstone. Thickness is about 1,500 to 2,450 ft. Descriptions are compiled from Erdmann (1934), Cashion (1973), Gill and Hail (1975), Fisher and others, (1960), Johnson and May (1980), Ellis and Gabaldo (1989), and Van Wagoner (1991a, 1991b, 1991c; 1995).			
Late Cretaceous	Hunter Canyon Formation	375-1,400	Buff to gray, medium- to coarse-grained cliff-forming sandstone, and gray to greenish-gray shale; Locally contains Ohio Creek Member; alluvial plain. Ohio Creek Member (155-370 ft) Located in upper part of Hunter Canyon Formation. Coarse-grained sandstone, conglomeratic sandstone, and conglomerate with interbeds of gray mudstone and siltstone. Fluvial.
	Mount Garfield Formation	970-1,070	Buff and gray, fine- to medium-grained sandstone, gray shale, and coal. The lower part of the formation contains the Rollins Sandstone and Cozzette and Corcoran Members, which are separated by tongues of the Mancos Shale. The Carbonera, Cameo, Palisade, and Anchor coal zones are in the lower 300-660 ft of the formation. Continental in upper part and nearshore marine and coastal-plain in lower part of formation. Rollins Sandstone Member (0-120 ft) White, fine- to coarse-grained, cliff-forming sandstone. Marginal marine and tidal, grades to nonmarine sandstone in western part of area. The Carbonera and Cameo coal zones overlie the Rollins Sandstone Member and equivalent strata. Cozzette Member (0-230 ft) Fine to very fine grained sandstone, siltstone, and shale, contains thin coal beds in the Chesterfield coal zone. Marginal marine, coastal-plain, and tidal. Corcoran Member (0-100 ft) Fine- to very fine-grained sandstone, siltstone, and shale; contains coal in the Palisade coal zone. Marginal marine, coastal-plain and tidal. The Anchor coal zone is located between the Corcoran Member and underlying Sego Sandstone (as redefined by Young, 1955, p. 189-191).
	Sego Sandstone	0-300	Buff and light-gray, fine-grained sandstone and gray shale. Upper and lower parts are sandstone and are separated by 20-200 ft of marine mudrock assigned to the Anchor Mine Tongue of the Mancos Shale. Nearshore marine and tidal.
	Castlegate Sandstone	0-20	Buff and light-gray, very fine- and fine-grained sandstone and gray shale. Separated from the Sego Sandstone by 400 ft of marine mudrock assigned to the Buck Tongue of the Mancos Shale. Fluvial to marginal marine.
			Grand Mesa and Somerset coal fields
Upper Cretaceous rocks are assigned to the Mesaverde Formation. Descriptions are from Ellis and others (1987), Dunrud (1989a, 1989b), and Hail (1972a, 1972b).			
Late Cretaceous	Mesaverde Formation	2,800 (maximum)	Gray to brown sandstone, siltstone, shale, and coal. The formation has been divided into (from upper to lower) the Ohio Creek Member, barren member, coal-bearing member, and Rollins Sandstone Member. Ohio Creek Member (50-900 ft) Interbedded fine- to coarse-grained and locally conglomeratic sandstone, siltstone, and shale; kaolinitic in upper part. Fluvial. barren member (250-1,000 ft) Fine- to very fine-grained sandstone, siltstone, mudstone, shale, and a few thin beds of coal. Continental. coal-bearing member (350-700 ft) Very fine- to fine-grained sandstone interbedded with and siltstone, mudstone, shale, and thick beds of coal. Coastal-plain and nearshore marine. Rollins Sandstone Member (80-200 ft) Tan, light-gray, and white, very fine- to fine-grained, cliff-forming sandstone. Nearshore marine. Cozzette Member (less than 35 ft) Fine- to very fine-grained sandstone, siltstone, and shale. Separated from the overlying Rollins sandstone by a tongue of the Mancos shale that thickens to the east. Present in eastern part of coal field. Nearshore marine.

Table 2. Stratigraphic summary of the Upper Cretaceous Mesaverde Group and Mesaverde Formation in the Book Cliffs, Grand Mesa, Somerset, Crested Butte, Carbondale, and Grand Hogback coal fields in the Piceance Basin, Colorado—*Continued*.

Age	Group or Formation	Thickness (ft)	Description and depositional interpretation
			Crested Butte coal field
Upper Cretaceous rocks are assigned to the Mesaverde Formation. Descriptions are from Gaskill and DeLong (1987)			
Late Cretaceous	Mesaverde Formation	1,600-2,400	Ohio Creek Member (90-400 ft) Interbedded light-gray to white, fine- to coarse-grained and locally conglomeratic sandstone, siltstone, and shale; kaolinitic in upper part. Fluvial. undifferentiated upper part (650-800 ft) Light-gray, medium- to coarse-grained sandstone interbedded with light to dark and greenish gray shale, carbonaceous shale and a few thin beds of coal. Continental. Paonia Shale Member (450 ft) Fine- to coarse-grained, lenticular fluvial sandstone interbedded with gray shale, carbonaceous shale and coal. Nonmarine, deltaic plain. Bowie Shale Member (160-250 ft) Interbedded sandstone, siltstone, shale, carbonaceous shale, and coal. Transitional upward through coastal-plain, offshore marine, and shoreface deposits. Top of member contains a 30- to 50-ft-thick marine sandstone called the Kmvb sandstone. Rollins Sandstone Member (30-120 ft) Gray to white, fine- to medium-grained, cliff-forming sandstone. Previously referred to as the Kmva sandstone. Nearshore marine.
			Carbondale and Grand Hogback coal fields
Tweto and others (1978) placed Upper Cretaceous rocks in the Grand Hogback coal field into the Mesaverde Group, and coeval rocks in the Carbondale coal field were placed into the Mesaverde Formation and Mancos Shale. We used the stratigraphy of Collins (1976) that placed Upper Cretaceous rocks in both coal fields into (in ascending order) the Iles Formation or Williams Fork Formation of the Mesaverde Group. The Ohio Creek Member was placed into the upper "undifferentiated" Williams Fork Formation based on its reassignment by Johnson and May (1980) to the Mesaverde and Hunter Canyon Formations in the southern and western parts of the Piceance Basin. The Mesaverde Group is about 4,660-6,070 ft thick. Descriptions of the Mesaverde Group are based on Collins (1976), Tweto and others (1978), Kent and Arndt (1980a, 1980b), Johnson (1982), and Ellis and Freeman (1984), Ellis and others (1988).			
Late Cretaceous	Williams Fork Formation	3,600- 5,155	Light-brown to white sandstone, conglomeratic sandstone, mudstone, gray to black shale, and coal. The Williams Fork Formation is divided into (in ascending order) the Bowie Shale Member, Paonia Shale Member, and upper "undifferentiated" Williams Fork Formation. upper Williams Fork Formation (2,000-4,000 ft) Fluvial sandstone, conglomeratic sandstone, and conglomerate, siltstone, shale, and coal. The Keystone coal group is about 800 ft above the base of the formation near New Castle. The Ohio Creek Member is at the top of the formation; it is 50-400 ft thick and composed of sandstone, conglomeratic sandstone, and conglomerate and includes thin interbeds of silty shale. Most sediment in the upper part of the Williams Fork is nonmarine. Paonia Shale Member (560 ft) Sandstone, siltstone, shale, and coal. The basal 400 ft contains the Coal Ridge coal group. Coastal plain and continental. Bowie Shale Member (680-1,000 ft) The Bowie consists of (in ascending order) (1) fresh to brackish-water deposits of sandstone, siltstone, shale, and coal; (2) marine shale; (3) a marginal marine sandstone named the "middle sandstone"; (4) marine shale; and (5) a marginal marine sandstone named the "upper sandstone". The Fairfield and South Canyon coal groups overlie the Rollins Sandstone and middle sandstone, respectively. Marginal marine and coastal plain.

Table 2. Stratigraphic summary of the Upper Cretaceous Mesaverde Group and Mesaverde Formation in the Book Cliffs, Grand Mesa, Somerset, Crested Butte, Carbondale, and Grand Hogback coal fields in the Piceance Basin, Colorado—*Continued*.

Age	Group or Formation	Thickness (ft)	Description and depositional interpretation
			Carbondale and Grand Hogback coal fields—*Continued*
Late Cretaceous	Iles Formation	890-1,175	Light-brown to white sandstone and interbedded siltstone, mudstone, and shale. The Iles is divided into (in ascending order) the Sego Sandstone Member, Corcoran Sandstone Member, Cozzette Sandstone Member, an upper tongue of the Mancos Shale, and the Rollins Sandstone Member. The Sego, Corcoran, and Cozzette members are divided by tongues of the Mancos Shale that are about 100 ft thick each. Marine, marginal marine, and coastal-plain. Rollins Sandstone Member (90-140 ft) Light- to medium-gray and white, fine- to medium-grained, includes thin interbeds of marine shale in lower part of unit. The Rollins is equivalent to the Trout Creek Sandstone Member north of the town of New Castle. Marginal marine and nonmarine. Upper tongue of Mancos Shale (270-970 ft) Dark-gray, clayey and silty shale. Marine. Cozzette Sandstone Member (30-200 ft) Gray, very fine- to fine-grained sandstone interbedded with medium- to dark-gray, clayey and silty shale. Corcoran Sandstone Member (0-130 ft) Buff to gray, very fine- to fine-grained sandstone, interbedded gray clayey and silty shale; upper part contains coal in the Black Diamond coal group. The Corcoran pinches out in T. 9 S., R. 89 W. (Donnell, 1962). Marginal marine and coastal-plain. Sego Sandstone Member (0-40 ft) The Sego sandstone is poorly described in the area and pinches out in T. 5 S., R 91 W. (Collins, 1976).

(1968), Gaskill and Godwin (1966a, 1966b), and Gaskill and others (1967, 1986, 1987) for details. Strata are highly faulted, steeply folded, and intruded by numerous Tertiary laccoliths (fig. 7*A*). Coal-bearing strata are inclined by 5° to more than 90° as they extend under and are draped onto the flanks of the wedge-shaped laccoliths. Strata in the Carbondale coal field and Grand Hogback coal fields are steeply inclined to the west and southwest along the Grand Hogback monocline. Upper Cretaceous rocks located north of the town of Marble in the Carbondale coal field are inclined by about 10° to 40°, and strata in the Grand Hogback coal field are inclined 30° to 70° and are locally overturned (Collins, 1976).

The structure in the subsurface of the Piceance Basin was mapped on the top of the Rollins Sandstone Member by Johnson (1983). A modified version of his structure map (fig. 7*B*) indicates that there is as much as 16,000 ft of structural relief on this datum within the study area. The Rollins Sandstone Member is about 6,000 to 7,500 ft above sea level where it is exposed along the Book Cliffs and Grand Hogback and rises gently to 11,000 ft above sea level where it is exposed near the town of Crested Butte. The maximum deformation of the Rollins in the study area is along the western limb of the Grand Hogback monocline where the member plunges as much as 12,000 ft, to a depth of 4,500 ft below sea level, within a distance of 4 mi.

Coal Distribution, Quality, and Resources in the Mesaverde Group and Mesaverde Formation

Several laterally persistent coal zones have been identified and mapped in the Mesaverde Group and Mesaverde Formation in the southern part of the Piceance Basin. Coal-bearing strata below the Rollins Sandstone and Trout Creek Sandstone Members are within the Anchor, Palisade, and Chesterfield coal zones (figs. 6, 8; table 2). These coal-bearing intervals extend northeastward through the subsurface and become part of the Black Diamond coal group (fig. 8), which was named for coal-bearing strata in the lower part of the Iles Formation in the northern Piceance Basin by Hancock and Eby (1930). A thick coal-bearing interval above the Rollins Sandstone Member has been referred to as the Cameo-Fairfield coal zone by Johnson (1989a) and is referred to as the Cameo-Fairfield coal group (fig. 8) in this report.

The Cameo-Fairfield contains the most extensively mined coals in the Piceance Basin and is an important source for natural gas (Johnson, 1989a). The Cameo-Fairfield crops out along the study areas southern and eastern boundaries and extends through its subsurface (fig. 9). The Cameo-Fairfield coal group includes the Cameo and Carbonera coal zones

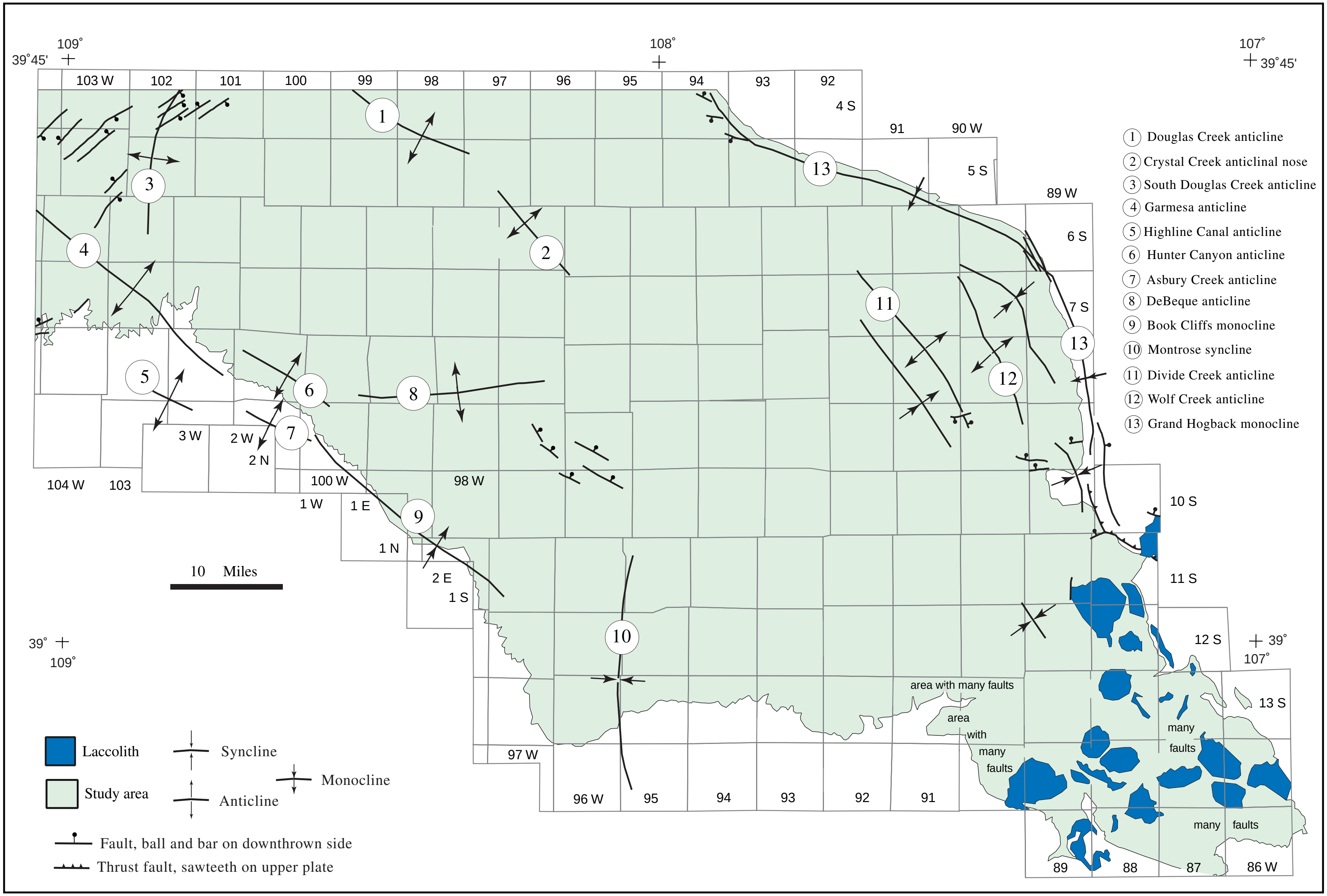


Figure 7A. Faults and folds in the southern part of the Piceance Basin. The study area represents areas that are underlain by the Rollins Sandstone Member and laterally equivalent strata. Geology is modified from Cashion (1973), Murray and Haun (1974), Tweto (1979), and Grout and Verbeek (1992). Small structural features are not shown.

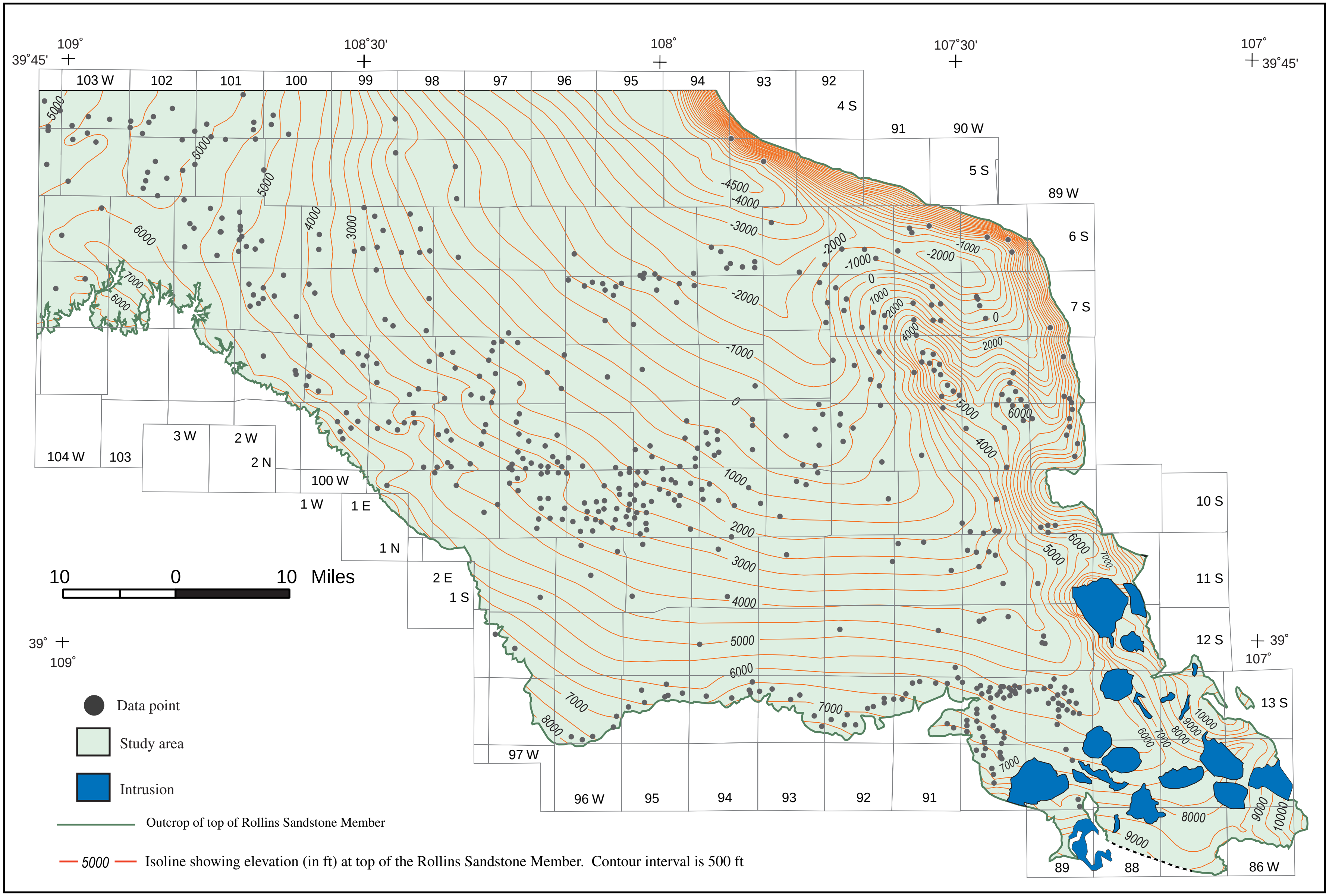


Figure 7*B*. Structure contour map of the top of the Rollins Sandstone Member of the Mount Garfield, Mesaverde, and Iles Formations in the southern part of the Piceance Basin, Colorado. The map was constructed using elevations at each data point for the top of the Rollins Sandstone Member and modified according to Johnson (1983). Data points are identified on figure A of plate 1, and elevations at the top of the Rollins Sandstone Member are provided in Appendix 1.

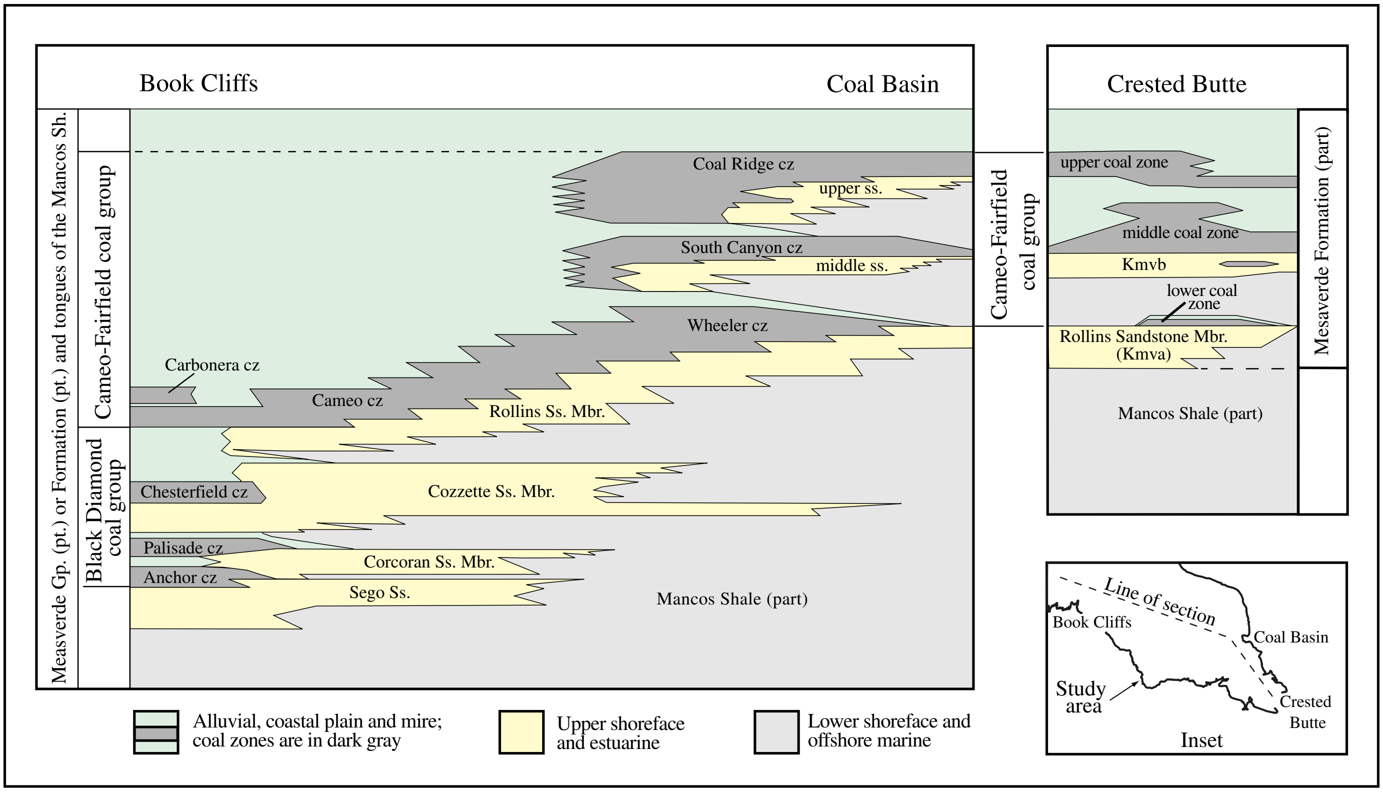


Figure 8. Schematic diagram showing the stratigraphic position and nomenclature used in this report for coal groups and coal zones in the southern part of the Piceance Basin, Colorado. The Black Diamond coal group includes all coal in the Mesaverde Group and Mesaverde Formation below the Rollins Sandstone Member. The Cameo-Fairfield coal group includes all coal in and between the Cameo, Carbonera, South Canyon, and Coal Ridge coal zones, and the lower, middle, and upper coal zones in the Crested Butte area. Stratigraphy of the Mesaverde Group and Mesaverde Formation provided in figure 6. Abbreivations include: Sandstone (Ss), sandstone (ss.), Shale (Sh), Member (Mbr.), coal zone (cz), Group (Gp.), part (pt.). Line of section is shown in the inset.

(Book Cliffs coal field), the Cameo coal zone (Grand Mesa coal field), the coal-bearing member (Somerset coal field), and the Wheeler-Fairfield, South Canyon, and Coal Ridge coal zones (Grand Hogback and Carbondale coal fields) (figs. 6, 8). Also included in the Cameo-Fairfield coal group are the informally named lower, middle, and upper coal zones in the Crested Butte coal field (figs. 6, 8). Coal zones in the Crested Butte area were not correlated west of long 107°15′W. because of structural and stratigraphic complexities and a lack of data.

The upper "undifferentiated" Williams Fork Formation contains several thin beds of coal that are stratigraphically about 700 ft above the Coal Ridge coal zone. These coal beds are exposed in the northeastern part of the study area near the town of New Castle and were assigned to the Keystone coal group by Gale (1910). Coal beds in the Keystone are thin and poorly exposed along the Grand Hogback south of New Castle and are not considered to be economical to mine (Collins, 1976).

Coal Distribution in Outcrops

Black Diamond Coal Group (Anchor, Palisade, and Chesterfield Coal Zones)

The Anchor and Palisade coal zones were identified and mapped in the Book Cliffs coal field by Erdmann (1934) and were refined by Young (1955). The Anchor coal zone includes coal-bearing strata in the Mount Garfield Formation that overlie the upper part of the Sego Sandstone, and the Palisade coal zone is restricted to coal-bearing strata within the Corcoran Member (Young, 1955). In the Grand Hogback coal field, the Corcoran Member is overlain by coal beds that were correlated into the Black Diamond coal group by Collins (1976); we consider these coals to be within the Palisade coal zone based on their stratigraphic position. The Chesterfield coal zone was defined along the Book Cliffs in Utah by Fisher

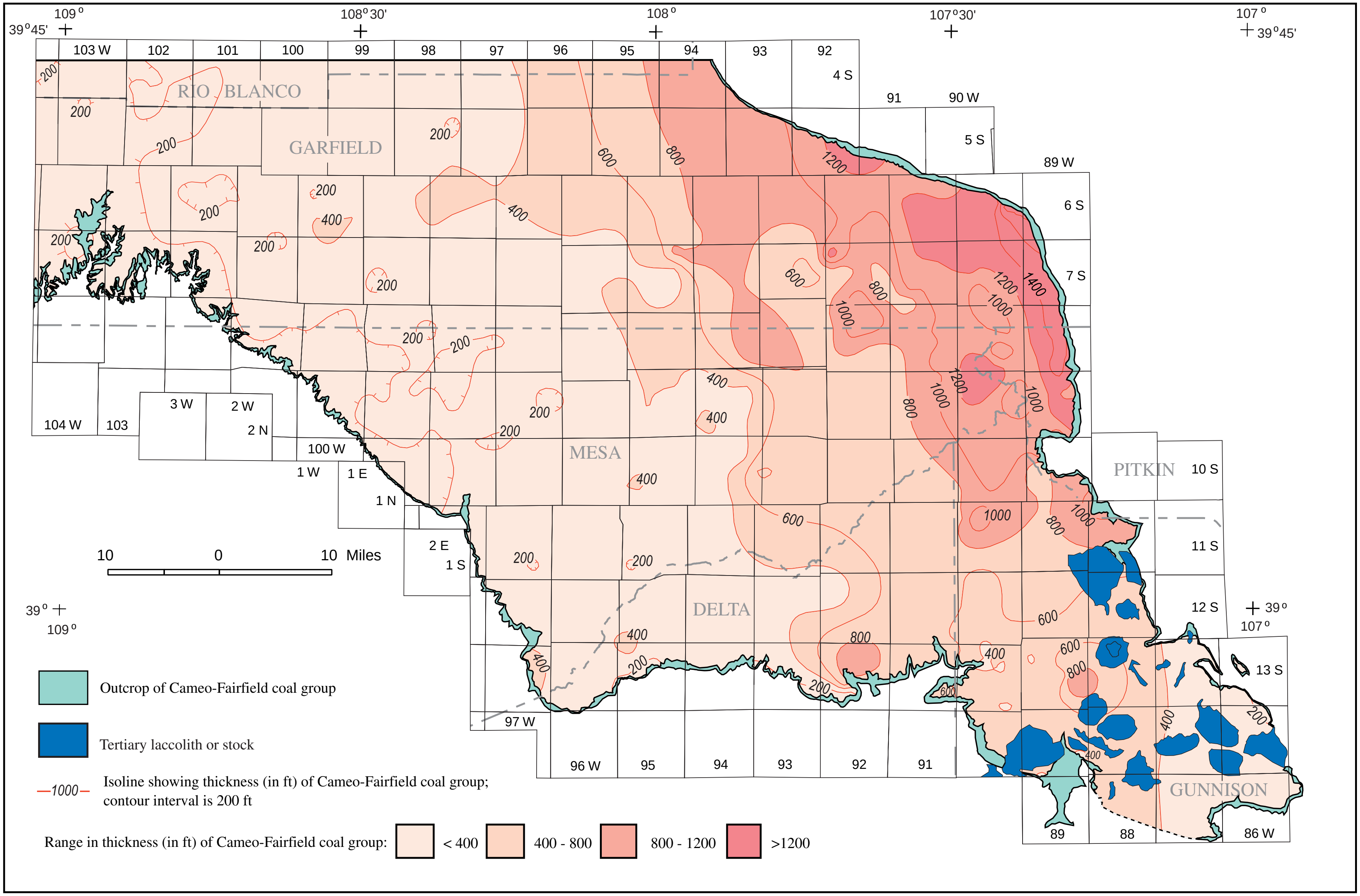


Figure 9. Isopach map showing the thickness of the Cameo-Fairfield coal group in the southern part of the Piceance Basin, Colorado. The coal group overlies the Rollins Sandstone and includes coal in the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones, and coeval coal-bearing strata in the Crested Butte–West Elk Mountains region. The Cameo-Fairfield coal group is about 4 to 1,400 ft thick.

(1936) and was traced eastward into the Cozzette Member in the study area by Kirschbaum and Hettinger (1998). The Chesterfield contains only one or two thin beds of coal that pinch out near East Salt Creek in T. 7 S., R. 102 W. (Kirschbaum and Hettinger, 1998).

The Anchor coal zone, as defined by Young (1955), extends eastward from the State line and pinches out near Hunter Canyon (sec. 5, T. 9 S., R. 100 W.) (Kirschbaum and Hettinger, 1998). It includes coals that Erdmann (1934) previously mapped in the Anchor coal zone and as well as coals that he mapped in the Palisade coal zone in areas west of Big Salt Wash (sec. 12, T. 8 S., R. 102 W.). Where exposed, the Anchor coal zone is generally less than 60 ft thick (Young, 1955). Descriptions by Erdmann (1934) indicate that the Anchor contains several beds of coal that are generally less than 2 ft thick and one bed that is between 3.0 and 5.4 ft thick in T. 8 S., Rs. 101 and 102 W. The main coal is the Anchor coal bed as redefined by Young (1955, p. 190).

The Palisade coal zone, as defined by Young (1955), extends approximately 32 mi along the Book Cliffs from Big Salt Wash (sec. 12, T. 8. S, R. 102 W.) to the vicinity of the Colorado River. It includes coals that Erdmann (1934) previously mapped in the Palisade coal zone in areas east of Big Salt Wash. The Palisade coal zone is generally less than 40 ft thick along the Book Cliffs, and descriptions by Erdmann (1934) indicate that it contains one to four coal beds that range from 1 to 6 ft in thickness; net-coal accumulations vary from 2 to 10 ft. Laterally equivalent coals in the Black Diamond coal zone extend southeast along the Grand Hogback and pinch out near the town of New Castle (Collins, 1976). Johnson (1982) measured about 12 ft of net coal in a 60-ft-thick interval within the Corcoran Member at Rifle Gap; the interval contains six coal beds that range from 1 to 6 ft in thickness. The main coal is the Palisade coal bed as redefined by Young (1955, p. 190–191).

Cameo-Fairfield Coal Group West of Long 107°15′W. (Cameo-Wheeler, South Canyon, and Coal Ridge Coal Zones)

Cameo-Wheeler Coal Zone

The Cameo-Wheeler coal zone, as used in this report, contains coal-bearing strata within an 100- to 450-ft-thick interval that overlies and intertongues with the Rollins Sandstone Member and laterally equivalent strata. The Cameo-Wheeler is restricted to areas west of long 107°15′W. and is within the Mount Garfield Formation in the Book Cliffs coal field, the coal-bearing member in the Grand Mesa and Somerset coal fields, and the lower part of the Bowie Shale Member in the Carbondale and Grand Hogback coal fields. The Cameo-Wheeler contains coal previously described in the Cameo and Carbonera coal zones (Erdmann, 1934), Fairfield coal zone (Collins, 1976), and Wheeler coal zone (Fender and Murray, 1978; Ellis and others, 1988).

The Cameo coal zone (figs. 6, 8) has been mapped in the Book Cliffs coal field by Erdmann (1934), and he measured the coal zone at 46 localities. Surface measurements are limited because the coal zone is burned extensively burned along outcrop and is not accessible in many areas where it overlies shear cliffs of the Rollins Sandstone Member. Based on Erdmann's measurements, the Cameo coal zone contains one to three coal beds in a 10- to 50-ft-thick interval; the coal beds are 1 to 15 ft thick and net coal is generally less than 16 ft. The Cameo zone has only one or two thin beds of coal near the State line; elsewhere Erdmann recorded at least one coal bed that was more than 6 ft thick at each measured locality.

The Carbonera coal zone (figs. 6, 8) lies about 60 ft above the base of the Cameo coal zone and is exposed in the Book Cliffs coal field near the State line in Tps. 6 and 7 S., Rs. 103 and 104 W. The Carbonera was mapped throughout the exposed area and measured at 19 localities by Erdmann (1934). Coal beds were reported to be lenticular and difficult to measure because the beds were commonly burned or were inaccessible due to cliffs formed in underlying strata (Erdmann, 1934). Measured sections by Erdmann demonstrate that the Carbonera coal zone is about 20 to 80 ft thick and has one to five lenticular coal beds that generally range from 1 to 5 ft in thickness. Thicker coals were measured by Erdmann at several localities; these include two beds in sec. 31, T. 6 S., R. 103 W. that were about 7 and 13 ft thick, and two beds in secs. 3 and 14, T. 7 S., R. 104 W. that were about 7 ft thick.

The Wheeler coal zone was named by Fender and Murray (1978) and used by Ellis and others (1988) to describe coal-bearing strata in the lower part of the Bowie Shale Member along the Grand Hogback and Carbondale coal fields between Glenwood Springs and Coal Basin (figs. 6, 8). The coal-bearing interval has also been referred to as the lower coal zone (Donnell, 1959, 1962; Kent and Arndt, 1980a, 1980b), the Fairfield coal group (Collins, 1976), and the Songer coal-bearing unit (Madden, 1989). Collins (1976) correlated the coal-bearing interval to the lower part of the Fairfield coal group, which is about 30 mi northwest of the study area. The Wheeler coal zone is about 350 to 450 ft thick and contains at least 40 ft of net coal at Rifle Gap (secs. 7 and 8, T. 5 S., R. 92 W.); it thins to the southeast and contains less than 10 ft of net coal in a 70-ft-thick interval a few mi south of Coal Basin (Ellis and others, 1988). This zone contains the most economically important coal beds in the Grand Hogback and Carbondale area (Collins, 1976). Significant coal beds include the Wheeler, Coal Basin A and B, Diamond, Somerset, Pocahontas, Black Diamond, Bear, and A, B, C, and D (Ellis and others, 1988). However, attempts by Collins (1976) to correlate individual beds were unsuccessful as beds rapidly split and pinch out. The Wheeler bed is 30 ft thick at Rifle Gap (Gale, 1910) and 50 ft thick in the New Castle area (Collins, 1976). Twenty-seven mi southeast, near the Black Diamond mine (sec. 8, T. 7 S., R. 89 W.), the coal zone is about 200 ft thick and contains about 40 ft of net coal in five coal beds that range from 4 to 15 ft in thickness; these include the A, B, C, D, and Pocahontas beds (Ellis and others, 1988). Still farther southeast at Coal Basin, the coal zone is about 50 to 65 ft thick and contains about 7 to 27 ft of net coal in one to three beds that range from 3 to 18 ft in thickness; these include the Coal Basin A, B (Somerset), and C (Bear) beds (Dunrud, 1989a; Ellis and others, 1988). The A and B beds merge into a single bed in sec. 5, T. 10 S., R. 89 W. that contains 27 ft of coal (Ellis and others, 1988).

Approximately 50 to 300 ft of coal-bearing strata overlie the Rollins Sandstone Member in the Grand Mesa and Somerset coal fields. This coal-bearing interval is included in the Cameo-Wheeler coal zone in this report. These coal-bearing strata were described by Lee (1912) and were included in the lower part of the coal-bearing member by Dunrud (1989a, b); they were traced westward to the Cameo coal zone by Erdmann (1934) and eastward to the Wheeler coal zone by Ellis and others (1988). Coal exploration holes reported by Eager (1978, 1979) show that the Cameo-Wheeler is about 200 ft thick along the southern flank of Grand Mesa and has as many as 15 beds of coal that range from 1 to 30 ft in thickness; net-coal ranges from 15 to 65 ft and increases to the east. Farther east, drill-hole data reported by Dunrud (1989a, 1989b), Johnson (1948), and Toenges and others (1949, 1952) show that the Cameo-Wheeler is about 250 ft thick a few miles north of the town of Paonia and contains as many as 10 beds of coal that range from 1 to 30 ft in thickness and has net-coal thickness values that range from 40 to 60 ft. Principal coals in the Somerset coal field include the Old King Coal (A) bed, Somerset (B) bed, Bear (C) bed, and Orchard Valley (D) bed (Dunrud, 1989a, 1989b). Some coals have been intruded by mafic sills and dikes in sec. 34, T. 11 S., R. 94 W. and secs. 4 and 5, T. 13 S., R. 91 W. (Dunrud, 1989a, 1989b). The Cameo-Wheeler thins to the east and is only 50 ft thick where it was drilled about 15 mi southeast of Paonia in sec. 35, T. 14 S., R. 89 W.; at that location it contains only three beds of coal that range from 1 to 9 ft thick, and the net-coal thickness is only 12 ft (Dunrud, 1989a).

South Canyon Coal Zone

The South Canyon coal zone (figs 6, 8), as used in this report, includes coal-bearing strata located west of long 107°15′W. that overlie and intertongue with the middle sandstone in the Bowie Shale Member of the Williams Fork Formation (Carbondale and Grand Hogback coal fields) and laterally equivalent strata in the coal-bearing member of the Mesaverde Formation (Somerset coal field). The coal zone was named by Ellis and others (1988) for South Canyon Creek near New Castle where the coals are best developed (Collins, 1976) and includes coals previously described in the South Canyon coal group (Collins, 1976), middle coal zone (Donnell, 1959, 1962; Kent and Arndt, 1980a, 1980b).

In outcrops along the Grand Hogback, the South Canyon coal zone is 10 to about 200 ft thick and contains one to six beds of coal that range from 1 to 20 ft in thickness. Coals in the South Canyon group are less continuous along the Grand Hogback than are those in the underlying Wheeler coal zone (Fairfield group) (Collins, 1976). The coal zone contains the Allen (Nu Gap No. 3 bed) and Anderson beds near New Castle; the Allen bed is as much as 14 ft thick (Collins, 1976). Madden (1989) measured two coal beds at Harvey Gap (sec. 24, T. 5 S., R. 92 W.) that are 20 and 25 ft thick each; although Madden placed the coals into the Songer coal-bearing unit, our regional correlations show the coals are more likely to be in the South Canyon coal zone. At Coal Basin the coal zone contains the Dutch Creek bed, which varies from 3 to 20 ft in thickness (Collins, 1976; Dunrud, 1989a). The Dutch Creek was apparently referred to as the Huntsman coal bed by Ellis and others (1988) and extends for 10 mi from the northern part of Coal Basin south to sec. 5, T. 11 S., R. 88 W. near the Crystal River.

The South Canyon coal zone was extended into the subsurface by Ellis and others (1988) and the Dutch Creek bed was correlated from Coal Basin southwest to the Somerset coal field by Dunrud (1989a). Our interpretations of drill-hole data by Dunrud (1989a), Johnson (1948), and Toenges and others (1949, 1952) indicate that the South Canyon is about 50 to 130 ft thick in Tps. 12, 13, and 14 S., R. 90 W. and T. 13 S., R. 91 W. near the town of Paonia. In those townships, the coal zone contains 15 to 35 ft of net coal in two to five beds that are 1 to 25 ft thick; important beds include the Oliver (D), and D-1, and D-2 coal beds (Dunrud 1989a). The laterally extensive Oliver bed is 6 to 30 ft thick and correlates to the Dutch Creek bed at Coal Basin (Dunrud 1989a). The D-1 and D-2 beds are 2 to 13 ft thick and were described only in parts of T. 13 S., Rs. 90 and 91 W. The South Canyon coal zone thins to the south and is less than 50 ft thick in Tps. 13 and 14 S., R. 89 W., and the coal zone also thins to the west and pinches out near sec. 15, T. 13 S., R. 92 W.

Coal Ridge Coal Zone

The Coal Ridge coal zone is in the lower part of the Paonia Shale Member of the Williams Fork Formation in the Grand Hogback and Carbondale coal fields (figs. 6, 8). As used in this report, it includes coal-bearing strata located west of long 107°15′W. that overlie and intertongue with the upper sandstone in the Bowie Shale Member of the Williams Fork Formation. It includes equivalent strata in the coal-bearing member of the Mesaverde Formation in the Somerset coal field. The Coal Ridge zone is located in approximately the same part of the study area as the underlying South Canyon coal zone. The coal zone was named by Ellis and others (1988) for Coal Ridge near New Castle where its coals are best developed. The zone includes coals previously described in the Coal Ridge coal group (Collins, 1976), and the upper coal zone (Donnell, 1959, 1962; Kent and Arndt, 1980a, 1980b).

The Coal Ridge coal zone is about 100 to 350 ft thick in outcrops in the Grand Hogback and Carbondale coal fields and contains 2 to 10 beds of coal that range from 1 to 23 ft in thickness (Collins, 1976; Ellis and others, 1988). The coal zone contains (in ascending order) the Placita, Sunshine, Anderson, North Rim, Lake Ridge, and Thompson beds that were described by Gale (1910) and correlated and mapped by Ellis and others (1988). Coal beds in the Coal Ridge were considered to be less persistent than those in the underlying South Canyon and Wheeler coal zones (Collins, 1976; Ellis and others, 1988). The Placita and Sunshine beds are at the base of the coal zone. The Placita bed extends more than 10 mi from Coal Basin south to the northwest flank of Chair Mountain in sec. 26, T. 11 S., R. 89 W; it averages about 5 ft in thickness but is locally as much as 23 ft thick in the southern part of Coal Basin. The Sunshine bed is about 4 to 9 ft thick and extends more than 13 mi from Coal Basin north to Fourmile Creek (sec. 33, T. 7 S., R. 89 W.). The Anderson coal bed varies from 4 to 14 ft in thickness; it is about 70 ft above the base of the coal zone and extends 16 mi from North Thompson Creek (sec. 34, T. 8 S., R. 89 W.) northwest to South Canyon Creek (sec. 14, T. 6 S., R. 90 W.). The North Rim, Lake Ridge, and Thompson coal beds are in the middle and upper part of the Coal Ridge coal zone. They are lenticular beds that vary from 1 to 5 ft in thickness and are located between the northern part of Coal Basin and South Canyon Creek.

The Coal Ridge coal zone was extended into the subsurface by Ellis and others (1988), and the Placita coal bed was correlated from Coal Basin southwest to the Somerset coal field by Dunrud (1989a). Our interpretations of drill-hole data by Dunrud (1989a), Johnson (1948), and Toenges and others (1949, 1952) indicate that the Coal Ridge coal zone is about 60 to 160 ft thick in Tps. 13 and 14 S., R. 90 W. near the town of Paonia. In those townships, the coal zone contains 10 to 26 ft of net coal in two to seven beds that are 1 to 10 ft thick; important beds include the Hawksnest (E) and E-2 coal beds (Dunrud 1989a). The laterally continuous Hawksnest (E) bed is about 5 to 10 ft thick and correlates to the Placita bed at Coal Basin (Dunrud 1989a). The coal zone thins to the southeast and is generally less than 50 ft thick in Tps. 13 and 14 S., R. 89 W. It also thins to the west and pinches out near sec. 20, T. 13 S., R. 92 W. The E-2 bed is about 2 to 6 ft thick and was traced about 3 mi in the subsurface in T. 13 S., R. 92 W. by Dunrud (1989a).

Cameo-Fairfield Coal Group East of Long 107°15′W. in the Crested Butte Coal Field (Lower, Middle, and Upper Coal Zones)

The Cameo-Fairfield coal group is poorly exposed, steeply folded, and split and concealed by Tertiary intrusions in parts of the study area that are located east of long 107°15′W. Because of the structural and stratigraphic complexities and paucity of data, we did not attempt to correlate coal zones in the southern part of the Carbondale (south of Coal Basin) and Crested Butte coal fields to those described west of long 107°15′W. Coal beds in the Mesaverde Formation were initially measured and described in the Crested Butte coal field–West Elk Mountain region by Lee (1912), and the geology has been mapped in detail in various quadrangles by Hanks (1962), Gaskill and Godwin (1966a, 1966b), Godwin (1968), Gaskill and others (1967, 1986), and Gaskill and DeLong (1987). These geologic maps show that the Mesaverde Formation is generally covered, steeply inclined, displaced by numerous faults, and intruded by multiple sills, dikes, and laccoliths throughout the West Elk Mountains. Coal beds in the Mesaverde Formation underlie parts of the Mt. Carbon, Mt. Axtell, and Anthracite Range laccoliths (Gaskill and others, 1987); the Whetstone Mountain laccolith (Gaskill and others, 1986); Raspberry Creek phacolith and Snowmass stock (Gaskill and Godwin, 1966a); and igneous intrusions that form East Beckwith Mountain and West Beckwith Peak (Lee, 1912). The Mesaverde Formation contains coal in three zones in the Crested Butte coal field, which we informally refer to as the lower, middle, and upper coal zones (figs. 6, 8; table 2). Coal in the lower zone is in the Bowie Shale Member, and coal in the middle and upper zones are in the Paonia Shale Member of the Mesaverde Formation.

Lower Coal Zone

The lower coal zone overlies a basal marine sandstone (Kmva) that was considered to be equivalent to the Rollins Sandstone Member by Gaskill and Godwin (1966a, 1966b), Godwin (1968), Gaskill and others (1967, 1986), and Gaskill and DeLong (1987). The lower coal zone contains only one or two beds of coal that were measured locally along outcrops in the West Elk Mountains. The coal beds are as thick as 1.6 and 3.2 ft in sec. 25, T. 11 S., R. 89 W. in the Chair Mountain quadrangle (Godwin, 1968) and 0 to 4 ft thick in sec. 9, T. 15 S., R. 86 W. in the Mt. Axtell quadrangle (Gaskill and others, 1987); the beds thin and pinch out a few miles east of those localities. The only important coal is the A bed, which is located in T. 15 S., R. 86 W. in the Mt. Axtell quadrangle; the A bed is 0 to 4.0 ft thick.

Middle Coal Zone

The middle coal zone overlies a second marine sandstone (Kmvb) that is about 100 to 200 ft stratigraphically above the basal Kmva sandstone (Rollins Sandstone Member equivalent). The Kmvb sandstone was previously mapped as the Rollins Sandstone by Lee (1912). The middle coal zone contains two to six beds of coal that are generally between 1 and 25 ft thick. Coal beds in the middle zone thicken to the southeast, and four beds were described near the town of Crested Butte; these include bed I (1.5 to 6.5 ft thick), II (5.0 to 10.0 ft thick), III (2.0 to 25.0 ft thick), and IV (0 to 6.0 ft thick) (Gaskill and others, 1986). Other important beds in the middle zone include the B bed, which is 5.6 to 8.6 ft thick in the Ohio Creek district (Gaskill and others, 1987) and several unnamed beds that were mined on Anthracite Mesa (T. 13 S., R. 86 W.) (Gaskill and others, 1967).

Upper Coal Zone

The upper zone contains several lenticular coal beds in the Mt. Axtell quadrangle; important coal beds include the C bed, which is about 5 to 6 ft thick in the southeastern part of the quadrangle, and an anthracite bed which is 3.5 to 4.5 ft thick in the northeastern part of the quadrangle (Gaskill and others, 1987). The upper coal zone is located about 300 ft stratigraphically above the Rollins Sandstone Member equivalent and is described only in the Mt. Axtell quadrangle.

Subsurface Distribution of Coal in the Cameo-Fairfield Coal Group

The distribution of coal in the Cameo-Fairfield coal group is demonstrated by a series of isopach maps that show the thickness and net coal of the Cameo-Fairfield coal group and for each coal zone in the group. The isopach maps were constructed using data from 627 drill holes and measured sections, which are identified in Appendix 1 and located on figure A on plate 1. Criteria used to determine coal thicknesses is provided in the Methods section of this report. Net-coal thickness maps were made for specified stratigraphic intervals by summing the thickness of coal at each data point and contouring the summed values. The distribution of coal is also demonstrated on a correlation diagram shown on cross section A-A′ (fig. C on pl. 1). Cross section A-A′ is oriented approximately perpendicular to paleoshorelines of the Cretaceous Western Interior Seaway and extends about 115 mi southeastward from near the Colorado-Utah State line to Coal Basin located along the eastern margin of the Piceance Basin in T. 10 S., R. 89 W. (fig. C on pl. 1). Stratigraphic sections by Kirschbaum and Hettinger (1998) were used for stratigraphic control in the Book Cliffs area, and a section described by Collins (1976) was used for stratigraphic control in the Coal Basin area. The datum used for most of the cross section is a bentonite bed located near the base of a tongue of Mancos Shale that is located between the Cozzette Sandstone and Rollins Sandstone Members. The bentonite extends westward to the maximum transgression of the Rollins Sandstone Member and is interpreted to reflect the surface of maximum marine flooding.

Correlations shown on cross section A-A′ indicate that the top of the Rollins Sandstone Member is about 80 ft above the datum at locality 94 (fig. C on pl. 1) and nearly 800 ft above the datum at locality 525 (fig. C on pl. 1) and therefore has a stratigraphic rise of about 720 ft to the southeast across a distance of 87 mi. Thick coal beds at the base of the Cameo-Wheeler coal zone pinch out to the southeast into successively higher shoreface wedges of the Rollins Sandstone Member; the same thick beds of coal thin and pinch out to the northwest and are represented by thin coal beds in the upper part of the Cameo-Wheeler coal zone.

The Cameo-Fairfield group has one to 26 beds of coal that are distributed throughout a stratigraphic interval that varies from about 4 to 1,400 ft thick (fig. 9). The coal group is 1,000 to 1,400 ft thick in the northeastern part of the study area where the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones are separated by thick clastic wedges of shoreface sandstone and mudrock. The coal group thins as the South Canyon and Coal Ridge coal zones and shoreface wedges pinch out to the southwest and is less than 400 ft thick in the western half of the study area. The coal group also thins to the southeast and is less than 400 ft thick in the Paonia area and less than 200 ft thick in the Crested Butte area.

The Cameo-Fairfield coal group has as much as 140 ft of net coal in beds that are greater than 1 ft thick (fig. 10). Net-coal thicknesses exceed 70 ft in a 15- to 30-mi-wide beltway that extends about N. 15° W. across the eastern part of the study area. The beltway is approximately parallel to paleoshorelines of the Cretaceous seaway and occurs in the area where the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones are all well developed. Net-coal thicknesses decrease to less than 60 ft in the western part of the study area where only the Cameo-Wheeler coal zone is present. The net-coal accumulation also decreases rapidly to the southeast and is generally less than 50 ft thick in the Coal Basin and West Elk Mountains.

Cameo-Wheeler Coal Zone

The Cameo-Wheeler coal zone underlies approximately 3,880 mi^2 of the study area in areas west of long 107°15′W.; it is generally 100 to 450 ft thick but thins to less than 50 ft near outcrops in the Book Cliffs area and it pinches out beneath the West Elk Mountains (figs. 2*B* and 11). The Cameo-Wheeler contains from 1 to 87 ft of net coal (fig. 12) in 1 to 21 beds that range from 1 to 44 ft in thickness. The maximum accumulation of net coal is located in T. 6 S., R. 94 W., about 12 mi southwest from the Grand Hogback (figs. 2*B* and 12). Net coal thickness exceeds 50 ft in an approximate 1,000-mi^2 area located in the central part of the study area and is less than 30 ft throughout much of the western and southeastern part of the study area. Coal beds are generally thinner in the upper part of the coal zone. The thinner beds may extend eastward into thicker coals that are in the lower part of the coal zone. The relative change in stratigraphic position is the result of the stratigraphic rise of the eastwardly prograding shoreline.

A series of isopach maps show the distribution of net coal in the Cameo-Wheeler coal zone and net coal in bed-thickness categories that range from 1–2.3, 2.3–3.5, 3.5–7, 7–14, and greater than 14 ft in thickness (figs. 13, 14, 15, 16, and 17, respectively). The net coal and number of beds in each category are shown for each data point in Appendix 1. Coal beds less than 7.0 ft thick are widely distributed throughout the study area and account for a significant portion of the net coal in the western part of the study area (figs. 13, 14, and 15). As much as 34 ft of net coal is in as many as 16 beds that are less than or equal to 3.5 ft thick, and as much as 29 ft of net

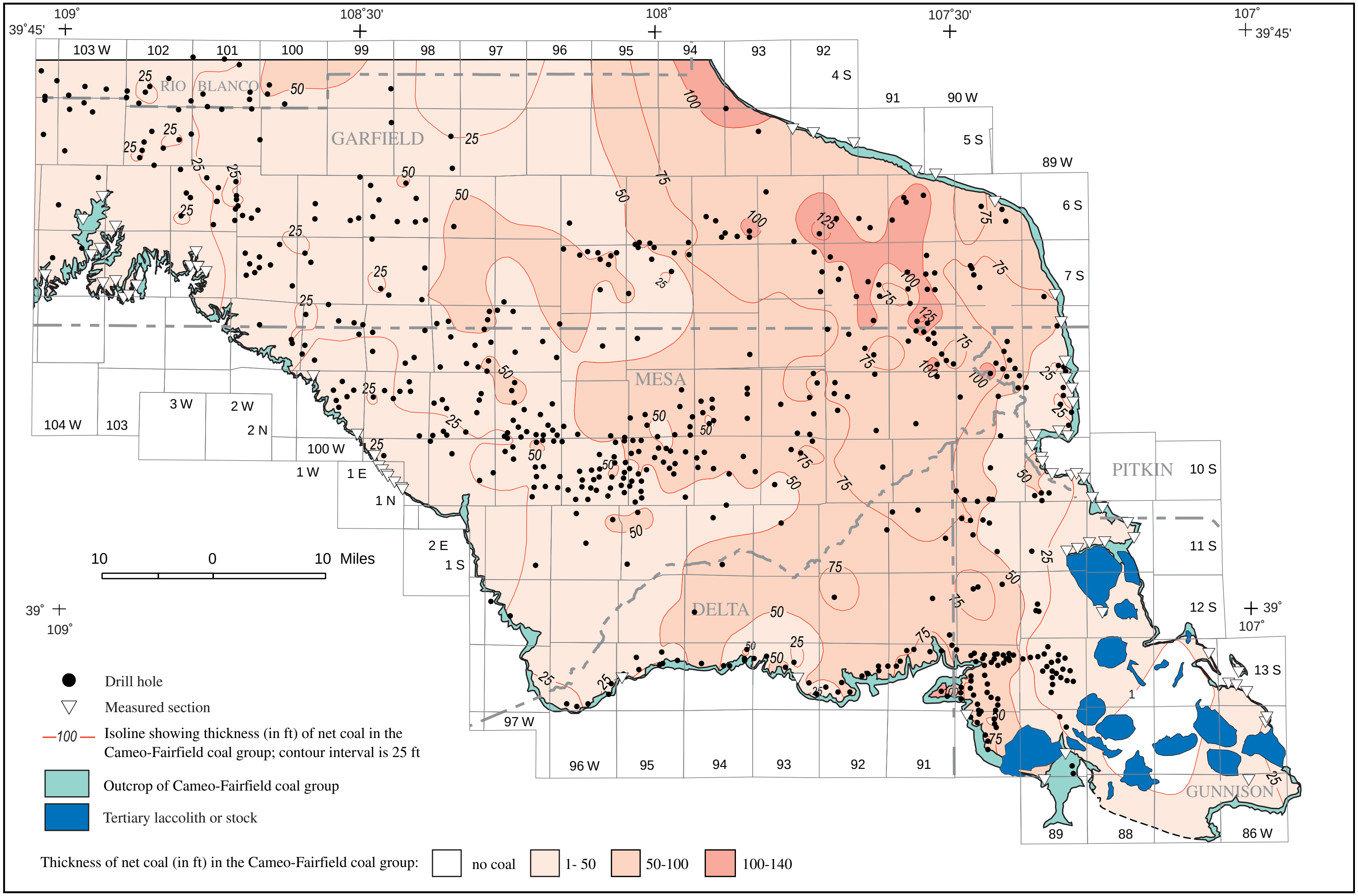


Figure 10. Isopach map of net coal in the Cameo-Fairfield coal group in the southern part of the Piceance Basin, Colorado. Net-coal values represent all beds of coal that are more than 1 ft thick and are determined from 627 data points listed in Appendix 1; data points are identified on figure A of plate 1.

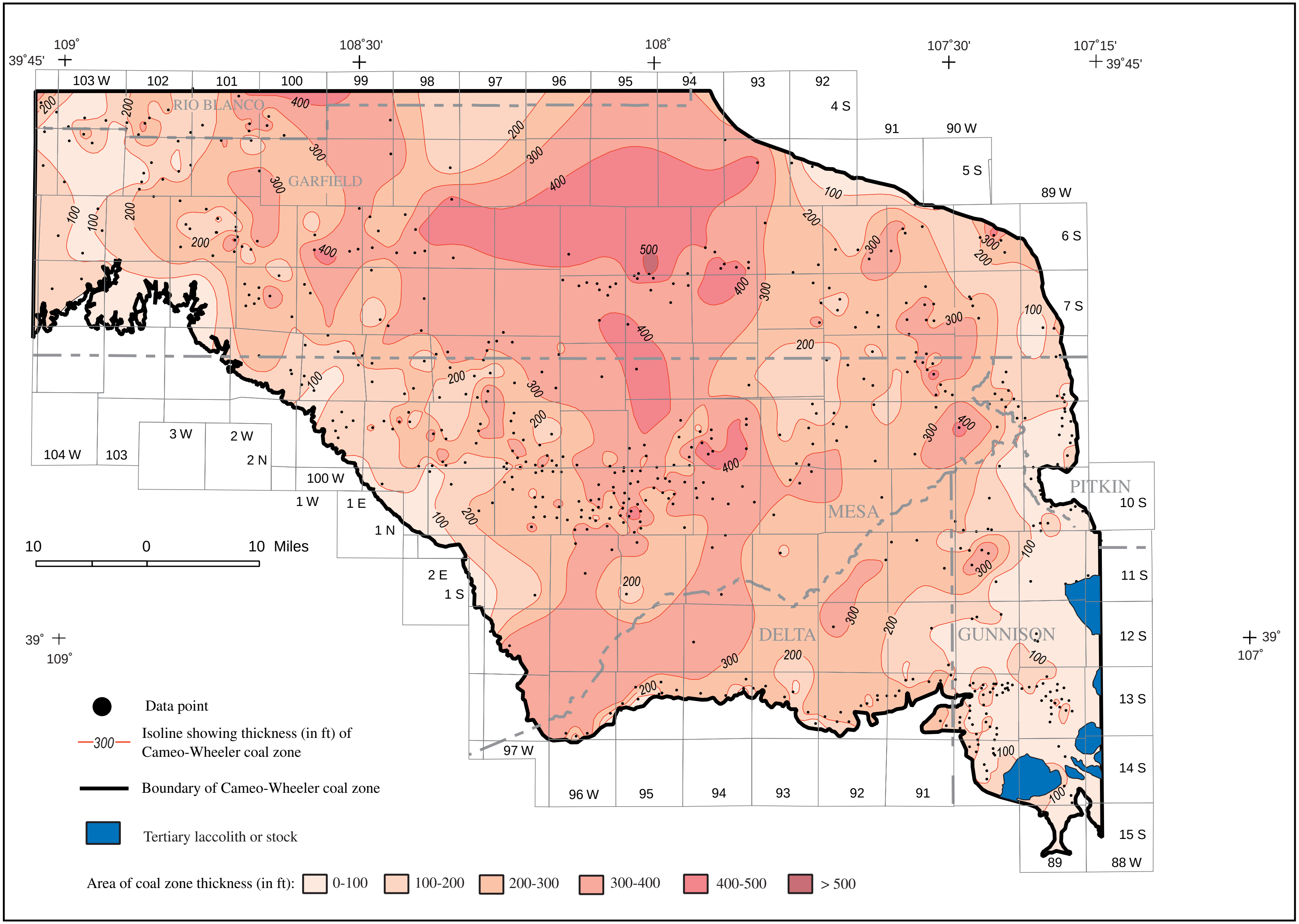


Figure 11. Isopach map showing thickness of Cameo-Wheeler coal zone. Thickness is based on 627 data points identified on figure A of plate 1 and in Appendix 1.

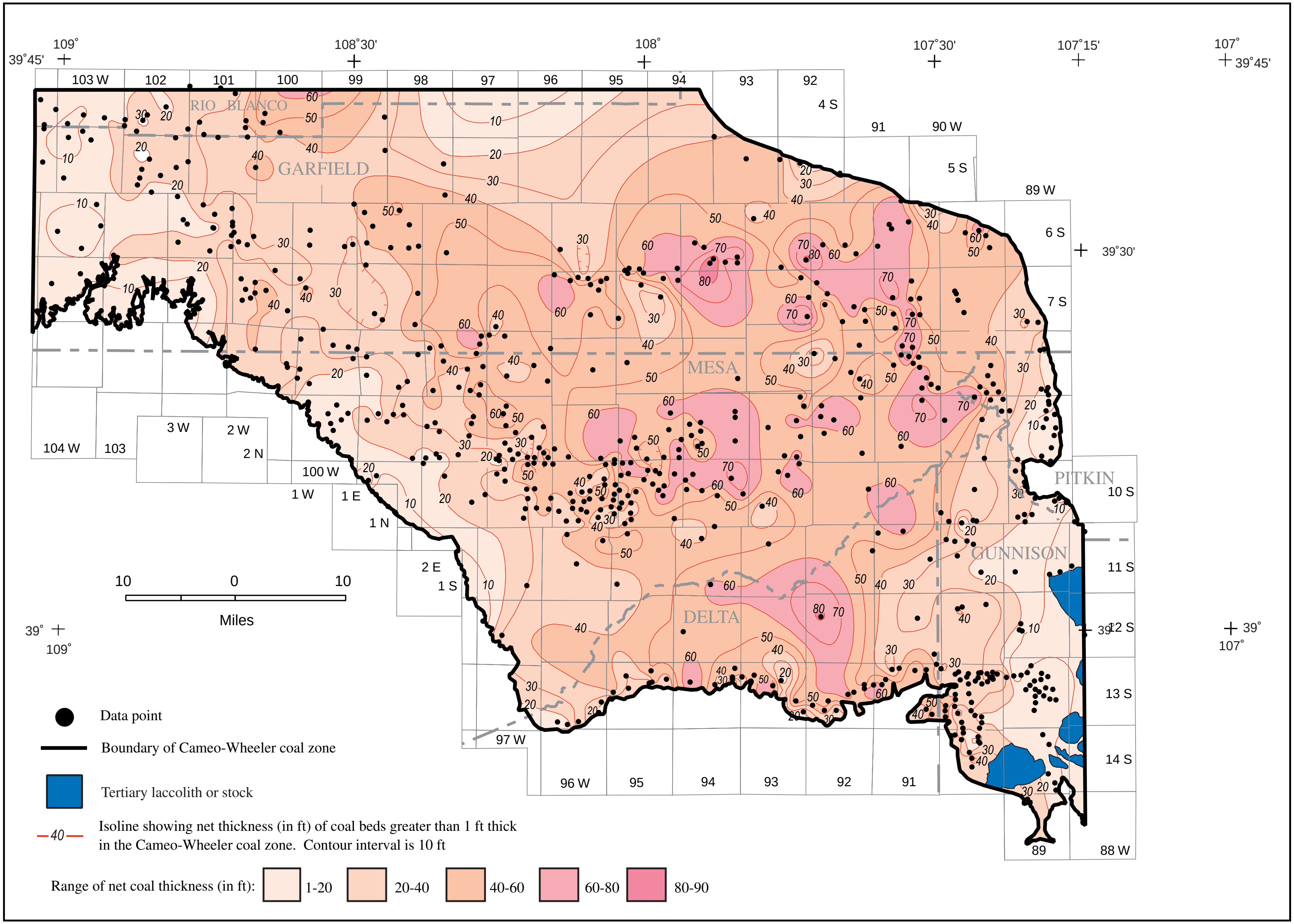


Figure 12. Isopach map of net coal in the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado. Net coal values represent all coal beds that are more than 1 ft thick and are determined from 627 data points that are identified on figure A of plate 1 and in Appendix 1.

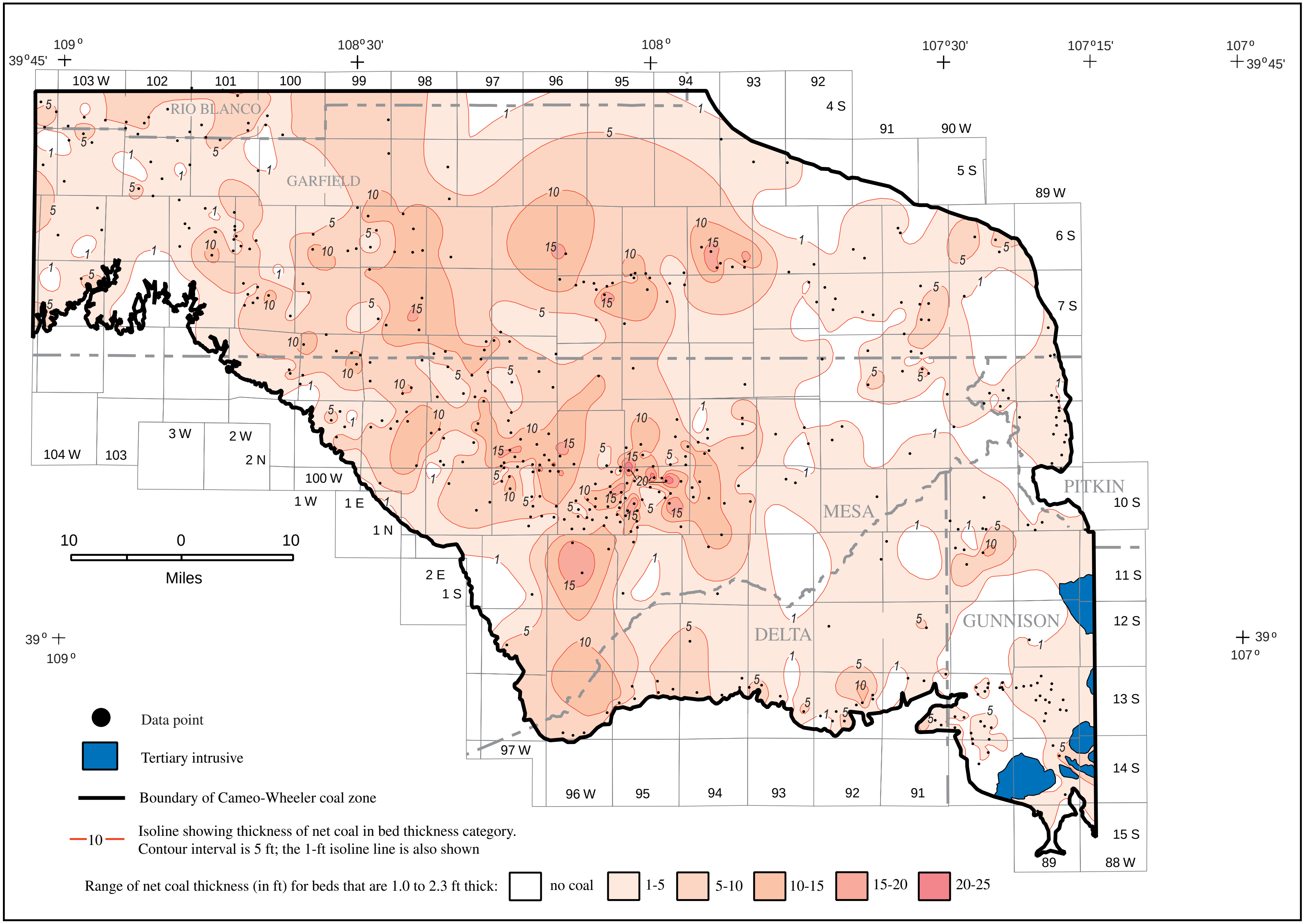


Figure 13. Isopach map showing distribution of net coal in beds that are 1.0–2.3 ft thick in the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado.

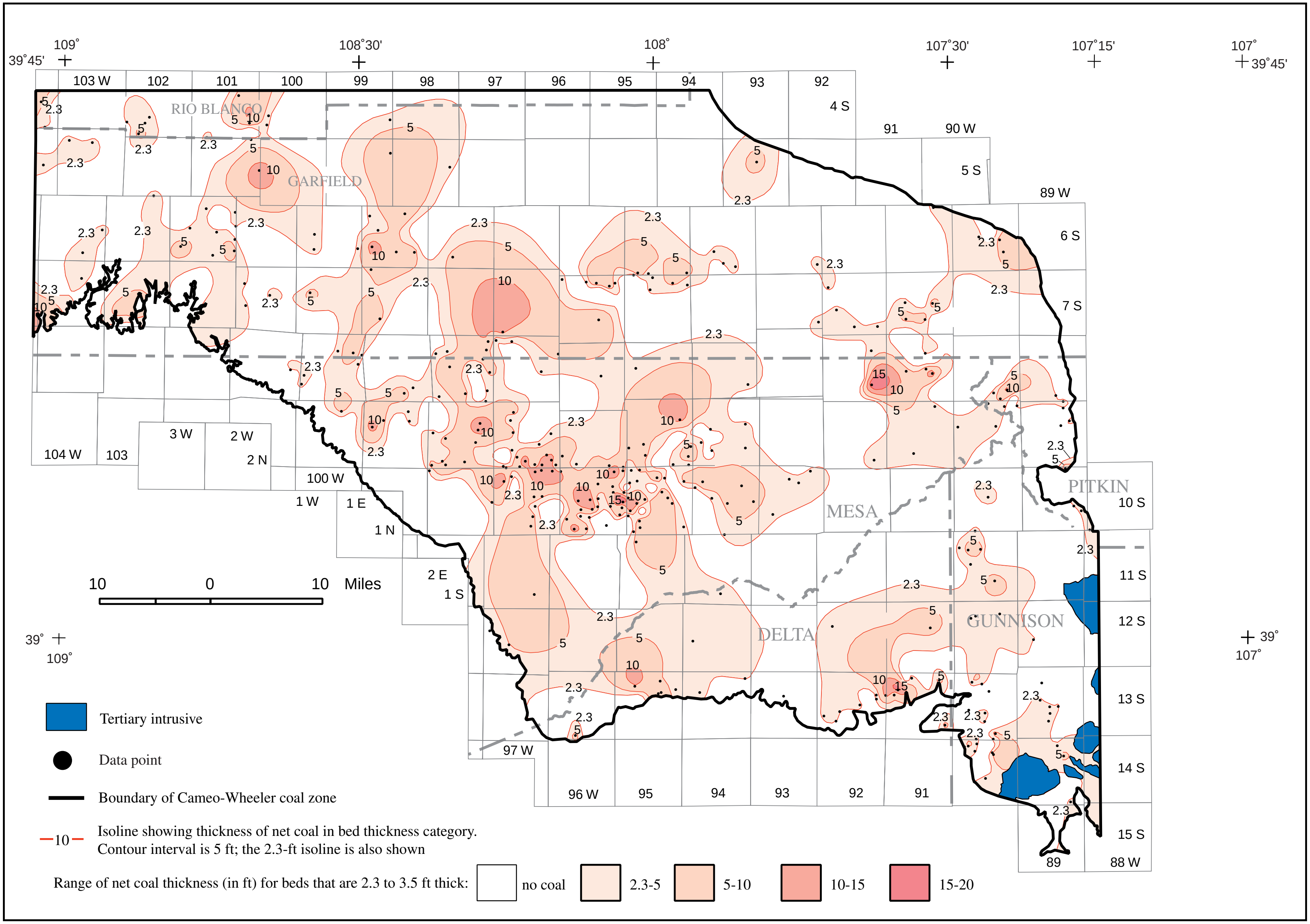


Figure 14. Isopach map showing distribution of net coal in beds that are 2.3–3.5 ft thick in the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado.

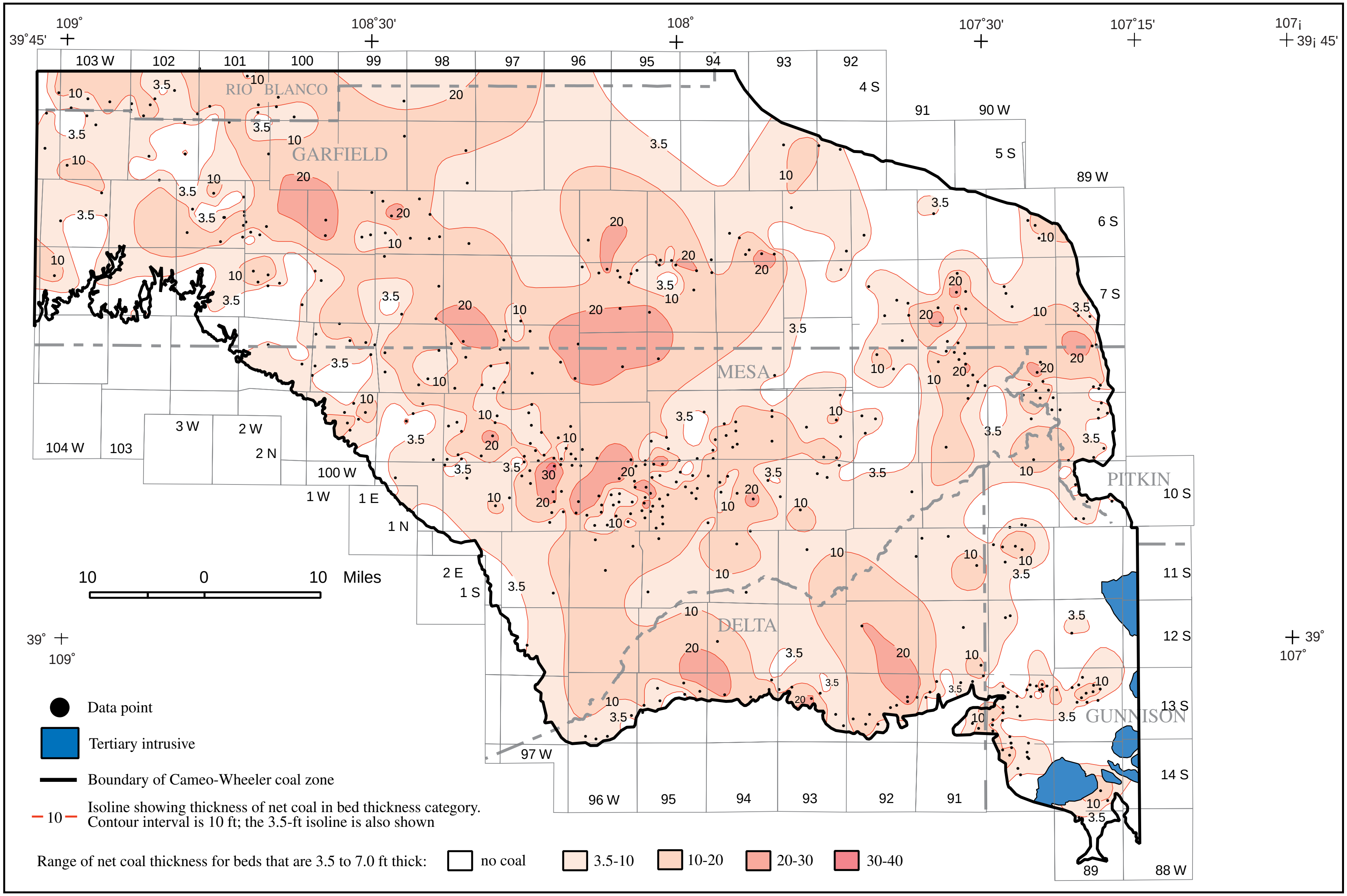


Figure 15. Isopach map showing distribution of net coal in beds that are 3.5–7.0 ft thick in the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado.

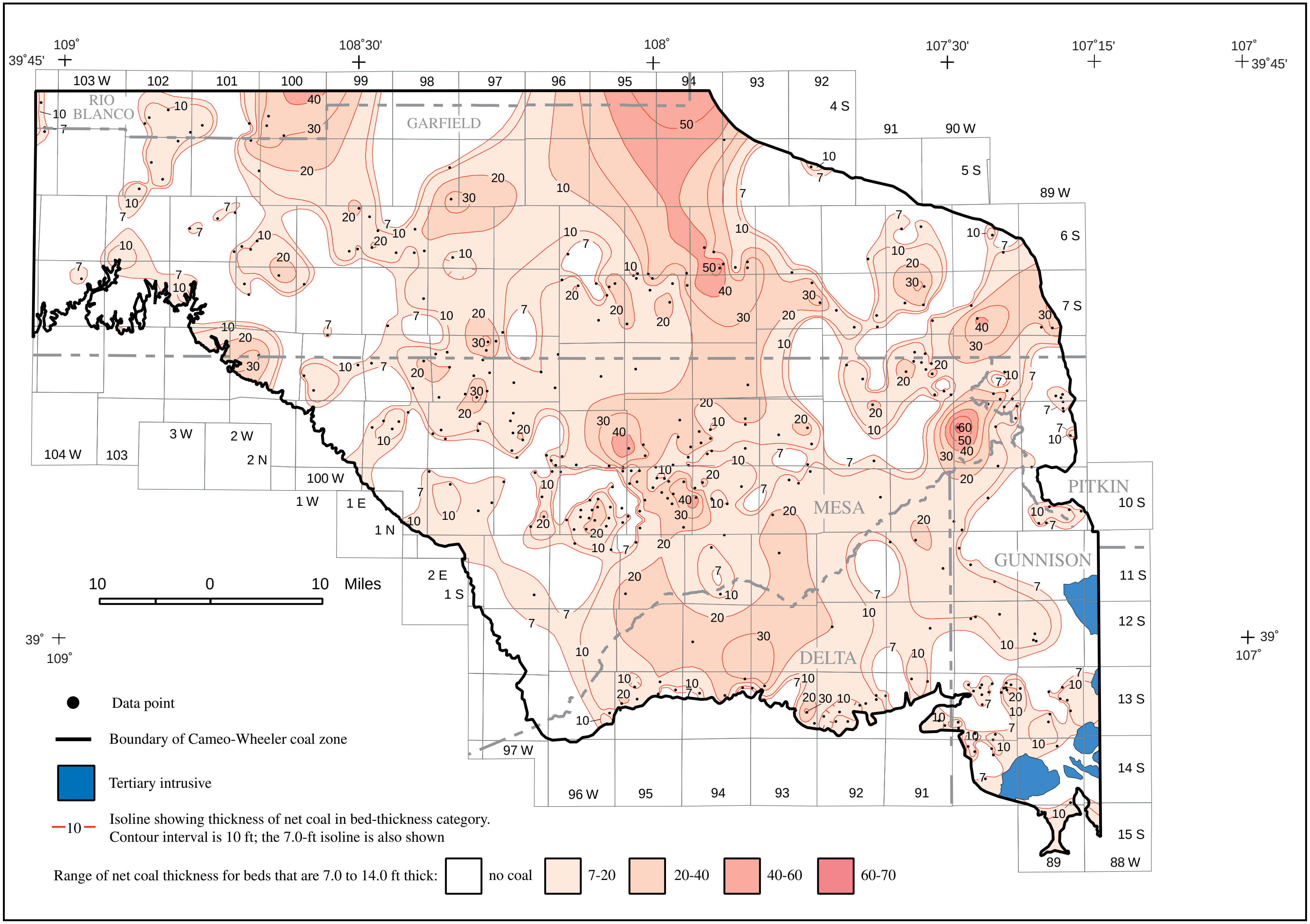


Figure 16. Isopach map showing distribution of net coal in beds that are 7.0–14.0 ft thick in the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado. Data points with less than 7 ft of net coal in this bed-thickness category are not shown.

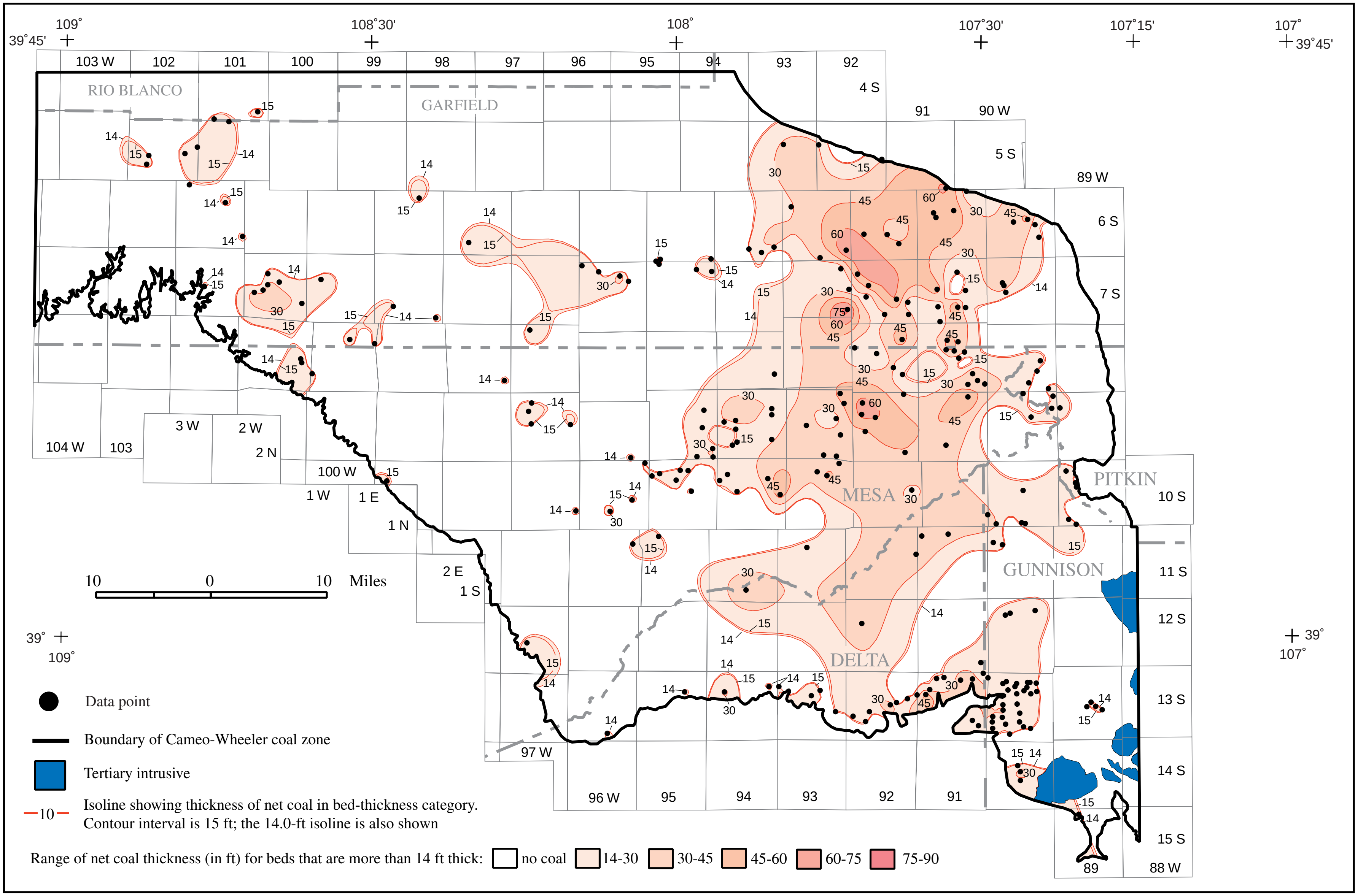


Figure 17. Isopach map showing distribution of net coal in beds that are more than 14 ft thick in the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado. The maximun net-coal thickness is 77 ft. Data points with less than 14 ft of net coal in this bed-thickness category are not shown.

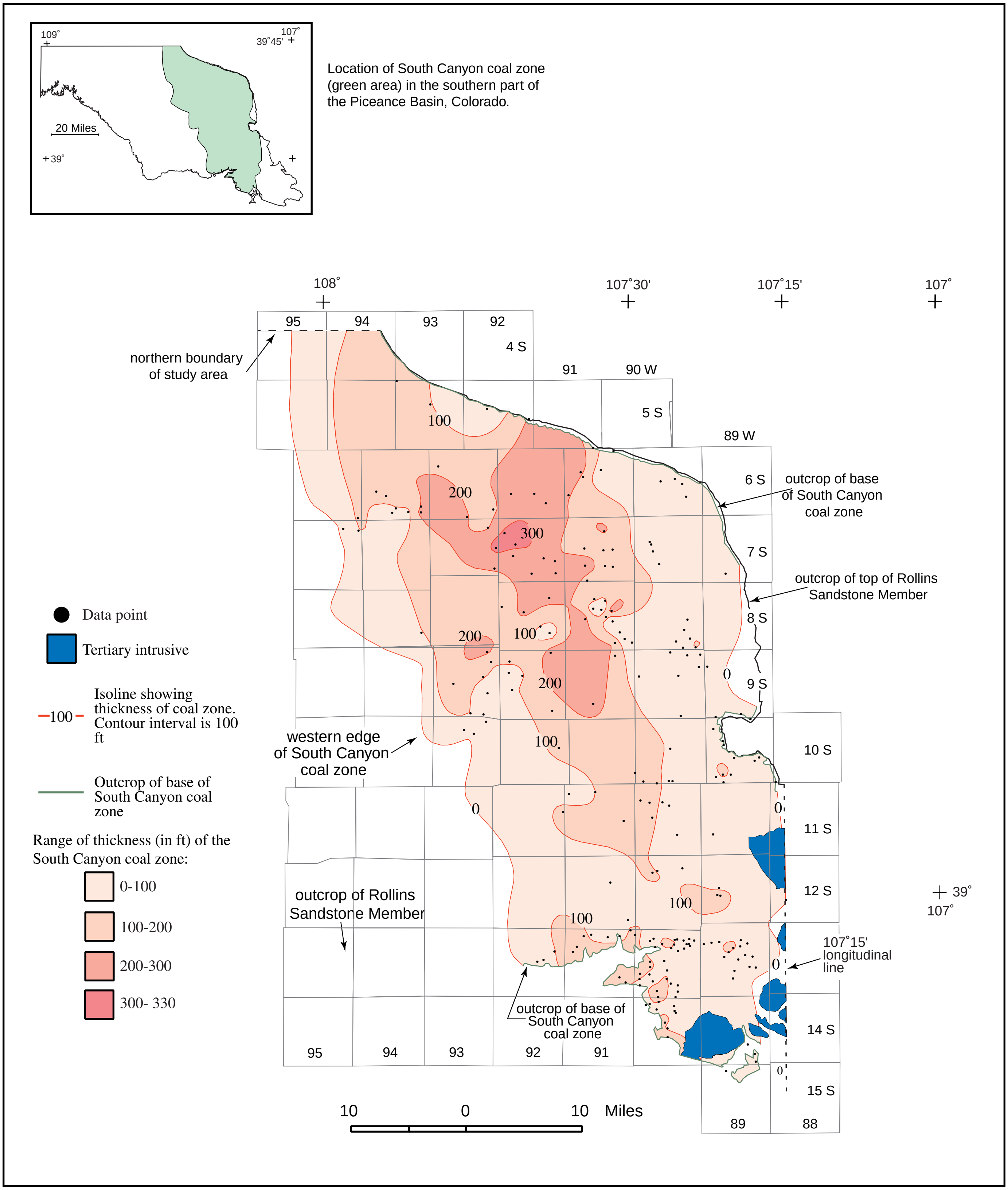


Figure 18. Isopach map showing thickness of the South Canyon coal zone. Data points are identified on figure A of plate 1 and in Appendix 1.

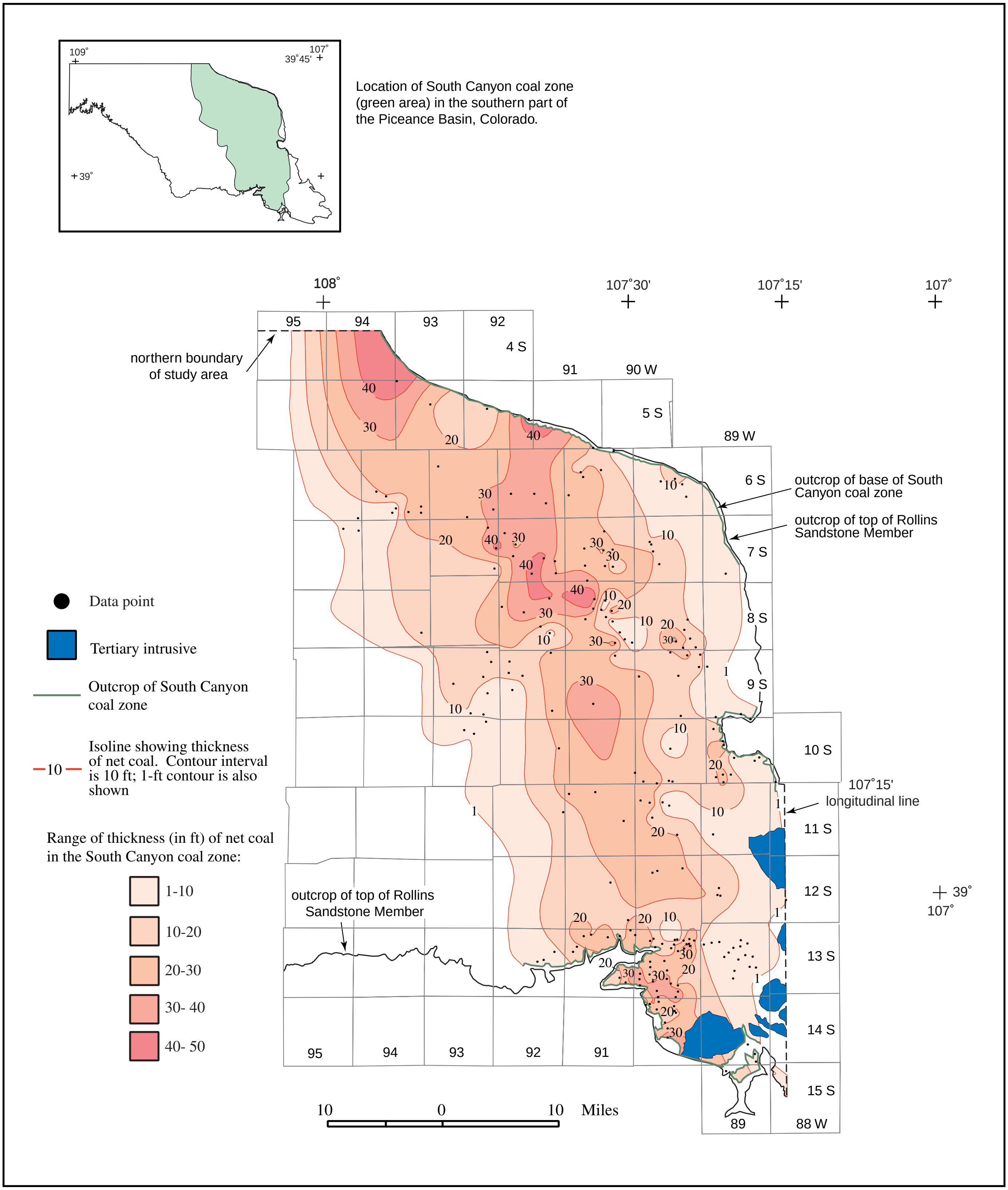


Figure 19. Isopach map of net coal in the South Canyon coal zone. Net-coal values represent all coal beds that are more than 1 ft thick. Data points are identified on figure A of plate 1 and in Appendix 1.

coal is in as many as six beds that are between 3.5 to 7.0 ft thick. Coal beds that are between 7 and 14 ft thick are also widely distributed but are absent in many areas in the western and eastern parts of the study area (fig. 16). As much as 64 ft of net coal is contained in six beds that are between 7.0 and 14.0 ft thick (fig. 16). Coal beds more than 14 ft thick are concentrated in an irregularly shaped 6- to 16-mi-wide beltway that extends north-south across the eastern part of the study area (fig. 17). The beltway contains 14 to 77 ft of net coal in one to three beds that are 14 to 44 ft thick. Several isolated pods in the central and western part of the study area also contain 14 to 35 ft of net coal in beds that are 14 to 35 ft thick (fig. 17).

South Canyon Coal Zone

The South Canyon coal zone underlies approximately 1,500 mi^2 in the eastern part of the study area and pinches out to the west along a sinuous line that trends N. 20° W. from sec. 22, T. 13 S., R. 92 W. to sec. 10, T. 4 S., R. 95 W. (fig. 18). The South Canyon zone is 0 to 330 ft thick (fig. 18) and contains 1 to 48 ft of net coal (fig. 19) in 1 to 11 beds that range from 1 to 29 ft thick. The coal zone is more than 100 ft thick and contains 20 to 48 ft of net coal in a 6- to 20-mi-wide area that extends about N. 15° W. through the central part of the region where the zone occurs.

Coal Ridge Coal Zone

The Coal Ridge coal zone underlies 1,520 mi^2 in the eastern part of the study area and occupies approximately the same region as the underlying South Canyon coal zone (fig. 20). The Coal Ridge is 200 to 500 ft thick along the Grand Hogback and Coal Basin area (fig. 20), and the zone is less than 100 ft thick throughout most of its western half. The coal zone pinches out along a line that trends N. 20° W. from sec. 27, T. 13 S., R. 92 W. to sec. 9, T. 4 S., R. 95 W. (fig. 20). The thickness of the Coal Ridge varies considerably due to the lenticular nature of coal beds within the zone. The zone contains 1 to 44 ft of net coal (fig. 21) in 1 to 14 beds that range from 1 to 23 ft thick. The Coal Ridge coal zone generally has less than 10 ft of net coal, but the net coal exceeds 20 ft along the steeply dipping limb of the Grand Hogback monocline and in small pods located south of Coal Basin (sec. 10, T. 10 S., R. 89 W.) and northeast of Paonia (secs. 2 and 3, T. 13 S., R. 89 W.).

Coal in the Cameo-Fairfield Coal Group East of Long 107°15′W.

The Cameo-Fairfield coal group underlies about 260 mi^2 in areas located east of long 107°15′W. (fig. 22). The coal group is about 800 to 1,000 ft thick in the northern and western part of the area but thins to the southeast and is only about 200 to 250 ft thick near the town of Crested Butte (figs. 2 and 9). Coal-bed distribution in this region is largely unknown owing to the paucity of outcrop and drill-hole data. Based on available data, the Cameo-Fairfield coal group has 1 to 30 ft of net coal in one to five beds east long 107°15′W. (fig. 22), and the beds range from 1 to 25 ft in thickness. As previously stated, throughout much of the area the coal is buried beneath numerous sills and laccoliths and is steeply folded and faulted.

Coal Quality

Coal in the southern part of the Piceance Basin varies from subbituminous A to anthracite in apparent rank (Hornbaker and others, 1976). Coal with coking properties has been identified in the eastern part of the Somerset coal field, southern part of the Carbondale coal field, and in the Crested Butte coal field (Hornbaker and others, 1976; Murray and others, 1977). The coal's apparent rank increases toward the trough of the basin (Johnson, 1989a), owing to depth of burial and heating from intrusions (Hornbaker and others, 1976). The apparent rank of coal along the basin's southern flank is subbituminous A to high-volatile B bituminous and generally increases to the southeast. Some beds in the Crested Butte area have been metamorphosed to low-volatile bituminous coal, semianthracite, and anthracite. The apparent rank of coal along the basin's eastern flank also increases to the southeast and ranges from high-volatile C bituminous to medium-volatile bituminous; some coal in Coal Basin and Crested Butte areas has been metamorphosed to semianthracite and anthracite.

Ash, sulfur, and calorific values have been summarized for prominent coal fields in the Piceance Basin by Hornbaker and others (1976), Murray and others (1977), and Tremain and others (1996) (Appendix 2). We have also summarized ash, sulfur, and calorific values from the southern Piceance Basin that were compiled from the U.S. Geological Survey USCHEM database by R.H. Affolter (written commun., 1998) (Appendix 2). Additional coal-quality data were also reported by Toenges and others (1949, 1952) for cores of coal retrieved from 25 holes drilled in the eastern part of the Somerset coal field (Appendix 2). A synthesis of these data shows that coal in the southern part of the Piceance Basin has an ash yield ranging from 1.9 to 29.9 percent, sulfur content from 0.3 to 3.2 percent, and calorific values of 8,160–15,190 Btu/lb (table 3). Ash yield, sulfur content, and calorific values are summarized by coal field in table 4 and by coal zone in table 5. Calorific values of some coal beds exceed 14,000 Btu/lb in the southern part of the Carbondale coal field, eastern part of the Somerset coal field, and in the Crested Butte coal field. Additional tables in Appendix 2 provide ranges of ash yield, sulfur content, and calorific values for each coal zone within the various coal fields in the southern part of the Piceance Basin.

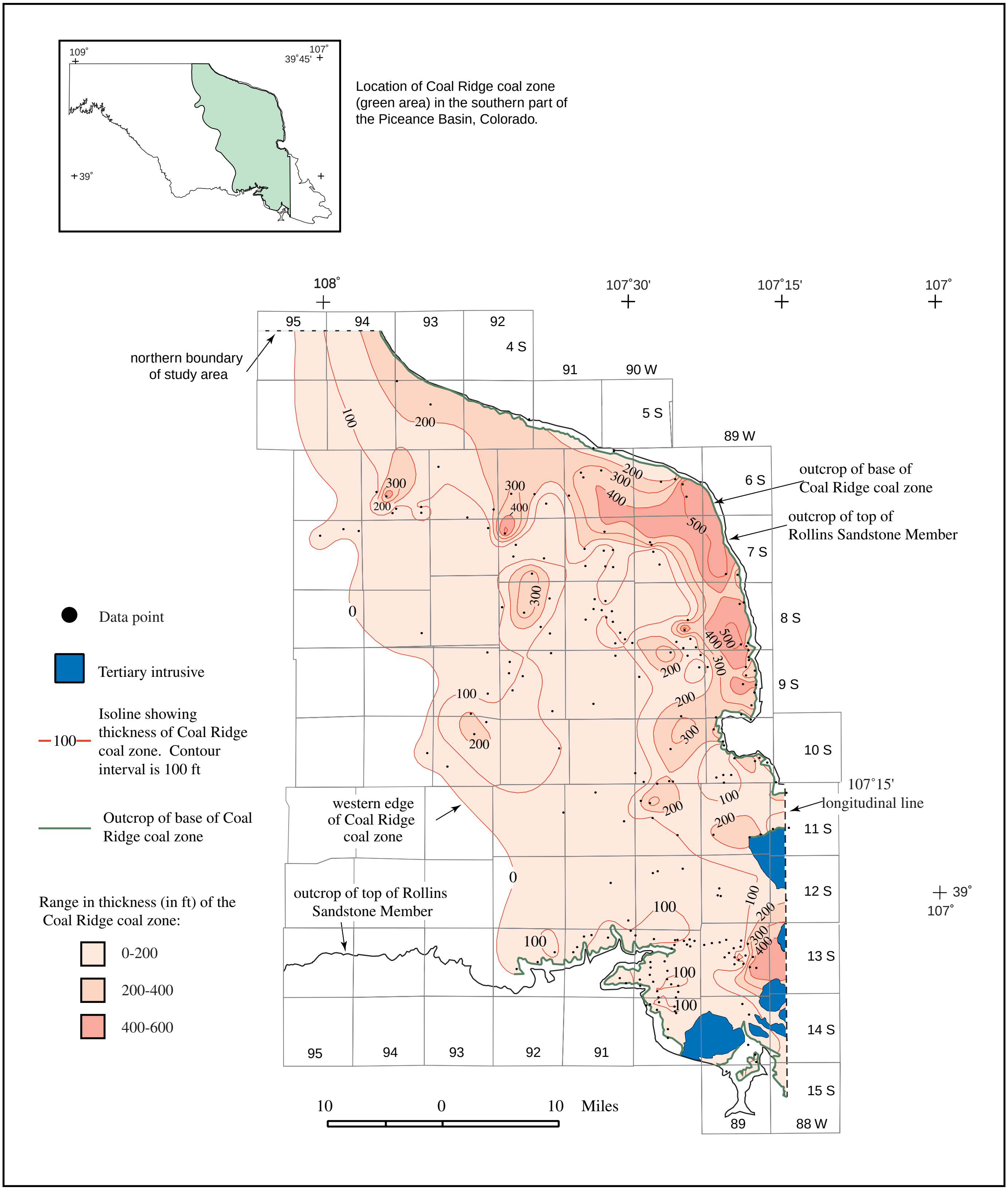


Figure 20. Isopach map showing thickness of the Coal Ridge coal zone. Data points are identified on figure A of plate 1 and in Appendix 1.

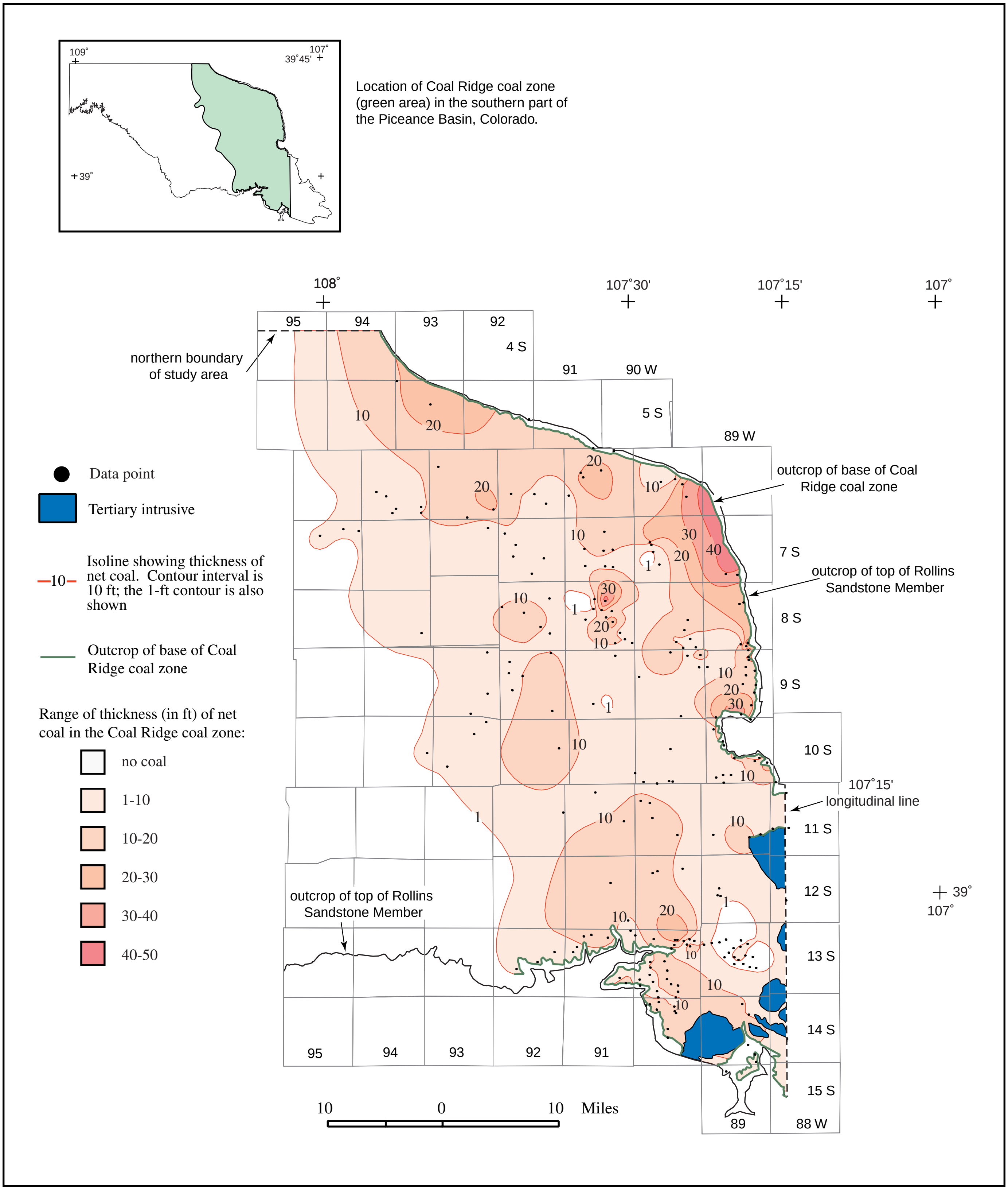


Figure 21. Isopach map of net coal in the Coal Ridge coal zone. Net-coal values represent all coal beds that are more than 1 ft thick. Data points are identified on figure A of plate 1 and in Appendix 1.

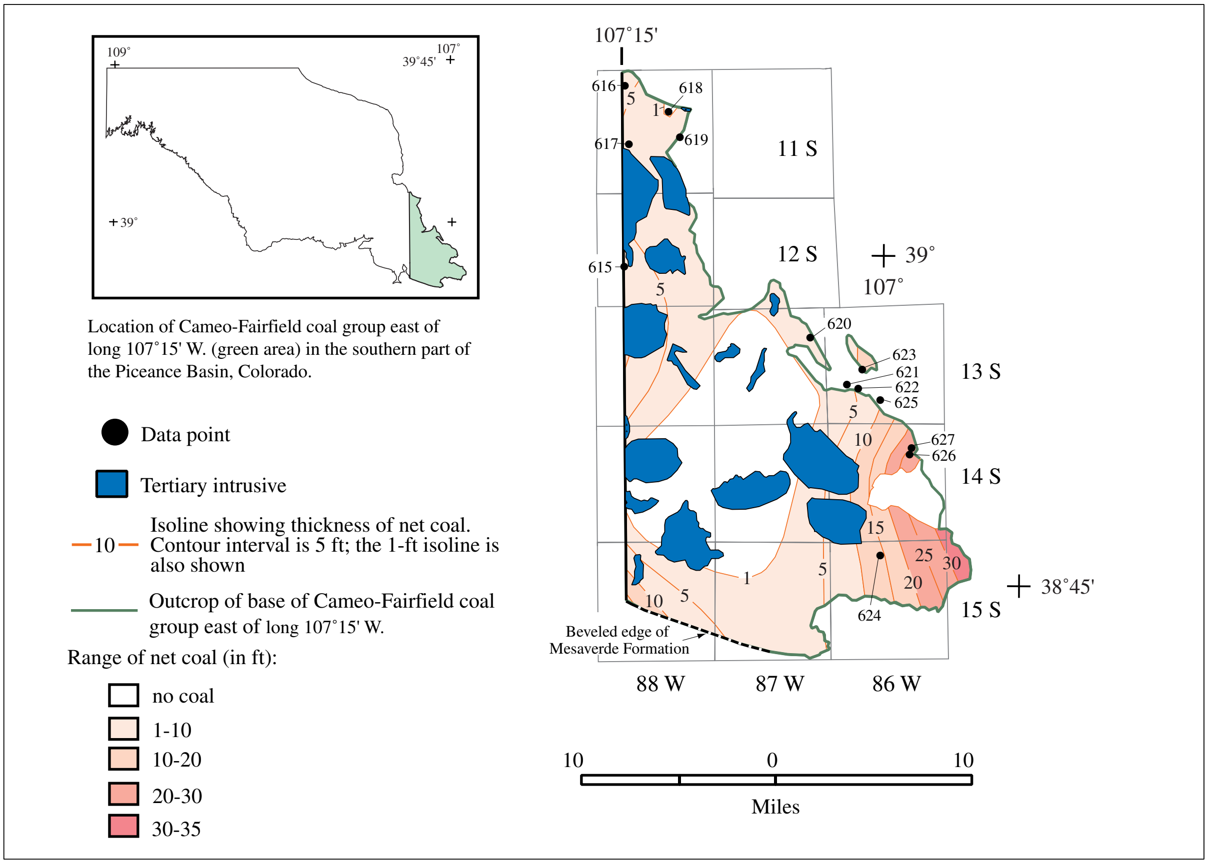


Figure 22. Isopach map of net coal in the Cameo-Fairfield coal group east of long 107°15′W. in the Piceance Basin, Colorado. Net-coal values represent all coal beds that are more than 1 ft thick. Data points are identified in figure A of plate 1 and in Appendix 1.

Table 3. Range of ash yield, sulfur content, and calorific values for coal in the Mesaverde Group and Mesaverde Formation in the southern part of the Piceance Basin, Colorado, reported by various authors.

[The range of values are based on summaries of proximate and ultimate analyses by Toenges and others (1949, 1952), Hornbaker and others (1976), Murray and others (1977), Tremain and others (1996), and values in the U.S. Geological Survey USCHEM database provided by R.H. Affolter (written commun., 1998)]

Source of data	Ash (%)	Sulfur (%)	Btu/lb
U.S. Geological Survey USCHEM database	2.7-29.9	0.3-2.2	8,300-15,090
Tremain and others (1996)	2.1-23.3	0.3-2.2	8,300-15,190
Murray and others (1977)	3.1-14.1	0.4-1.7	10,170-14,680
Hornbaker and others (1976)	1.9-17.4	0.3-2.1	8,160-15,190
Toenges and others (1949, 1952) (Somerset coal field)	2.4-19.6	0.3-3.2	10,230-14,380

Table 4. Range of ash yield, sulfur content, and calorific values in the Mesaverde Group and Mesaverde Formation for coal fields in the southern part of the Piceance Basin, Colorado.

[Values are based on ranges of proximate and ultimate analyses summarized by Hornbaker and others (1976), Murray and others (1977), Tremain and others (1996), values in the U.S. Geological Survey USCHEM database provided by R.H. Affolter (written commun., 1998), and include values summarized by Toenges and others (1949, 1952) for the Somerset coal field. Coal from the C.M.C. mine has an ash yield of 23.3 percent and was included in the Book Cliffs coal field by Tremain and others (1996); we included that ash value in the Grand Mesa coal field because the C.M.C mine was located on the east bank of the Colorado River and is in the Grand Mesa coal field as defined by Landis (1959)]

Coal field	Ash (%)	Sulfur (%)	Btu/lb
Book Cliffs	4.9-23.3	0.4-1.7	9,830-13,560
Grand Mesa	2.1-23.3	0.4-2.2	8,300-13,490
Somerset	2.4-29.9	0.3-3.2	8,160-14,380
Crested Butte	3.2-9.1	0.4-1.9	11,080-14,440
Carbondale	1.9-16.2	0.3-2.1	10,160-15,190
Grand Hogback	3.1-11.3	0.3-0.9	11,020-13,270

Coal Resources

The southern part of the Piceance Basin has an original resource of 120 billion short tons of coal in the Cameo-Fairfield coal group. That resource number was calculated for all beds of coal that are greater than 1 ft thick and under less than 6,000 ft of overburden; the beds are distributed across a 2,930-mi^2 area. The resource does not include coal that might be folded over the flanks of laccoliths or buried beneath laccoliths that are located in the region. The Cameo-Fairfield group contains an additional 100 billion short tons of non-resource coal that is covered by 6,000 to 14,000 ft of overburden; those deeper beds are distributed across a 1,210-mi^2 area in the basin's central region. Coal beds deeper than 6,000 ft are not considered to be a resource using criteria of Wood and others (1983, p. 30). Speltz (1976) reported that the southern Piceance Basin does not have any significant coal deposits that are susceptible to strip mining, and, although underground mining is the most likely method for extracting coal in the southern part of the Piceance Basin, much of the coal is too deep or too thin to be economically mined in the foreseeable future.

Resources of the Cameo-Fairfield group are distributed throughout the Cameo-Wheeler, South Canyon, Coal Ridge coal zones (located west of long 107°15′W.) and the lower, middle, and upper coal zones (located east of long 107°15′W.). Resources in the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones are reported by overburden and reliability categories, and by county in tables 6, 7, and 8; and by 7.5′ quadrangle, township, and areas of land and coal ownership in Appendix 3. For the area east of long 107°15′W., the resources of the lower, middle, and upper coal zones are combined and reported by overburden and reliability categories and by county in table 9; and by 7.5′ quadrangle, township, and areas of land ownership in Appendix 3. Townships, 7.5′ quadrangles, and areas of land and coal ownership are shown in figures provided in Appendix 4.

Methods used to determine overburden, reliability, and coal resources are based on Wood and others (1983). The methodology is described in the Methods section of this report and in chapter C of this CD-ROM; specific details are summarized below:

1. Original resources represent coal that was in the ground prior to production. Resource figures do not indicate the amount of coal that can be economically mined. Reported resources are rounded to two significant figures; some categories in the resource tables do not equal the sum of their components because of independent rounding.
2. Resources were calculated by multiplying the volume of coal by the average density of coal. The volume of coal in the Cameo-Fairfield group is the product of its net-coal thickness and areal distribution as shown

Table 5. Range of ash yield, sulfur content, and calorific values for coal zones in the Mesaverde Group and Mesaverde Formation in the southern part of the Piceance Basin, Colorado.

[Values are based on ranges of proximate and ultimate analyses summarized by Toenges and others (1949, 1952), Hornbaker and others (1976), Murray and others (1977), Tremain and others (1996), and values in the U.S. Geological Survey USCHEM database provided by R.H. Affolter (written commun., 1998). The Coal ridge and South Canyon coal zones were reported separately where possible and combined when previously reported values were grouped or where the zone could not be identified from the reported coal -bed nomenclature]

Coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
Keystone	5.4-9.2	0.3-0.4	11,020-13,120
Coal Ridge	6.0-8.3	0.5-0.7	13,030-14,310
South Canyon	3.4-10.0	0.3-1.5	11,290-15,190
Combined Coal Ridge and South Canyon (Somerset coal field)	2.7-29.9	0.3-1.7	8,160-13,450
Cameo-Wheeler	2.1-25.9	0.3-3.2	8,300-15,090
Anchor and Palisade	2.1-17.4	0.4-1.7	10,360-13,560
Middle and upper zones (Crested Butte area)	3.2-9.1	0.4-1.9	11,080-14,440

on its net-coal isopach map (fig. 10). Volumes of net-coal in the Cameo-Wheeler, South Canyon, and Coal Ridge zones were calculated using data shown in their respective net-coal isopach maps (figs. 12, 19, and 21). Coal density in the study area varies from 1,700 short tons per acre-ft for subbituminous coal to 2,000 short tons per acre-ft for anthracite. We used an average density of 1,800 short tons per acre-ft for bituminous coal.

3. Resources were determined for all net coal in beds greater than 1 ft thick and under less than 6,000 ft of overburden. Reported coal tonnages do not include the weight of partings in the coal beds. Coal that is deeper than 6,000 ft is not considered to be a resource but is reported as “other occurrences of non-resource coal.”
4. Maximum overburden (overburden on the base of a coal zone) was determined by subtracting elevations at the base of the specified coal zone from surface elevations; maximum overburden lines are shown on resultant maps at 500-; 1,000-; 2,000-; 3,000-; 6,000-; and 10,000-ft intervals. The base of the Cameo-Wheeler coal zone was portrayed by the structure contour map shown in figure 7*B*. Similar maps (not shown) were made for the base of the South Canyon and Coal Ridge coal zones, and they were used to determine overburden on those zones.
5. Identified resources reside within 3 mi from a data point, and hypothetical resources reside more than 3 mi from a data point; therefore, hypothetical resources are considered to be less geologically assured.

Cameo-Wheeler Coal Zone

The Cameo-Wheeler zone has an original resource of 95 billion short tons of coal (table 6 *A*) that are distributed across a 2,668-mi^2 area where the coal is covered by less than 6,000 ft of overburden (fig. 23) . Approximately 37 billion short tons of the resource are under less than 3,000 ft of overburden and 22 billion short tons are under less than 2,000 ft of overburden (table 6*A*); an isopach map of overburden is shown in figure 23. About 84 billion short tons (88 percent) are an identified resource, and 11 billion short tons (12 percent) are a hypothetical resource; areas of identified and hypothetical resources are shown in figure 24. Approximately 79 percent (75 billion short tons) of the resource is federally owned, and 21 percent (20 billion short tons) is either State or privately owned (Appendix 3). The Cameo-Wheeler contains an additional 78 billion short tons of coal that are covered by 6,000 to about 14,000 ft of overburden (table 6*B*). These deeper volumes of coal are distributed across a 1,212-mi^2 area shown on figure 23.

Table 6*A*. Original coal resources (in millions of short tons) in the Cameo-Wheeler coal zone, southern part of the Piceance Basin, Colorado.

[Coal under less than 6,000 ft of overburden is considered a resource using criteria of Wood and others (1983). Coal covered by more than 6,000 ft of overburden is not considered a resource but is reported as other occurrences of coal in table 6*B*. Coal resources were calculated for all beds more than 1 ft thick and were reported by reliability and overburden categories and by county. Resources were not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Coal resources were rounded to two significant figures, and categories showing total resources might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)					TOTAL
		0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Delta	Identified	1,300	1,600	2,800	2,400	4,800	13,000
	Hypothetical	0.00	0.00	0.00	170	3,700	3,900
Delta Total		1,300	1,600	2,800	2,600	8,500	17,000
Garfield	Identified	1,300	1,300	3,800	3,400	19,000	29,000
	Hypothetical	120	70	70	110	2,700	3,000
Garfield Total		1,400	1,400	3,900	3,500	22,000	32,000
Gunnison	Identified	590	610	1,200	1,440	4,000	7,900
	Hypothetical	42	7.5	4.9	170	100	320
Gunnison Total		640	620	1,220	1,600	4,100	8,200
Mesa	Identified	490	630	2,900	6,200	19,000	29,000
	Hypothetical	120	140	370	470	1,900	3,000
Mesa Total		610	770	3,300	6,700	21,000	32,000
Pitkin	Identified	73	72	170	140	1,500	2,000
Pitkin Total		73	72	170	140	1,500	2,000
Rio Blanco	Identified	1.0	230	1,400	580	980	3,200
	Hypothetical	0.00	0.00	0.00	5.1	680	690
Rio Blanco Total		1.0	230	1,400	580	1,700	3,900
TOTAL		**4,000**	**4,600**	**13,000**	**15,000**	**58,000**	**95,000**

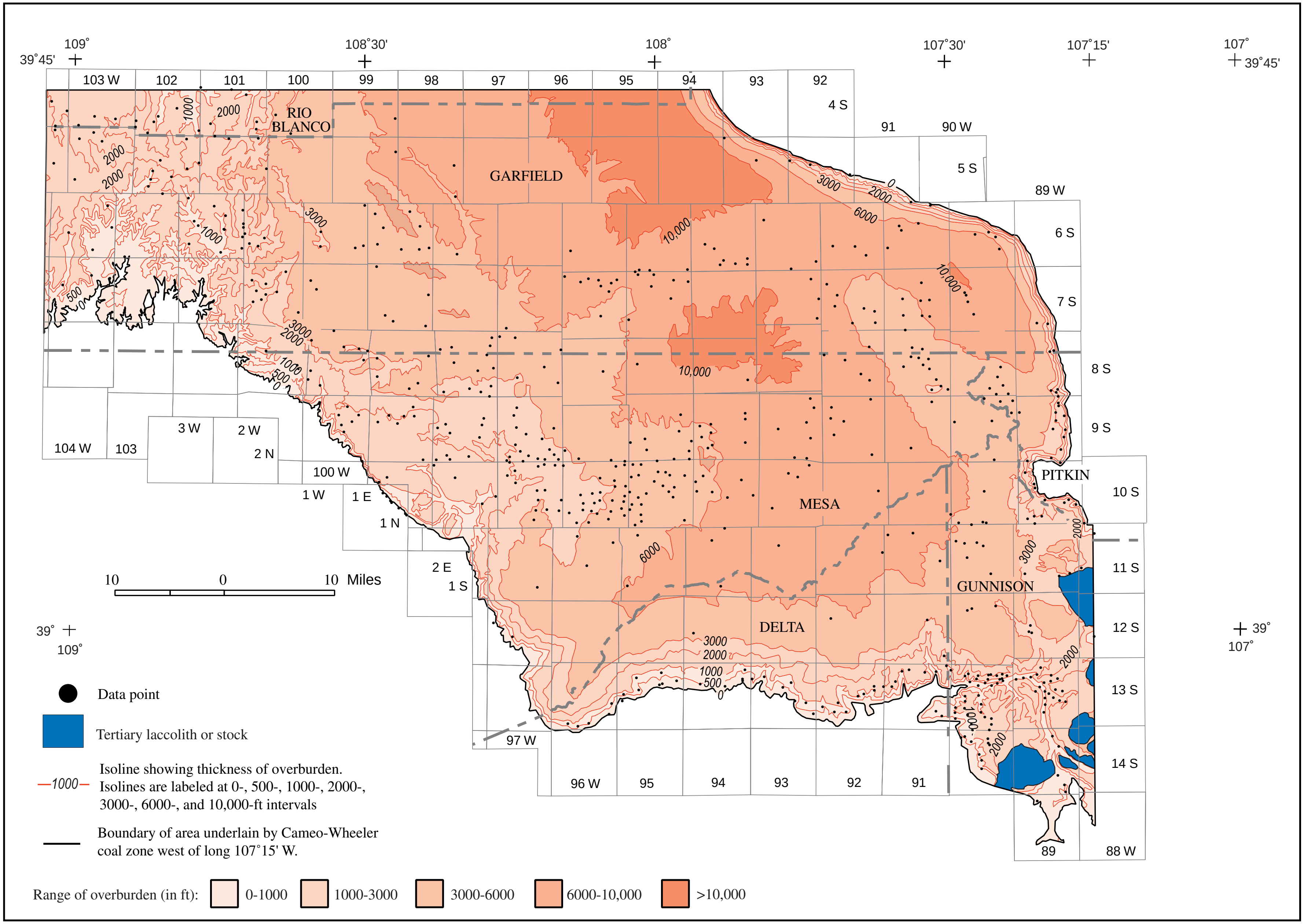


Figure 23. Isopach map of overburden on base of the Cameo-Wheeler coal zone in the southern part of the Piceance Basin, Colorado. Data points are identified in figure A of plate 1.

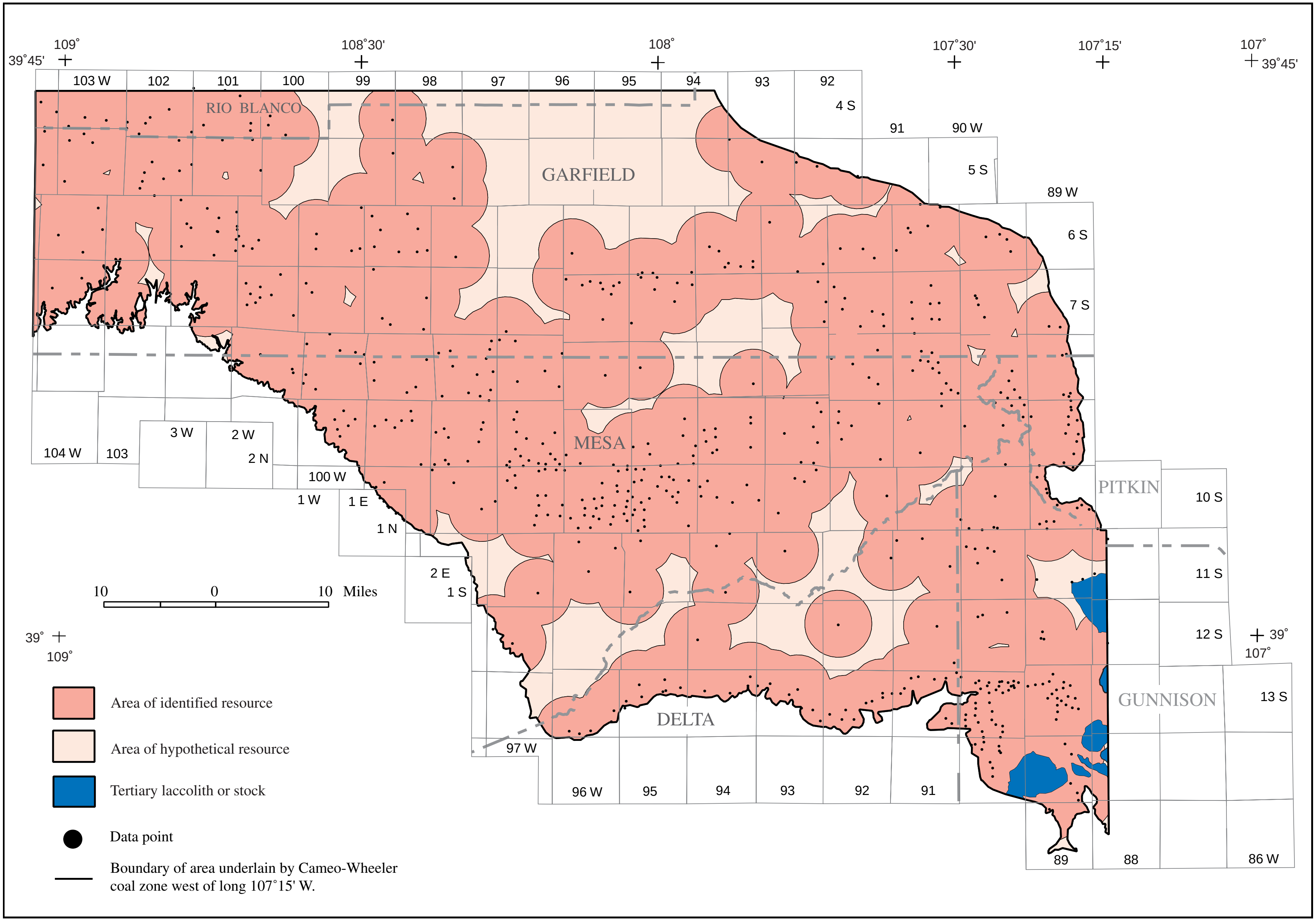


Figure 24. Map showing areas of reliability for coal resources in the Cameo-Wheeler coal zone, southern part of the Piceance Basin, Colorado. Areas having identified resources are within 3 mi of a data point, and areas having hypothetical resources are more than 3 mi from a data point; areas are based on 627 data points that are identified in Appendix 1 and figure A on plate 1.

Table 6*B*. Other occurrences of coal (in millions of short tons) at depths greater than 6,000 ft in the Cameo-Wheeler coal zone, southern part of the Piceance Basin, Colorado.

[Coal covered by more than 6,000 ft of overburden is not considered a resource using criteria of Wood and others (1983). Tonnage was calculated for all coal beds more than 1 ft thick and was reported by reliability and overburden categories and by county. Tonnage was not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Coal tonnage was rounded to two significant figures, and categories showing total tonnage might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)		TOTAL
		6,000-10,000	>10,000	
Delta	Identified	4,200	0.00	4,200
	Hypothetical	1,500	0.00	1,500
Delta Total		5,700	0.00	5,700
Garfield	Identified	28,000	1,500	29,000
	Hypothetical	6,600	7,500	14,000
Garfield Total		35,000	9,000	44,000
Gunnison	Identified	390	0.00	390
	Hypothetical	99	0.00	99
Gunnison Total		490	0.00	490
Mesa	Identified	22,000	500	23,000
	Hypothetical	3,700	480	4,100
Mesa Total		26,000	980	27,000
Pitkin	Identified	200	0.00	200
Pitkin Total		200	0.00	200
Rio Blanco	Identified	260	0.00	260
	Hypothetical	220	340	570
Rio Blanco Total		480	340	820
TOTAL		**67,000**	**10,000**	**78,000**

Coal resources in the Cameo-Wheeler coal zone were also determined by bed-thickness categories. The resources within various bed-thickness categories are reported in table 6*C* and have been determined by integrating data shown in net-coal isopach maps for each bed-thickness category (figs. 13–17) with overburden data for the Cameo-Wheeler coal zone (fig. 23). The resource figures reported for each bed-thickness category were normalized (adjusted) to match the resource figure reported for the Cameo-Wheeler coal zone in table 6*A*. Of the approximate 37 billion short tons of coal that are under less than 3,000 ft of overburden, about 27 percent is in beds that are less than 3.5 ft thick, 30 percent is in beds that are 3.5 to 7 ft thick, 25 percent is in beds that are 7 to 14 ft thick, and 18 percent is in beds that are thicker than 14 ft thick.

South Canyon Coal Zone

The South Canyon zone has an original resource of approximately 13 billion short tons of coal (table 7 *A*) that is distributed across an 856-mi^2 area where the coal is covered by less than 6,000 ft of overburden (fig. 25). Approximately 5.1 billion short tons are under less than 3,000 ft of overburden, and 3 billion short tons are under less than 2,000 ft of overburden (table 7*A*); areas of overburden are shown in figure 25. About 12 billion short tons (94 percent) are an identified resource, and 890 million short tons (6 percent) are a hypothetical resource; areas of identified and hypothetical resources are shown in figure 26. Approximately 79 percent (10 billion short tons) of the resource is federally owned, and 21 percent (2.8 billion short tons) is either State or privately owned (Appendix 3). The South Canyon zone contains an additional 16 billion short tons of coal that are covered by 6,000 to nearly 14,000 ft of overburden (table 7*B*). These deeper beds of coal are distributed across a 644-mi^2 area shown on figure 25.

Table 6*C*. Estimated coal (in millions of short tons) in bed-thickness categories in the Cameo-Wheeler coal zone, southern part of the Piceance Basin, Colorado.

[Coal tonnage is reported by bed-thickness and overburden categories as suggested for bituminous coal by Wood and others (1983)]

Coal bed thickness category (ft)	Overburden category (ft)							TOTAL
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
1-2.3	480	630	2,500	2,800	8,100	6,200	960	22,000
>2.3-3.5	340	300	1,000	1,600	4,400	2,400	150	10,000
>3.5-7.0	1,000	1,400	4,100	4,800	17,000	12,000	1,100	41,000
>7.0-14.0	1,100	1,300	3,000	3,800	19,000	19,000	6,600	54,000
>14.0	1,000	1,100	2,300	2,000	10,000	27,000	1,200	45,000
TOTAL	**4,000**	**4,600**	**13,000**	**15,000**	**58,000**	**67,000**	**10,000**	**170,000**

Coal tonnages were rounded to two significant figures and categories showing total tonnages might not equal the sum of the components because of independent rounding.

Coal tonnages were normalized to 100 percent of the total for each overburden category shown in tables 6*A*, 6*B*.

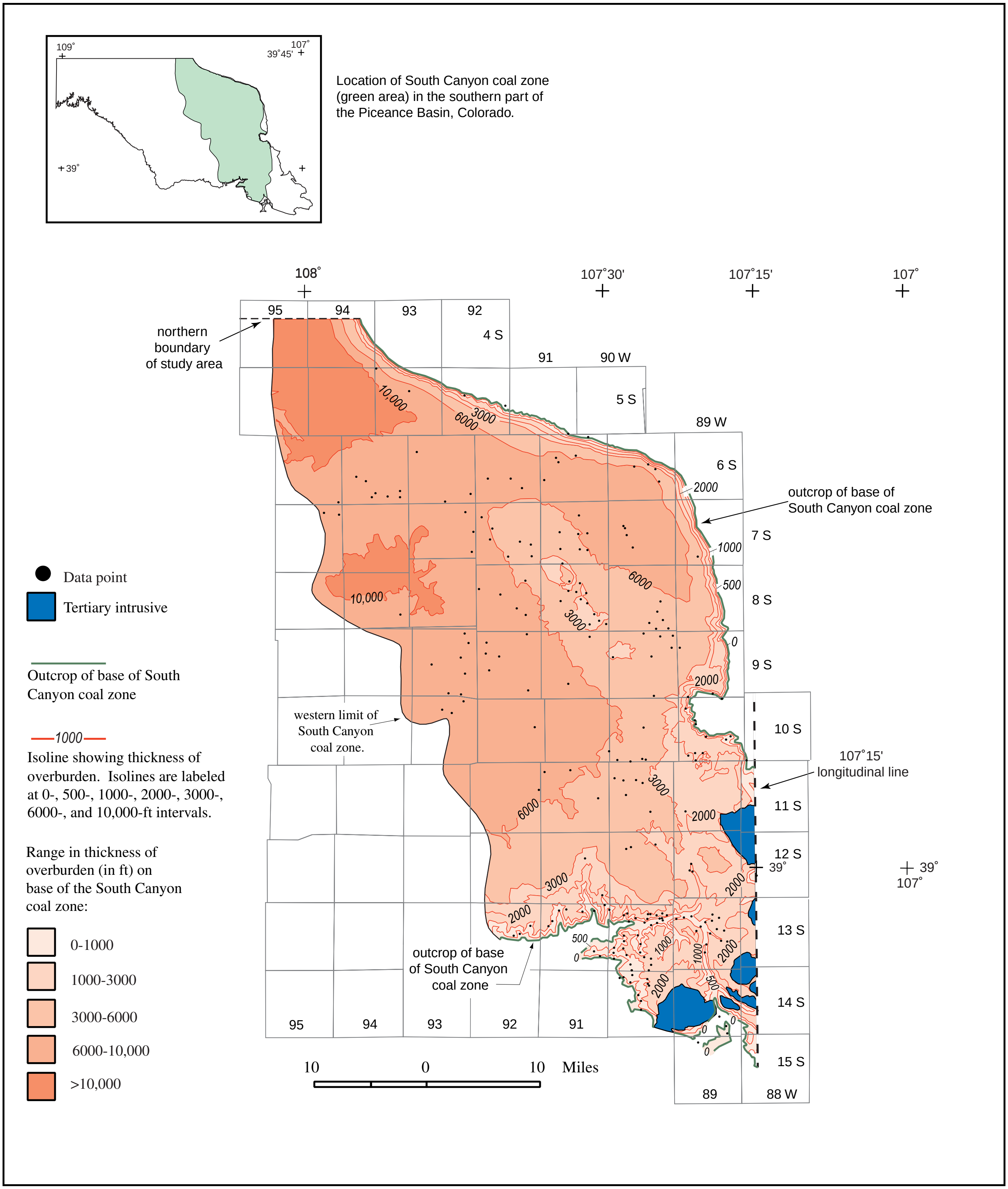


Figure 25. Isopach map of overburden on the base of the South Canyon coal zone in the southern part of the Piceance Basin, Colorado. Data points are identified in figure A on plate 1 and in Appendix 1.

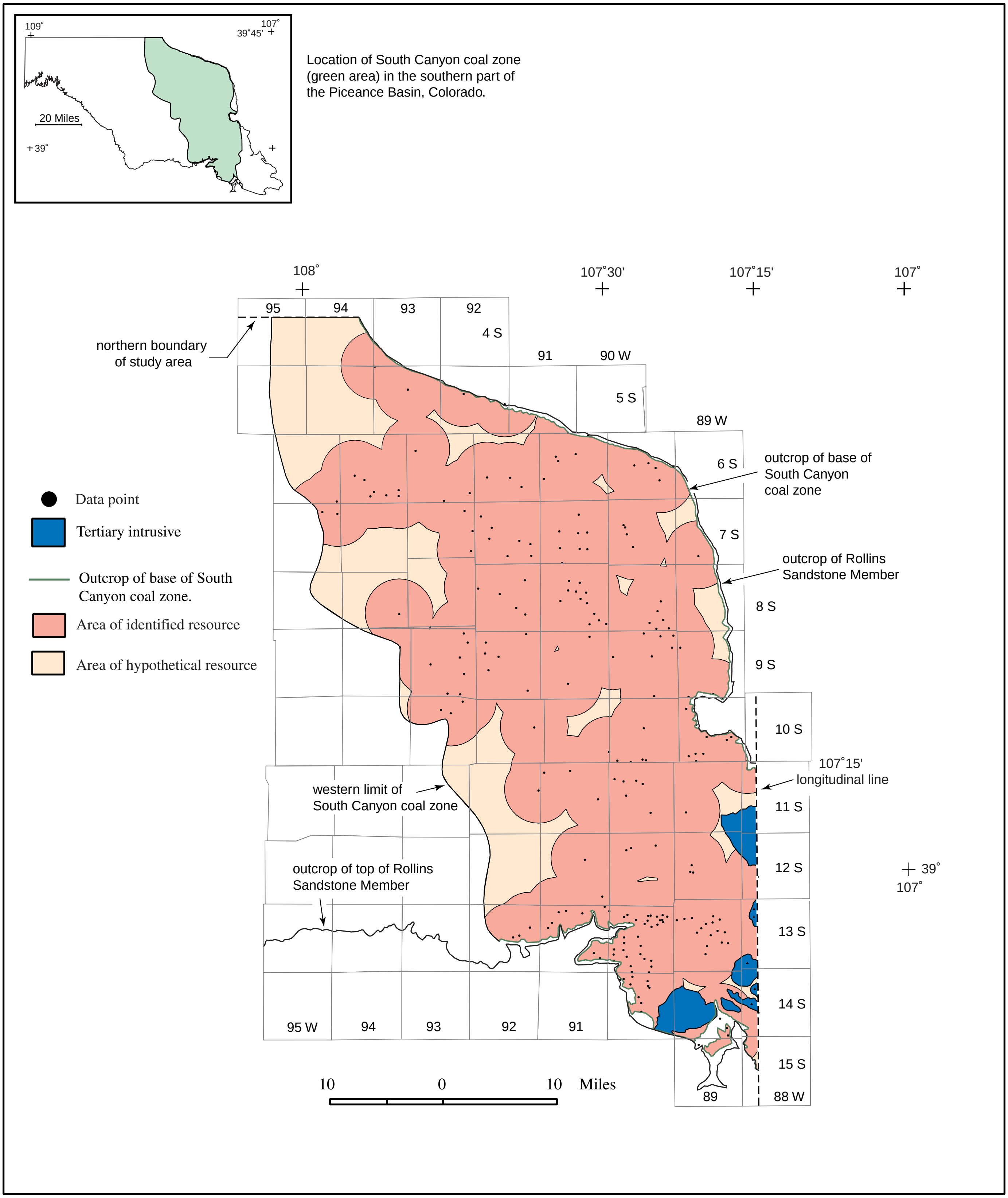


Figure 26. Map showing areas of reliability for coal resources in the South Canyon coal zone, southern part of the Piceance Basin, Colorado. Areas having identified resources are less than 3 mi from a data point, and areas having hypothetical resources are more than 3 mi from a data point. Data points are identified in figure A on plate 1 and in Appendix 1.

Table 7*A*. Original coal resources (in millions of short tons) in the South Canyon coal zone, southern part of the Piceance Basin, Colorado.

[Coal under less than 6,000 ft of overburden is considered a resource using criteria of Wood and others (1983). Coal covered by more than 6,000 ft of overburden is not considered a resource but is reported as other occurrences of coal in table 7*B*. Coal resources were calculated for all beds more than 1 ft thick and were reported by reliability and overburden categories and by county. Resources were not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Coal resources were rounded to two significant figures, and categories showing total resources might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)					TOTAL
		0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Delta	Identified	129	160	340	280	910	1,800
	Hypothetical	0.00	0.00	0.06	18	400	420
Delta Total		129	160	340	300	1,300	2,200
Garfield	Identified	120	130	240	440	2,800	3,700
	Hypothetical	9.4	9.5	27	39	210	300
Garfield Total		130	140	270	480	3,000	4,000
Gunnison	Identified	310	470	870	1,100	2,000	4,700
	Hypothetical	0.20	2.9	23	44	39	110
Gunnison Total		310	470	890	1,100	2,100	4,800
Mesa	Identified	0.00	0.00	0.00	170	1,400	1,600
	Hypothetical	0.00	0.00	0.00	0.00	36	36
Mesa Total		0.00	0.00	0.00	170	1,400	1,600
Pitkin	Identified	22	26	47	23	400	520
	Hypothetical	0.00	0.00	0.20	0.96	12	13
Pitkin Total		22	26	47	24	410	530
Rio Blanco	Hypothetical	0.00	0.00	0.00	0.00	0.06	0.06
Rio Blanco Total		0.00	0.00	0.00	0.00	0.06	0.06
TOTAL		**590**	**790**	**1,600**	**2,100**	**8,200**	**13,000**

Coal Ridge Coal Zone

The Coal Ridge coal zone has an original resource of approximately 9.1 billion short tons of coal (table 8*A*) that is distributed across a 911-mi² area where the coal is covered by less than 6,000 ft of overburden (fig. 27). Approximately 4.5 billion short tons of the resource are under less than 3,000 ft of overburden, and 2.7 billion short tons are under less than 2,000 ft of overburden (table 8*A*); areas of overburden are shown in figure 27. About 8.2 billion short tons (91 percent) are an identified resource, and 850 million short tons (9 percent) are a hypothetical resource; areas of identified and hypothetical resources are shown in figure 28. Approximately 82 percent (7.5 billion short tons) of the resource is federally owned, and 18 percent (1.6 billion short tons) is either State or privately owned (Appendix 3). The Coal Ridge coal zone contains an additional 7.6 billion short tons of coal that are covered by 6,000 to about 14,000 ft of overburden (table 8*B*). These deeper beds of coal are distributed across a 611-mi² area shown on figure 27.

Coal Resources in the Cameo-Fairfield Coal Group East of Long 107°15′ W.

The Crested Butte–West Elk Mountains area east of long 107°15′W. is estimated to have an original resource of 1.3 billion short tons of coal (table 9) distributed across a 261-mi² area. This resource figure is tenuous because of the complex geology and paucity of coal measurements in the area. Additionally, the resource figure does not include coal that is folded over the flanks of laccoliths, or which is buried beneath outcrops of laccoliths that are located in the region. The coal is in the lower, middle, and upper coal zones in the Cameo-Fairfield coal group as defined in this report. Net coal in the Crested Butte–West Elk Mountains area east of long 107°15′W. is shown in figure 10. Approximately 1.2 billion short tons of coal are under less than 3,000 ft of overburden, and 1.1 billion short tons are under less than 2,000 ft of overburden (table 9); areas of overburden are shown in figure 29. About 740 million short tons (57 percent) are an identified resource, and 570 million short tons (43 percent) are a hypothetical resource; areas of identified and hypothetical resources are shown in

Table 7*B*. Other occurrences of coal (in millions of short tons) at depths greater than 6,000 ft in the South Canyon coal zone, southern part of the Piceance Basin, Colorado.

[Coal covered by more than 6,000 ft of overburden is not considered a resource using criteria of Wood and others (1983). Coal tonnage was calculated for all beds more than 1 ft thick and was reported by reliability and overburden categories and by county. Tonnage was not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Coal tonnages were rounded to two significant figures, and categories showing total coal might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)		TOTAL
		6,000-10,000	>10,000	
Delta	Identified	1,000	0.00	1,000
	Hypothetical	150	0.00	150
Delta Total		1,200	0.00	1,200
Garfield	Identified	6,900	600	7,500
	Hypothetical	820	2,200	3,000
Garfield Total		7,700	2,800	10,000
Gunnison	Identified	81	0.00	81
	Hypothetical	24	0.00	24
Gunnison Total		100	0.00	100
Mesa	Identified	3,700	84	3,800
	Hypothetical	350	56	400
Mesa Total		4,100	140	4,200
Pitkin	Identified	19	0.00	19
Pitkin Total		19	0.00	19
Rio Blanco	Hypothetical	51	166	220
Rio Blanco Total		51	166	220
TOTAL		**13,000**	**3,100**	**16,000**

Table 8*B*. Other occurrences of coal (in millions of short tons) at depths greater that 6,000 ft in the Coal Ridge coal zone, southern part of the Piceance Basin, Colorado.

[Coal covered by more than 6,000 ft of overburden is not considered a resource using criteria of Wood and others (1983). Coal tonnage was calculated for all beds more than 1 ft thick and was reported by reliability and overburden categories and by county. Tonnage was not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Coal tonnages were rounded to two significant figures, and categories showing total resources might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)		TOTAL
		6,000-10,000	>10,000	
Delta	Identified	230	0.00	230
	Hypothetical	31	0.00	31
Delta Total		260	0.00	260
Garfield	Identified	3,700	220	3,900
	Hypothetical	600	650	1,300
Garfield Total		4,300	870	5,100
Gunnison	Identified	1.7	0.00	1.7
	Hypothetical	1.1	0.00	1.1
Gunnison Total		2.8	0.00	2.8
Mesa	Identified	1,700	15	1,700
	Hypothetical	320	11	330
Mesa Total		2,000	26	2,100
Pitkin	Identified	32	0.00	32
Pitkin Total		32	0.00	32
Rio Blanco	Hypothetical	19	51	70
Rio Blanco Total		19	51	70
TOTAL		**6,600**	**950**	**7,600**

Table 8*A*. Original coal resources (in millions of short tons) in the Coal Ridge coal zone, southern part of the Piceance Basin, Colorado.

[Coal under less than 6,000 ft of overburden is considered a resource using criteria of Wood and others (1983). Coal covered by more than 6,000 ft of overburden is not considered a resource but is reported as other occurrences of coal in table 8*B*. Coal resources were calculated for all beds more than 1 ft thick and were reported by reliability and overburden categories and by county. Resources were not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Coal resources were rounded to two significant figures, and categories showing total resources might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)					TOTAL
		0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Delta	Identified	88	98	220	240	540	1,200
	Hypothetical	0.0	0.00	1.4	40	350	390
Delta Total		88	98	230	280	890	1,600
Garfield	Identified	130	120	260	360	1,600	2,500
	Hypothetical	31	30	67	64	240	430
Garfield Total		160	160	330	430	1,900	2,900
Gunnison	Identified	230	280	660	690	990	2,800
	Hypothetical	0.96	0.82	0.10	6.3	12	20
Gunnison Total		230	280	660	690	1,000	2,900
Mesa	Identified	0.00	0.00	7.7	230	420	660
	Hypothetical	0.00	0.00	0.00	0.00	7.7	7.7
Mesa Total		0.00	0.00	7.7	230	430	670
Pitkin	Identified	99	90	230	210	410	1,000
Pitkin Total		99	90	230	210	410	1,000
Rio Blanco	Hypothetical	0.00	0.00	0.00	0.00	0.22	0.22
Rio Blanco Total		0.00	0.00	0.00	0.00	0.22	0.22
TOTAL		**580**	**620**	**1,500**	**1,800**	**4,600**	**9,100**

Table 9. Original coal resources (in millions of short tons) in the Cameo-Fairfield coal group east of long 107°15′W., southern part of the Piceance Basin, Colorado.

[The resources are calculated for coal beds more than 1 ft thick and under less than 6,000 ft of overburden, using criteria of Wood and others (1983). East of long 107°15′W., the Cameo-Fairfield coal group includes the lower, middle, and upper coal zones as defined in this report, and these coal zones are less than 6,000 ft deep. The resource does not include coal that is folded over or located under laccoliths. Coal tonnage is reported by reliability and overburden categories and by county. Coal resources have been rounded to two significant figures, and categories showing total resources might not equal the sum of the components because of independent rounding]

County	Reliability	Overburden (ft)					TOTAL
		0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Gunnison	Identified	310	210	150	55	2.8	730
	Hypothetical	180	78	160	100	57	570
Gunnison Total		480	290	310	160	60	1,300
Pitkin	Identified	1.4	5.0	2.7	0.00	0.00	9.0
Pitkin Total		1.4	5.0	2.7	0.00	0.00	9.0
TOTAL		**480**	**300**	**310**	**160**	**60**	**1,300**

figure 30. Approximately 77 percent (1 billion short tons) of the resource is federally owned, and 23 percent (300 million short tons) of the resource is either State or privately owned (Appendix 3). The area does not have additional coal in the Cameo-Fairfield coal group that is deeper than 6,000 ft.

Coal Production

Coal has been produced from the southern part of the Piceance Basin since the late 1800's, and about 110 mines have operated at various times along the margin of the study area (fig. 31). Historic production compiled by the Colorado Geological Survey (Eakins and Coates, 1998) indicate that about 176 million short tons of coal have been mined from Gunnison (99), Pitkin(30), Delta (21), Mesa (18), and Garfield (8) Counties; the cumulative production from each county is shown in millions of short tons in parentheses. These production figures reflect the cumulative coal mined from the southern part of the Piceance Basin because no significant amounts of coal have been mined elsewhere in the counties.

A summary of mining activity in the southern Piceance Basin prior to 1977 was compiled by Murray and others (1977). Their study indicates that about 84 million short tons of coal were mined from the southern Piceance Basin from 1864 through 1976. Most of the coal was mined from the Cameo-Fairfield coal group. Mines that had a cumulative production greater than 1 million short tons prior to 1977 include: the King (2,996), New Castle (1,345), Alpine (2,135), Bear (2,871), Crested Butte No 1 and No. 2 (10,068), Hawk's Nest West (1,279), Oliver #1 (1,155), Somerset (20,455), Coal Basin (1,330), Dutch Creek #1 (5,748), Dutch Creek #2 (1,011), L.S. Wood (3261), Spring Gulch (3,372), and the Thompson Creek #1 (1,079) (fig. 31); the number in parentheses is the cumulative coal production (in thousands of short tons) prior to 1977 as reported by Murray and others (1977).

Our survey of production records indicates about 94.2 million short tons of coal have been produced from 31 mines between January 1977 and December 1997. Production records examined include (1) the September 1998 COALdat database (Resource Data International, Inc., 1998); (2) the Diskette user's handbook (MSHA, 1996); (3) Keystone Coal Industry Manuals (1978 through 1998); and (4) summaries of mineral industry activities in Colorado (Colorado Division of Mines, 1977 through 1980). These sources indicate that between 1.9 and 8.6 million short tons of coal were produced annually from the southern part of the Piceance Basin during the period from 1/1977 to 12/1997. A compilation of production data is shown in table 10. Only six mines were producing coal at the end of 1997; these include the Bowie No. 1 (Orchard Valley mine), Bowie No. 2 mine, McClane Canyon mine, Roadside North Portal, Sanborn Creek mine, and West Elk (Mt. Gunnison) mine. The Sanborn Creek and West Elk (Mt. Gunnison) mines produced 1.6 million and 5.6 million short tons of coal, respectively, in 1997.

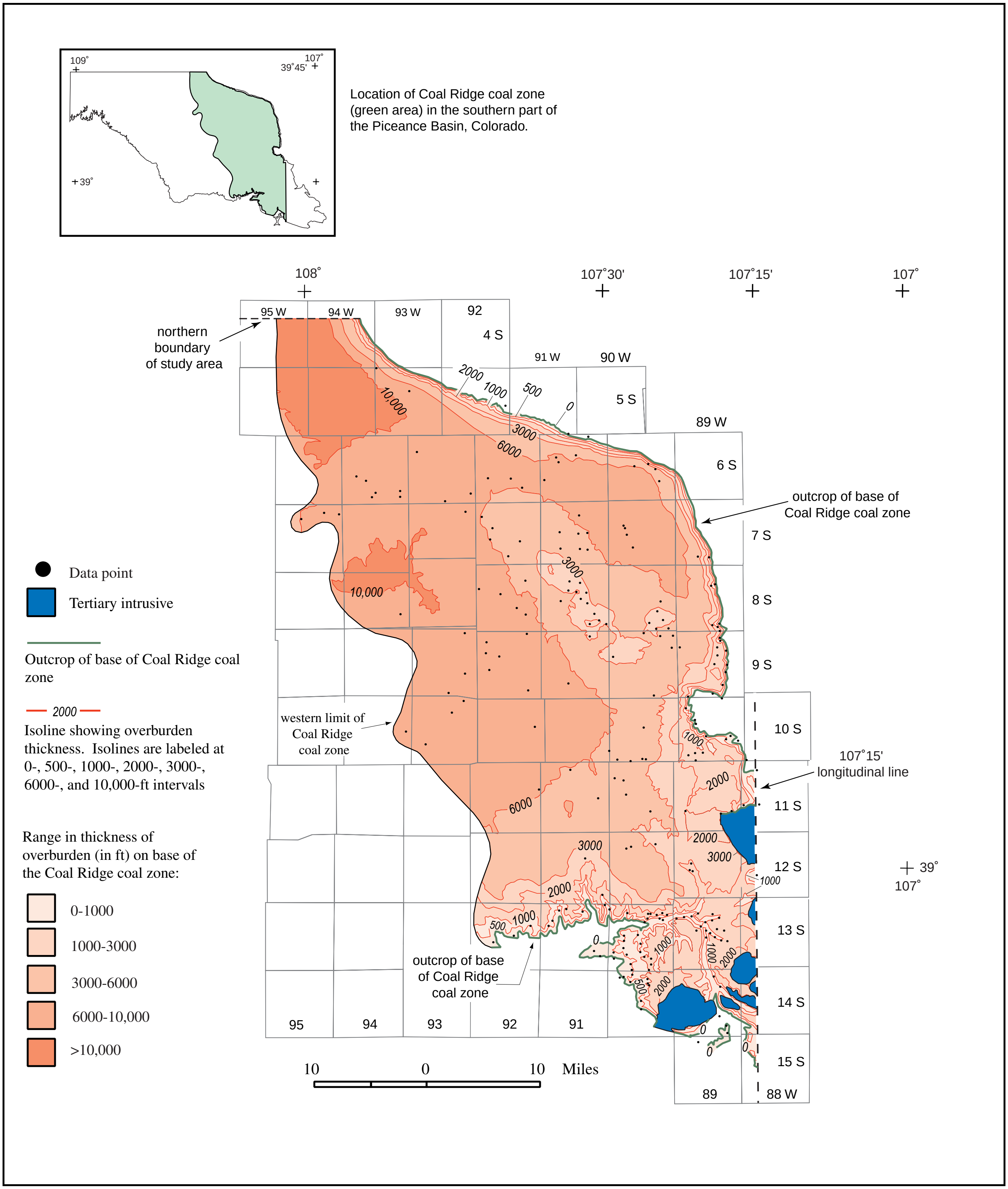


Figure 27. Isopach map of overburden on the base of the Coal Ridge coal zone in the southern part of the Piceance Basin, Colorado. Data points are identified in figure A on plate 1 and in Appendix 1.

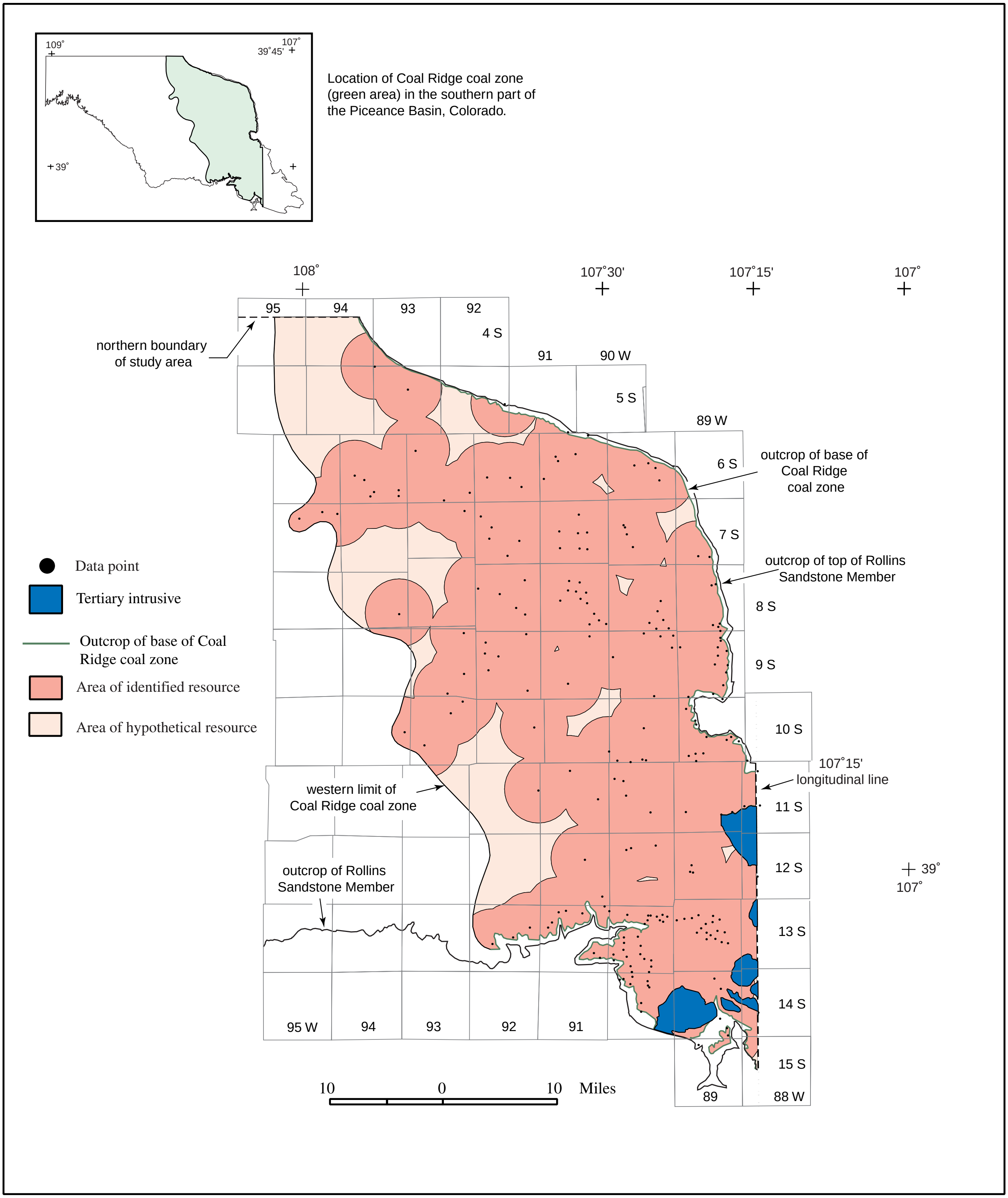


Figure 28. Map showing areas of reliability for coal resources in the Coal Ridge coal zone, southern part of the Piceance Basin, Colorado. Areas having identified resources are less than 3 mi from a data point, and areas having hypothetical resources are more than 3 mi from a data point. Data points are identified in figure A on plate 1 and in Appendix 1.

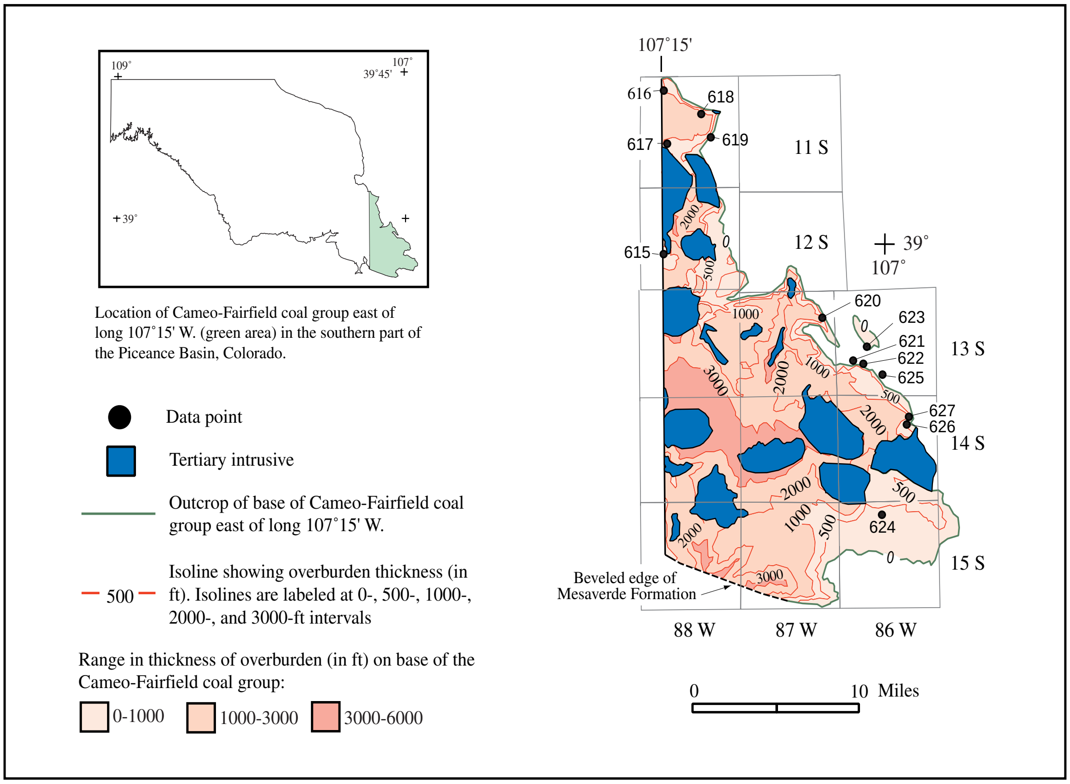


Figure 29. Isopach map of overburden on the base of the Cameo-Fairfield coal group east of long 107° 15′W., in the southern part of the Piceance Basin, Colorado. Data points are identified in figure A of plate 1 and in Appendix 1.

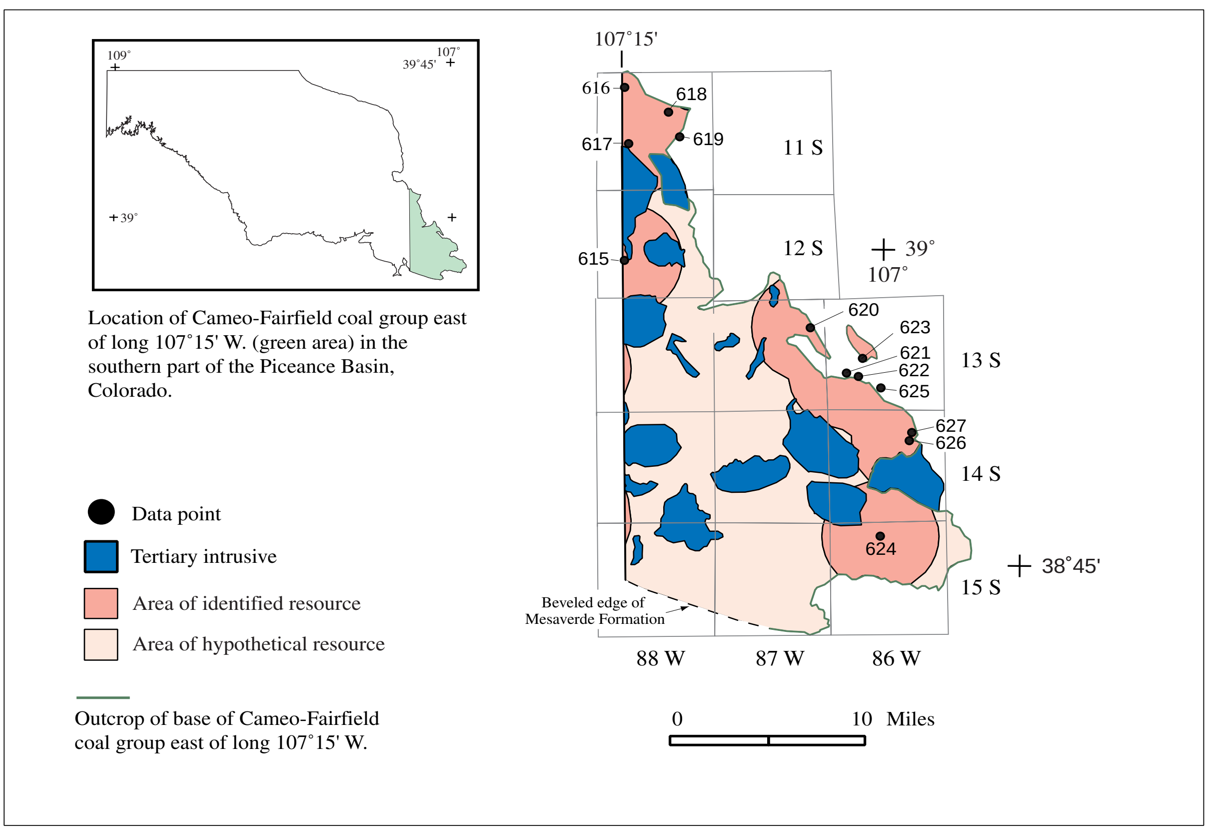


Figure 30. Map showing areas of reliability for coal resources in the Cameo-Fairfield coal group east of long 107°15′W., in the southern part of the Piceance Basin, Colorado. Areas having identified resources are less than 3 mi from a data point, and areas having hypothetical resources more than 3 mi from a data point. Data points are identified in figure A of plate 1 and in Appendix 1.

Table 10. Cumulative coal production (in short tons) for mines operating in the southern part of the Piceance Basin, Colorado, during the years from 1977 to 1997.

Name of coal mine	Cumulative production 1977-1997	Name of coal mine	Cumulative production 1977-1997
Bear Creek	148,000	Munger	80,000
Bear No. 3	6,394,000	Nu-Gap No. 3	400
Blue Ribbon	445,000	O.C. Coal	28,000
Bowie No.1 (Orchard Valley)	7,604,000	Ohio Creek No. 2	3,000
Bowie No. 2	49,000	Orchard Valley	7,498,000
Bowie (Orchard Valley)	2,859,000	Red Canon No. 1	303,000
C.M.C.	300,000	Roadside North Portal	1,123,000
Cameo and Roadside	6,830,000	Roadside South Portal	2,647,000
Coal Basin	675,000	Sanborn Creek	6,116,000
Cyprus Orchard Valley	2,084,000	Somerset	4,520,000
Dutch Creek No. 1	4,528,000	Sunlight	2,000
Dutch Creek No. 2	4,217,000	Thompson Creek No. 1 and No. 3	289,000
Eastside	27,000	Tomahawk	136,000
Fruita No. 2	12,000	West Elk (Mt. Gunnison)	30,287,000
Hawk's Nest East and West	2,800,000		
L.S. Wood	1,633,000	**Grand total (1977-1997)**	**94,244,000**
McClane Canyon	607,000		

Coal-Bed Methane

Cretaceous rocks in the Piceance Basin hold large quantities of natural gas. Most of these resources are contained in tight sandstones and coals (Johnson and Rice, 1990). Thermal maturation is greatest in the southern and central parts of the basin and generally increases with depth (Nuccio and Johnson, 1983; Johnson and Nuccio, 1986). Gas contents for coals in the Piceance Basin are as much as 604 cubic ft per short ton (Tremain, 1990; Reineck and others, 1991). Scott and others (1996) estimated that the deepest part of the Piceance Basin has a gas-in-place coal-bed methane resource that exceeds 60 billion cubic ft of gas (BCFG) per square mile and that most of that resource is within the Cameo-Fairfield coal group. The potential for commercial production of natural gas in the Piceance Basin remains largely unproven; through 1994 cumulative production of natural gas from coals approached 19 BCFG (Scott and others, 1996).

Coal Resource Summary

Coal in the Upper Cretaceous Cameo-Fairfield coal group is distributed throughout a 4- to 1,400-ft-thick stratigraphic interval that covers a 4,140-mi^2 area in the southern part of the Piceance Basin, Colorado. Coal is concentrated in the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones, and, in the southeastern most part of the basin, the coal is included in the informally named lower, middle, and upper coal zones. The coal group has an original coal resource of about 120 billion short tons that was calculated for beds that are more than 1 ft thick and covered by less than 6,000 ft overburden. The resource is distributed across a 2,930-mi^2 area that is located along the basin's outer region; the region does not contain significant coal deposits that are susceptible to strip mining. The Cameo-Fairfield group contains an additional 100 billion short tons of non-resource coal that is covered by 6,000 to 14,000 ft of overburden within a 1,210-mi^2 area located in the central part of the basin. Coal deeper than 6,000 ft is not considered to be a resource using criteria of Wood and others (1983).

Although the coal resources in the Cameo-Fairfield group are significant, the large 120-billion-short-ton figure must be regarded with caution because it does not reflect economic, land-use, environmental, technological, and geologic restrictions that affect its availability and recoverability. Those restrictions may be significant, as coal-production studies by Rohrbacher and others (1994) indicate that less than 10 percent of original coal resources in the central Appalachian region of the Eastern United States were mined and marketed at a profit. Technological and economic constraints generally limit current longwall mining to depths of less than 3,000 ft, beds that are more than 3.5 ft thick, and strata that are inclined by less than 12°; additionally, only about 14 ft of coal can be mined from beds that exceed that thickness (T.J. Rohrbacher, oral commun., 1996). These overburden and bed-thickness limits are supported by a summary given for 81 current longwalls operated in the United States by 30 companies (Merritt and Fiscor, 1995, p. 32–38).

Technological limitations render at least 170 billion short tons of coal in the Cameo-Fairfield coal group to be economically unminable because the coal is in beds that are more than 3,000 ft deep. These include approximately 71 billion short

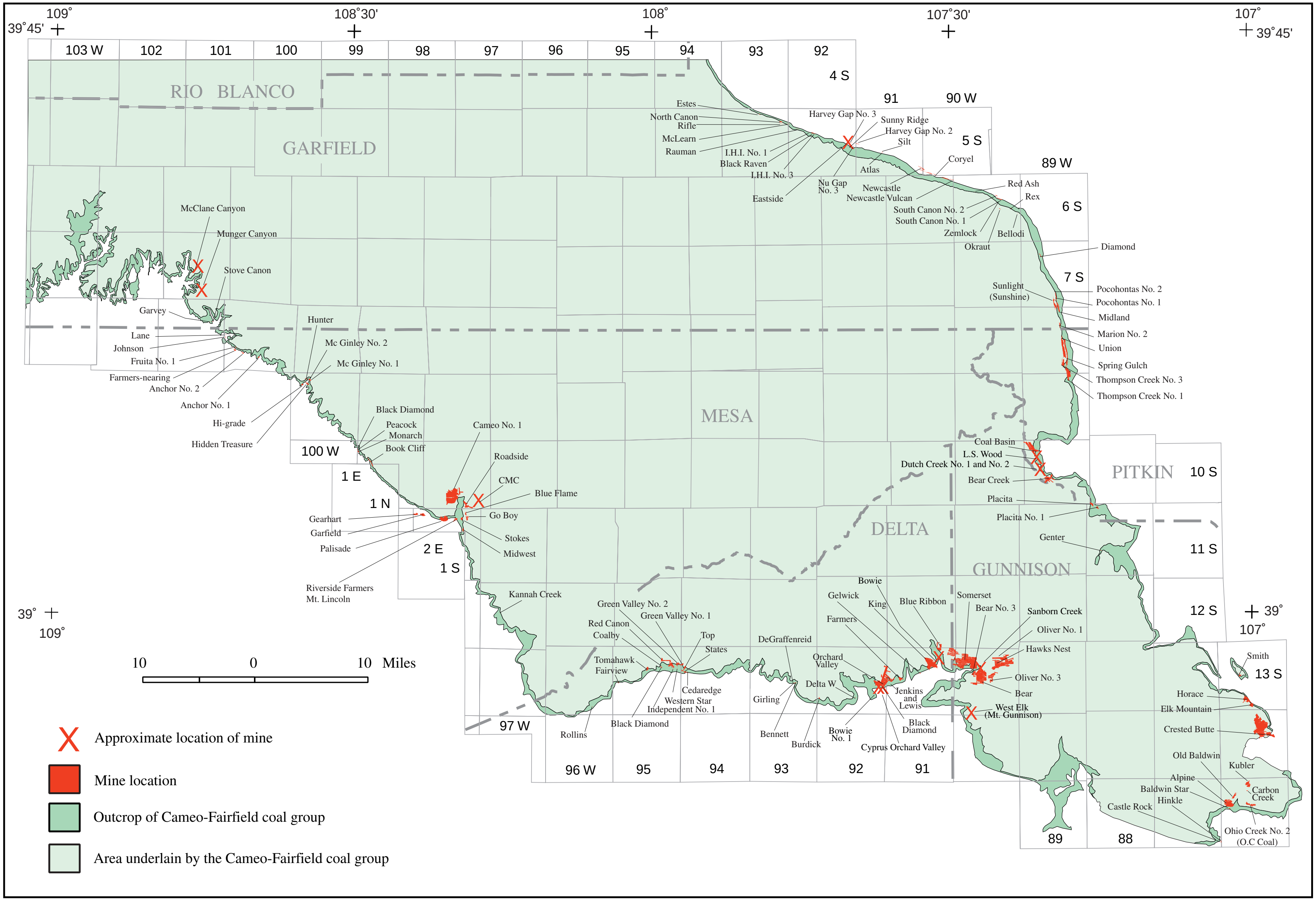


Figure 31. Locations of active and inactive coal mines in the southern part of the Piceance Basin, Colorado.

tons of resource coal that is 3,000 to 6,000 ft deep (tables 6*A*, 7*A*, 8*A*, and 9) and 100 billion short tons of non-resource coal that is 6,000 to 14,000 ft deep (tables 6*B*, 7*B*, and 8*B*) (note: the numbers do not total 170 billion short tons because they have been rounded to two significant figures). An additional 13 billion short tons of resource coal is estimated to be under less than 3,000 ft of overburden but is economically unminable because the beds are less than 3.5 ft thick; these include approximately 9.7 billion short tons in the Cameo-Wheeler coal zone (table 6*C*) and an estimated 2.8 billion short tons in the remainder of the Cameo-Fairfield coal group (these estimates were made using ratios determined for the Cameo-Wheeler coal zone). Although much of the coal in the Cameo-Fairfield coal group is too deep to be economically mined, the methane stored in the coal may have economic significance.

Only an estimated 34 billion short tons of coal in the Cameo-Fairfield coal group (28 percent of the original resource) meet favorable underground mining criteria regarding depth of burial (less than 3,000 ft) and bed thickness (more than 3 ft). However, only a fraction of that coal could be mined economically because many parts of the Grand Hogback, Carbondale, and Crested Butte coal fields are steeply inclined and many beds in the Cameo-Wheeler coal zone are more than 14 ft thick. Additional coal could not be mined economically from discontinuous beds, from beds that would be disturbed while mining adjacent strata, or from beds that would be left in the ground for roof support.

References Cited

Averitt, Paul, 1975, Coal Resources of the United States, January 1, 1974: U.S. Geological Survey Bulletin 1412, 131 p.

Cashion, W.B., 1973, Geologic and structure map of the Grand Junction quadrangle, Colorado and Utah: U.S. Geological Survey Miscellaneous Investigations Map I-736, scale 1:250,000.

Collins, B.A., 1970, Geology of the coal-bearing Mesaverde Formation (Cretaceous), Coal Basin area, Pitkin County, Colorado: Colorado School of Mines, M.S. thesis, 116 p.

Collins, B.A., 1976, Coal deposits of the Carbondale, Grand Hogback, and southern Danforth Hills coal fields, eastern Piceance Basin, Colorado: Quarterly of the Colorado School of Mines, v. 71, no. 1, 138 p.

Collins, B.A., 1977, Geology of the Coal Basin area, Pitkin County, Colorado, *in* Veal, H.K., ed., Exploration Frontiers of the Central and Southern Rockies: Rocky Mountain Association of Geologists Symposium, p. 363–377.

Colorado Division of Mines, 1977 through 1980, A summary of mineral industry activities in Colorado, Part 1. [Annual reports published by the Colorado Division of Mines Department of Natural Resources.]

Donnell, J.R., 1959, Mesaverde stratigraphy in the Carbondale area, northwestern Colorado: Rocky Mountain association of Geologists, Symposium on Cretaceous rocks of Colorado and adjacent areas, 11th Annual Field Conference, p 76–77.

Donnell, J.R., 1961, Tertiary geology and oil-shale resources of the Piceance Creek Basin between the Colorado and White Rivers, northwestern Colorado: U.S. Geological Survey Bulletin 1082-L, p. 835–891.

Donnell, J.R., 1962, Geology and coal resources of the Carbondale area, Garfield, Pitkin, and Gunnison Counties, Colorado: U.S. Geological Survey Open-File Report, 2 sheets.

Dunrud, C.R., 1989a, Geologic map and coal stratigraphic framework of the Paonia area, Delta and Gunnison Counties, Colorado: U.S. Geological Survey Coal Investigations Map C-115, scale 1:50,000.

Dunrud, C.R., 1989b, Geologic map and coal stratigraphic framework of the Cedaredge area, Delta County, Colorado: U.S. Geological Survey Coal Investigations Map C-116, scale 1:50,000.

Eager, P.G., 1978, Geophysical logs of coal test drill holes in the Grand Mesa coal field, Delta and Mesa Counties, Colorado: U.S. Geological Survey Open-File Report 78-540, 97 p.

Eager, P.G., 1979, Geophysical logs of coal test drill holes in the Grand Mesa coal field, Delta County, Colorado: U.S. Geological Survey Open-File Report 79-327, 21 p.

Eakins, Wynn, and Coates, M.M., 1998, Focus: Colorado Coal, *in* Colorado Geological Survey Rock Talk, v. 1, no. 3, 6 p.

Ellis, M.S., and Freeman, V.L., 1984, Geologic map and cross section of the Carbondale 30′x60′ quadrangle, west-central Colorado: U.S. Geological Survey Coal Investigations Map C-97-A, scale 1:100,000.

Ellis, M.S., Freeman, V.L., and Donnell, J.R., 1988, Cross sections showing coal beds and coal zones in the Mesaverde Formation in the Carbondale 30′x60′ quadrangle, west-central Colorado: U.S. Geological Survey Coal Investigations Map C-97-B, scale 1:100,000.

Ellis, M.S., and Gabaldo, V., 1989, Geologic map and cross section of parts of the Grand Junction and Delta 30′x60′ quadrangles, west-central Colorado: U.S. Geological Survey Coal Investigations Map C-124, scale 1:100,000.

Ellis, M.S., Gaskill, D.L., and Dunrud, C.R., 1987, Geologic map of the Paonia and Gunnison area, Delta and Gunnison Counties, Colorado: U.S. Geological Survey Coal Investigations Map C-109, scale 1:100,000.

Ellis, M.S., and Kelso, B.S, 1987, Cross section showing stratigraphic framework of Upper Cretaceous Dakota Sandstone, Mancos Shale, Mesaverde Group, and Mesaverde Formation, and lower Tertiary Wasatch Formation, west-central Piceance Basin, Garfield County, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-2008-A.

Erdmann, C.E., 1934, The Book Cliffs coal field in Garfield and Mesa Counties, Colorado: U.S. Geological Survey Bulletin 851, 150 p.

Fender, H.B., and Murray, D.K., 1978, Data accumulation on the methane potential of the coal beds of Colorado: Colorado Geological Survey Open-File Report 78-2.

Fisher, D.J., 1936, The Book Cliffs coal field in Emery and Grand Counties, Utah: U.S. Geological Survey Bulletin 852, 104 p.

Fisher, D.J., Erdmann, C.E., and Reeside, J.B., Jr., 1960, Cretaceous and Tertiary formations of the Book Cliffs, Carbon, Emery, and Grand Counties, Utah, and Garfield and Mesa Counties, Colorado: U.S. Geological Survey Professional Paper 332, 80 p.

Franczyk, K.J., 1989, Depositional controls on the late Campanian Sego Sandstone and implications for associated coal-forming environments in the Uinta and Piceance Basins: U.S. Geological Survey Bulletin 1787-F, 17 p.

Gale, H.S., 1910, Coal fields of northwestern Colorado and northeastern Utah: U.S. Geological Survey Bulletin 415, 265 p.

Gaskill, D.L., Colman S.M., DeLong, J.E., Jr., and Robinson, C.H., 1986, Geologic map of the Crested Butte quadrangle, Gunnison County, Colorado: U.S. Geological Survey Map GQ-1580.

Gaskill, D.L., and DeLong, J.E., Jr., 1987, Geologic map of the Mt. Axtell quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1604, scale 1:24,000.

Gaskill, D.L., and Godwin, L.H., 1966a, Geologic map of the Marble quadrangle, Gunnison and Pitkin Counties, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-512, scale 1:24,000.

Gaskill, D.L., and Godwin, L.H., 1966b, Geologic map of the Marcellina Mountain quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-511, scale 1:24,000.

Gaskill, D.L., Godwin, L.H., and Mutschler, F.E., 1967, Geologic map of the Oh-Be-Joyful quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-578, scale 1:24,000.

Gill, J.R., and Hail, W.J., Jr., 1975, Stratigraphic sections across Upper Cretaceous Mancos Shale–Mesaverde Group boundary, eastern Utah and western Colorado: U.S. Geological Survey Oil and Gas Investigations Chart OC-68.

Godwin, L.H., 1968, Geologic map of the Chair Mountain quadrangle, Gunnison and Pitkin Counties, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-704, scale 1:24,000.

Green, G.N., 1992, The geologic digital map of Colorado in ARC/INFO format: U.S. Geological Survey Open-File Report 92-0507.

Grout, M.A., and Verbeek, E.R., 1992, Fracture history of the Divide Creek and Wolf Creek anticlines and its relation to Laramide basin-margin tectonism, southern Piceance Basin, northwestern Colorado: U.S. Geological Survey Bulletin 1787-Z, 32 p.

Gualtieri, J.L., 1979, Preliminary results of coal exploratory drilling in the Book Cliffs coal region, Garfield county, Colorado, and Grand County, Utah: U.S. Geological Survey Open-File Report 79-999, 40 p.

Hail, W.J., Jr., 1972a, Reconnaissance geologic map of the Cedaredge area, Delta County, Colorado: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-697, scale 1:48,000.

Hail, W.J., Jr., 1972b, Reconnaissance geologic map of the Hotchkiss area, Delta and Montrose Counties, Colorado: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-698, scale 1:48,000.

Hancock, E.T., and Eby, J.B., 1930, Geology and coal resources of the Meeker quadrangle, Moffat and Rio Blanco Counties, Colorado: U.S. Geological Survey Bulletin 812-C, 242 p.

Hanks, T.L., 1962, Geology and coal deposits, Ragged–Chair Mountain area, Pitkin and Gunnison Counties, Colorado: Brigham Young University, Geologic Studies, v. 9. pt. 2, p. 137–160.

Hayden, F.V., 1878, Tenth Annual Report of the U.S. Geological and Geographical Survey of territories embracing Colorado and parts of adjacent territories, being a report of progress of the exploration year 1876, 546 p.

Hills, R.C., 1893, Coal fields of Colorado: U.S. Geological Survey Mineral Resources 1892, p. 319–365.

Hobbs, R.G., Gualtieri, J.L., and Babcock, R.N., 1982, Carbonera coal geophysical logging research hole core descriptions and coal analysis: U.S. Geological Survey Open-File Report 82-827, 39 p.

Horn, G.H., and Gere, W.C., 1954, Geology of the Rifle Gap coal district, Garfield County, Colorado: U.S. Geological Survey Open-File Report, 13 p.

Hornbaker, A.L., Holt, R.D., and Murray, K.D., 1976, Summary of coal resources in Colorado, 1975: Colorado Geological Survey Special Publication 9, 17 p.

Johnson, R.C., 1979a, Cross section A-A′ of Upper Cretaceous and lower Tertiary rocks, northern Piceance Creek Basin, Colorado. U.S. Geological Survey Miscellaneous Field Studies Map MF-1129A.

Johnson, R.C., 1979b, Cross section B-B′ of Upper Cretaceous and lower Tertiary rocks, northern Piceance Creek Basin, Colorado. U.S. Geological Survey Miscellaneous Field Studies Map MF-1129B.

Johnson, R.C., 1979c, Cross section C-C′ of Upper Cretaceous and lower Tertiary rocks, northern Piceance Creek Basin, Colorado. U.S. Geological Survey Miscellaneous Field Studies Map MF-1129C.

Johnson, R.C., 1982, Measured section of the Upper Cretaceous Mesaverde Formation and lower part of the lower Tertiary Wasatch Formation, Rifle Gap, Garfield County, Colorado: U.S. Geological Survey Open-File Report 82-590.

Johnson, R.C., 1983, Structure contour map of the top of the Rollins Sandstone Member of the Mesaverde Formation and Trout Creek Sandstone Member of the Iles Formation, Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1667.

Johnson, R.C., 1985, Early Cenozoic history of the Uinta and Piceance Creek Basins, Utah and Colorado, with special reference to the development of Lake Uinta, *in* Flores, R.M., and Kaplan, S.S., eds., Cenozoic Paleogeography of the West-Central United States, Rocky Mountain Paleogeography Symposium 3: Society of Economic Paleontologists and Mineralogists, The Rocky Mountain Section, p. 247–276.

Johnson, R.C., 1989a, Geologic history and hydrocarbon potential of Late Cretaceous-age, low-permeability reservoir, Piceance Basin, western Colorado: U.S. Geological Survey Bulletin 1787-E, 51 p.

Johnson, R.C., 1989b, Detailed cross sections correlating Upper Cretaceous and lower Tertiary rocks between the Uinta Basin of eastern Utah and western Colorado and the Piceance Basin of western Colorado: U.S. Geological Survey Miscellaneous Investigations Series I-1974.

Johnson, R.C., Crovelli, R.A., Spencer, C.W., and Mast, R.F., 1987, An assessment of gas resources in low-permeability sandstone of the Upper Cretaceous Mesaverde Group, Piceance Basin, Colorado: U.S. Geological Survey Open-File Report 87-357, 165 p.

Johnson, R.C., and Finn, T.M., 1986, Cretaceous through Holocene history of the Douglas Creek arch, Colorado and Utah, *in* Stone, D.S., ed., New Interpretations of Northwest Colorado Geology: Rocky Mountain Association of Geologists, p. 77–95.

Johnson, R.C., and Nuccio, V.F., 1986, Structural and thermal history of the Piceance Creek Basin, western Colorado, in relation to hydrocarbon occurrence in the Mesaverde Group, *in* Spencer, C.W., and Mast, R.F., eds., Geology of Tight Reservoirs: American Association of Petroleum Geologists, Studies in Geology 24, p. 165–206.

Johnson, R.C., Granica, M.P., and Dessenberger, N.C., 1979a, Cross section A-A′ of Upper Cretaceous and lower Tertiary rocks, southern Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1130A.

Johnson, R.C., Granica, M.P., and Dessenberger, N.C., 1979b, Cross section B-B′ of Upper Cretaceous and lower Tertiary rocks, southern Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1130B.

Johnson, R.C., Granica, M.P., and Dessenberger, N.C., 1979c, Cross section C-C′ of Upper Cretaceous and lower Tertiary rocks, southern Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1130C.

Johnson, R.C., and May, Fred, 1980, A study of the Cretaceous-Tertiary unconformity in the Piceance Basin, Colorado: The underlying Ohio Creek Formation (Upper Cretaceous) redefined as a member of the Hunter Canyon or Mesaverde Formation: U.S. Geological Survey Bulletin 1482-B, 27 p.

Johnson, R.C., May, Fred, Hansley, P.L., Pitman, J.K., and Fouch, T.D., 1980, Petrography, X-ray, mineralogy, and palynology of a measured section of the Upper Cretaceous Mesaverde Group in Hunter Canyon, western Colorado: U.S. Geological Survey Oil and Gas Investigations Chart OC-91.

Johnson, R.C., and Rice, D.D., 1990, Occurrence and geochemistry of natural gases, Piceance Basin, northwest Colorado: American Association of Petroleum Geologists Bulletin, v. 74, no. 6, p. 805–829.

Johnson, V.H., 1948, Geology of the Paonia coal field, Delta and Gunnison Counties, Colorado, U.S. Geological Survey Preliminary Map, scale 1:48,000.

Kent, B.H., and Arndt, H.H., 1980a, Geology of the Thompson Creek coal mining area, Pitkin County, Colorado, as related to subsurface hydraulic mining potential: U.S. Geological Survey Open-File Report 80-507, 81 p.

Kent, B.H., and Arndt, H.H., 1980b, Geology of the Carbondale coal mining area, Garfield and Pitkin Counties, Colorado, as related to subsurface hydraulic mining potential: U.S. Geological Survey Open-File Report 80-709, 94 p.

Keystone Coal Industry Manual, 1978 through 1998. [Mining information services of McGraw-Hill Publications; annual reports for the years 1978 through 1998.]

Kirschbaum, M.A., and Hettinger, R.D., 1998, Stratigraphy and depositional environments of the late Campanian coal-bearing Neslen/Mount Garfield Formations, eastern Book Cliffs, Utah and Colorado: U.S. Geological Survey Open-File Report 98-43, 1 sheet.

Landis, E.R, 1959, Coal resources of Colorado: U.S. Geological Survey Bulletin 1072-C, p. 131–232 p.

Lee, W.T., 1909, The Grand Mesa coal field, *in* Contributions to Economic Geology 1907, U.S. Geological Survey Bulletin 304, p. 316–334.

Lee, W.T., 1912, Coal fields of Grand Mesa and the West Elk Mountains, Colorado: U.S. Geological Survey Bulletin 510, 237 p.

Madden, D.J., 1989, Stratigraphy, depositional environments, and paleogeography of coal-bearing strata in the Upper Cretaceous Mesaverde Group, central Grand Hogback, Garfield County, Colorado: U.S. Geological Survey Professional Paper 1485, 45p.

McPhillips, M., 1980, Preliminary report on a coal exploratory drill hole in the Book Cliffs coal region, Garfield County, Colorado: U.S. Geological Survey Open-File Report 80-940, 7 p.

Merritt, Paul, and Fiscor, Steve, 1995, Longwall census: Coal Magazine, v.100, no.2, p. 30–39.

MSHA [Mineral Safety and Health Administration, Program Evaluation and Information Resource Center, System Design and Management Division], 1996, Diskette user's handbook: MSHA Information Resource Center, pt. 50.

Molenaar, C.W., and Cobban, W.A., 1991, Middle Cretaceous stratigraphy on the south and east sides of the Uinta Basin, northeastern Utah and northwestern Colorado: U.S. Geological Survey Bulletin 1787-P, 34 p.

Molenaar, C.W., and Wilson, B.W., 1993, Stratigraphic cross section of Cretaceous rocks along the north flank of the Uinta Basin, northeastern Utah, to Rangely, northwestern Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map I-1797-D.

Murray, D.K., and Haun, J.D., 1974, Introduction to the geology of the Piceance Creek Basin and vicinity, northwestern Colorado, *in* Murray, D.K., ed., Energy Resources of the Piceance Creek Basin, Colorado: Rocky Mountain Association of Geologists, 1974 Guidebook, p. 29–39.

Murray, D.K., Fender, H.B., and Jones, D.C., 1977, Coal and methane gas in the southeastern part of the Piceance Creek Basin, Colorado, *in* Veal, H.K., ed., Exploration Frontiers of the Central and Southern Rockies: Rocky Mountain Association of Geologists Symposium, p. 379–405.

Nowak, H.C., 1991, Depositional environments and stratigraphy of Mesaverde Formation, southeastern Piceance Basin, Colorado—Implications for coalbed methane exploration, *in* Schwochow, S.D., Murray, D.K., and M.F. Fahy, eds., Coalbed Methane of Western North America: Rocky Mountain Association of Geologists Fall Conference and Field Trip Guidebook, p. 1–20.

Nuccio, V.F., and Johnson, R.C., 1983, Preliminary thermal maturity map of the Cameo-Fairfield or equivalent coal zone in the Piceance Creek Basin, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-1575, scale 1:253,440.

Reinecke, K.M., Rice, D.D., Johnson, R.C., 1991, Characteristics and development of fluvial sandstone and coalbed reservoirs of Upper Cretaceous Mesaverde Group, Grand Valley field, Garfield County, Colorado, *in* Murray, D.K., Fahy, M.F., eds., Coalbed Methane of Western North America: Rocky Mountain Association of Geologists Guidebook, p. 209–225.

Resource Data International, Inc., 1998, COALdat database: Boulder, Colorado, Resource Data International, Inc. [Database available from Resource Data International , Inc., 1320 Pearl Street, Suite 300, Boulder, CO 80302.]

Roehler, H.W., 1974, Depositional environments of rocks in the Piceance Creek Basin, Colorado, *in* Murray, D.K., ed., Energy Resources of the Piceance Creek Basin, Colorado: Rocky Mountain Association of Geologists, 1974 Guidebook, p. 57–64.

Roberts, L.N.R., and Kirschbaum, M.A., 1995, Paleogeography of the Late Cretaceous of the Western Interior of middle North America—Coal distribution and sediment accumulation: U.S. Geological Survey Professional Paper 1561, 116 p.

Rohrbacher, T.J., Teeters, D.D., Osmonson, L M., and Plis, M.N., 1994, Coal recoverability and the definition of coal reserves—Central Appalachian Region, 1993, Coal Recoverability Series Report No. 2: U.S. Bureau of Mines Open File Report 10-94, 36 p.

Scott, A.R., Tyler, Roger, , Kaiser, W.R., McMurry, R.G., Nance, H.S., and Tremain, C.M., 1996, Coal and coalbed methane resources and production in the Piceance Basin, Colorado, *in* Geologic and Hydrologic Controls Critical to Coalbed Methane Producibility and Resource Assessment: Williams Fork Formation, Piceance Basin, Northwest Colorado: Gas Research Institute Topical Report 95/0532, December 1, 1993–November 30, 1995, p. 269–285.

Speltz, C.N., 1976, Strippable coal resources of Colorado—Location, tonnage, and characteristics of coal and overburden: U.S. Bureau of Mines Information Circular 8713, 70 p.

Toenges, A.L., Dowd, J.J., Turnbull, L.A., Davis, J.D., Smith, H.L., and Johnson, V.H., 1949, Reserves, petrographic and chemical characteristics, and carbonizing properties of coal occurring south of Dry Fork of Minnesota Creek, Gunnison County, near Paonia, Colorado, and the geology of the area: U.S. Bureau of Mines Technical Paper 721, 48 p.

Toenges, A.L., Turnbull, L.A., Davis, J.D., Reynolds, D.A., Parks, B.C., Cooper, H.M., and Abernethy , R.F., 1952, Coal deposit, Coal Creek district, Gunnison County, Colorado: Reserves, coking properties, and petrographic and chemical characteristics: U.S. Bureau of Mines Bulletin 501, 83 p.

Tremain, C.M., 1990, Coalbed methane development in Colorado: Colorado Geological Survey Open-File Report 81-4, 514 p.

Tremain, C.M., Hornbaker, A.L., Holt, R.D., Murray, D.K., Ladwig, L.R., 1996, Summary of coal resources in Colorado [1995]: Colorado Geological Survey Department of Natural Resources Special Publication 41, 19 p.

Tweto, O., 1979, Geologic map of Colorado, U.S. Geological Survey Map, scale 1:500,000.

Tweto, O., Moench, R.H., and Reed, J.C., Jr., 1978, Geologic map of the Leadville 1°x2° quadrangle, northwestern Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-999, scale 1:250,000.

Tweto, O., Steven, T.A., Hail, W.J., Jr., and Moench, R.H., 1976, Preliminary geologic map of the Montrose 1°x2° quadrangle, southwestern Colorado: U.S. Geological Survey Miscellaneous Field Investigations Map MF-761, scale 1:250,000.

Tyler, R., and McMurry, R.G., 1995, Genetic stratigraphy, coal occurrence, and regional cross sections of the Williams Fork Formation, Mesaverde Group, Piceance Basin, northwestern Colorado: Colorado Geologic Survey Division of Minerals and Geology Department of Natural Resources Open-File Report 95-2, 42 p.

Van Wagoner, J.C, 1991a, Road log, day one: High frequency sequence-stratigraphy and facies architecture of the Sego Sandstone in the Book Cliffs of western Colorado and eastern Utah, *in* Van Wagoner, J.C., Nummedal, D., Jones, C.R., Taylor, D.R., Jennette, D.C., and Riley, G.W., eds., Sequence Stratigraphy: Applications to Shelf Sandstone Reservoirs: American Association of Petroleum Geologists Field Conference, p. 1-1 to 1-10, 16 figures.

Van Wagoner, J.C, 1991b, Road log, day four: Nonmarine sequence stratigraphy and facies architecture of the downdip Castlegate Sandstone in the Book Cliffs of western Colorado and eastern Utah, *in* Van Wagoner, J.C., Nummedal, D., Jones, C.R., Taylor, D.R., Jennette, D.C., and Riley, G.W., eds., Sequence Stratigraphy: Applications to Shelf Sandstone Reservoirs: American Association of Petroleum Geologists Field Conference, p. 4-1 to 4-6, 10 figures.

Van Wagoner, J.C, 1991c, Sequence stratigraphy and facies architecture of the Desert Member of the Blackhawk Formation and Castlegate Formation in the Book Cliffs of eastern Utah and western Colorado, *in* Van Wagoner, J.C., Nummedal, D., Jones, C.R., Taylor, D.R., Jennette, D.C., and Riley, G.W., eds., Sequence Stratigraphy: Applications to Shelf Sandstone Reservoirs: American Association of Petroleum Geologists Field Conference, Day Four, p. 1–7, 2 figures.

Van Wagoner, J.C., 1995, Sequence stratigraphy and marine to nonmarine facies architecture of foreland basin strata, Book Cliffs, Utah, U.S.A., *in* Van Wagoner, J.C., and Bertram, G.T., eds., Sequence Stratigraphy of Foreland Basin Deposits: American Association of Petroleum Geologists Memoir 64, p. 137–224.

Warner, D.L., 1964, Mancos-Mesaverde (Upper Cretaceous) intertonguing relations, southeast Piceance Basin, Colorado: American Association of Petroleum Geologists Bulletin , v. 48, no. 7, p. 1091–1107.

Williams, P.L., 1964, Geology, structure, and uranium deposits of the Moab quadrangle, Colorado and Utah: U.S. Geological Survey Miscellaneous Investigations Map I-360, scale 1:250,000.

Wood, G.H., Jr., Kehn, T.M., Carter, M.D., and Culbertson W.C., 1983, Coal resource classification system of the U.S. Geological Survey: U.S. Geological Survey Circular 891, 65 p.

Young, R.G., 1955, Sedimentary facies and intertonguing in the Upper Cretaceous of the Book Cliffs, Utah-Colorado: Geological Society of America Bulletin, v. 66, no. 2, p. 177–202.

Young, R.G., 1983, Book Cliffs coal field, western Colorado: Grand Junction Geological Society 1983 Field Guide, p. 9–15.

Appendix 1—Summary of Data Used for the Assessment of Coal in the Southern Part of the Piceance Basin, Colorado

Appendix 1 provides a summary of information for each data point used in the coal assessment of the southern part of the Piceance Basin, Colorado. A printout of the complete database is provided in appendix 5 on disk 2 of this CD-ROM. Information includes data point identification, location, kelly bushing elevation, coal thicknesses, and elevation at the top Rollins Sandstone Member that was used for the base of the Cameo-Fairfield coal group. Elevations that are preceded by a minus sign (–) are below sea level. Total coal thickness is provided for the Cameo-Fairfield coal group. The total coal and number of coal beds are also provided for Cameo-Wheeler, South Canyon, and Coal Ridge coal zones, which are within the Cameo-Fairfield group.

The net coal and number of coal beds are also shown within various bed-thickness categories in the Cameo-Wheeler coal zone; the categories are 1 to 2.3 ft, 2.3 to 3.5 ft, 3.5 to 7.0 ft, 7.0 to 14 ft, and greater than 14 ft. Coal beds that are exactly 2.3, 3.5, 7.0, or 14.0 ft thick are included in the preceding (thinner) bed-thickness category; for example, a 7.0-ft-thick coal bed is included in the 3.5 to 7.0 ft bed-thickness category. Coal-bed thicknesses were determined using the methodology of Wood and others (1983). According to that methodology, a bed includes all coal and partings (non-coal material) that lie between the roof and floor, and the net thickness of coal in a bed does not include the thickness of partings that are more than 3/8 inch thick (Wood and others, 1983, p. 5, 31). Furthermore, according to Wood and others, (1983, p. 36), separate benches of coal are considered to be part of the same bed when the intervening parting is thinner than either bench; when the parting exceeds the thickness of either bench, the bed is considered to have split into two beds. Based on these criteria, we reported the thickness of a bed to included the combined thicknesses of benches and partings; however, the net coal in the bed only included the combined thicknesses of the coal benches.

Surface elevations and elevations for the top of the Rollins Sandstone Member were not provided for measured sections. Blank spaces in the columns identified as "top of the Rollins Sandstone Member" indicates that the drill hole was not deep enough to penetrate the Rollins Sandstone. Blank spaces in the column identified as "total coal in the Cameo-Fairfield coal group" indicate that the entire group was not drilled or that the total coal thickness was uncertain. Blank spaces in columns identified as "net coal" and "number of beds" in the Cameo-Wheeler coal zone indicates that the data point had no coal beds within the specified bed-thickness category. Blank spaces in columns identified as "total coal" or "number of beds" for the South Canyon and Coal Ridge coal zones indicates that the zones were not present at the location of the data point.

Abbreviations include: feet (ft), oil and gas hole (O&G), measured section (MS), lithologic log (LL), number (#), rotary exploration hole (ROT), core and rotary exploration hole (R/C), undefined (UND), section (Sec.), elevation (elev.), and Kelly bushing (Kelly bsh.). There are also several abbreviations used in the source column, and these include (1) drill hole names for oil and gas holes, and (2) references to U.S. Geological Survey (USGS) and U.S. Bureau of Mines (USBM) publications. The type of publication is abbreviated as Open-File Report (OF), Bulletin (Bull), Professional Paper (PP), Geologic Quadrangle (GQ), and Technical Paper (TP). Specific data points within a USBM or USGS publication are listed after the reference to the publication, and reports by the USBM and USGS are referenced below (i.e., the source "USGS MAP C-97-B; 18, 34" refers to data points 18 and 34 in the U.S. Geological Survey Map C-97-B by Ellis and others (1988)):

Identification of publication in source column	Reference to publication
USGS OF 78-540	Eager (1978)
USGS OF 79-327	Eager (1979)
USGS OF 79-999	Gualtieri (1979)
USGS OF 80-709	Kent and Arndt, (1980b)
USGS OF 82-827	Hobbs and others (1982)
USGS OF 82-590	Johnson (1982)
USGS MAP C-97-B	Ellis and others (1988)
USGS MAP C-115	Dunrud (1989a)
USGS MAP C-116	Dunrud (1989b)
USGS Map GQ-1604	Gaskill and DeLong (1987)
USGS BULL 415	Gale (1910)
USBM BULL 501	Toenges and others (1952)
USGS BULL 510	Lee (1912)
USGS BULL 851	Erdmann (1934)
USGS PP 1485	Madden (1989)
USBM TP 721	Toenges and others (1949)

Data point identification				Data point location						Top Rollins Sandstone Member	Total coal in Cameo-Fairfield coal group	Cameo/Wheeler coal zone: Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	elev. (ft)	(ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
1	05-103-08891	O&G	COSEKA-COLUMB 6-23-4-104	-109.03914	39.69586	23	4 S	104 W	6538	4721	19.0	19	6	4	3	6	2			9	1						
2	05-045-06157	O&G	TAIGA-1-5-23	-109.03428	39.61406	23	5 S	104 W	8317	5347	13.0	13	4	4	2	3	1	6	1								
3	05-045-06281	O&G	COSEKA-CLMBN 16-2-5-104	-109.03258	39.65797	2	5 S	104 W	6798	5236	13.0	13	2					4	1	9	1						
4	05-103-08662	O&G	COSEKA-CLMBINE1-35-4-104	-109.03239	39.66331	35	4 S	104 W	6648	5046	17.0	17	5	6	3	3	1			8	1						
5	ERD MS-2/19	MS	USGS BULL 851	-109.02886	39.42828	30	7 S	104 W			14.2	14.2	7	5.6	4	8.6	3										
6	CBBC 1	R/C	USGS OF 79-999	-109.01667	39.45417	0	7 S	104 W	5950	5738.7	16.3	14	3					14	3								
7	05-103-08933	O&G	COSEKA-CLMBINE9-25-4-104	-109.01267	39.68356	25	4 S	104 W	6618	5072	17.0	17	7	5	4			12	3								
8	05-045-06040	O&G	FUEL RES-CARONERA #1-20	-109.00744	39.52311	20	6 S	104 W	7511	6190	8.0	8	5	4	4			4	1								
9	05-045-07024	O&G	AMOCO-SNO GR MES30-5-103	-108.99786	39.59308	30	5 S	103 W	8496	5494	15.0	15	4	4	2			11	2								
10	05-103-08375	O&G	COSEKA-GENTRY 8-31-4-103	-108.99225	39.66481	31	4 S	103 W	6563	5357	7.0	7	3	3	2			4	1								
11	05-045-06212	O&G	COSEKA-GENTRY 1-6-5-103	-108.99056	39.64667	6	5 S	103 W	6748	5556	4.0	4	2	1	1	3	1										
12	CARBONERA 1C	R/C	USGS OF 82-827	-108.96736	39.46728	10	7 S	104 W	5808	5486	20.1	19.6	6	5	3	4.8	2			9.8	1						
13	05-045-06297	O&G	COSEKA-ARCOFED11-4-5-103	-108.96614	39.65528	4	5 S	103 W	6626	5601	13.0	13	7	9	6			4	1								
14	ERD MS-5/22	MS	USGS BULL 851	-108.96594	39.50081	34	6 S	104 W			5.1	3.2	1			3.2	1										
15	05-103-08822	O&G	COSEKA-ARCOFED3-28-4-103	-108.96489	39.67656	28	4 S	103 W	7038	5536	9.0	9	3	1	1			8	2								
16	ERD MS-10/26	MS	USGS BULL 851	-108.95161	39.45492	14	7 S	104 W			10.6	8.8	4	5.1	3			3.7	1								
17	05-045-06394	O&G	COSEKA-EVAC 13-10-5-103	-108.95153	39.64381	10	5 S	103 W	6802	5293	14.0	14	5	3	2	3	1	8	2								
18	05-045-06246	O&G	Fuelco-B-12-6-104S	-108.94086	39.55892	12	6 S	104 W	6431	6011	12.0	12	3	2	1			10	2								
19	ERD MS-11/30	MS	USGS BULL 851	-108.93594	39.46353	12	7 S	104 W			12.9	12.9	6	5.4	4			7.5	2								
20	ERD MS-7/24	MS	USGS BULL 851	-108.93328	39.53067	24	6 S	104 W			9.1	8.2	3	1.6	1	2.6	1	4	1								
21	ERD MS-35	MS	USGS BULL 851	-108.93108	39.41897	25	7 S	104 W			5.1	5.1	3	2.6	2	2.5	1										
22	05-103-08632	O&G	COSEKA-BAXTR 13-35-4-103	-108.92883	39.67325	35	4 S	103 W	7078	5601	19.0	19	7	5	4			14	3								
23	ERD MS-12/31	MS	USGS BULL 851	-108.91078	39.49239	31	6 S	103 W			21.9	21.9	3	2	1			6.9	1	13	1						
24	ERD MS-37	MS	USGS BULL 851	-108.90972	39.42197	29	7 S	103 W			5.7	5.7	2			5.7	2										
25	ERD MS-39	MS	USGS BULL 851	-108.89575	39.39989	4	8 S	103 W			9.5	9.5	2	1.4	1					8.1	1						
26	05-103-08679	O&G	TENNECO GOVT 13-31-4	-108.89422	39.66292	31	4 S	102 W	8573	5979	22.0	22	4	3	2			6	1			13	1				
27	05-103-08897	O&G	TENNECO EVAC CRK 30-1202	-108.89325	39.67114	30	4 S	102 W	8436	5622	18.0	18	8	7	5	3	1	8	2								
28	ERD MS-40	MS	USGS BULL 851	-108.88717	39.40328	4	8 S	103 W			8.4	7.6	2					7.6	2								
29	ERD MS-42	MS	USGS BULL 851	-108.87458	39.41625	33	7 S	103 W			5.3	5.3	2			5.3	2										
30	05-103-08576	O&G	PROVIDENT GOVT5-32-4-102	-108.87333	39.65572	32	4 S	102 W	8145	6123	22.0	22	6	4	2	6	2	12	2								
31	05-045-06427	O&G	TENNECO-DGLS/YOUNG 32-3	-108.87103	39.58494	32	5 S	102 W	6913	6172	27.0	27	6	7	4					20	2						
32	05-045-06408	O&G	TENNECO-DGLS/YOUNG 29-10	-108.86711	39.59431	29	5 S	102 W	6994	6108	23.0	23	1									23	1				
33	05-045-06293	O&G	TENNECO-DOUGLAS USA20-15	-108.86386	39.60553	20	5 S	102 W	7260	6276	21.0	21	2					7	1			14	1				
34	05-103-08544	O&G	PROVIDENT-GOVT7-29-4-102	-108.86261	39.66997	29	4 S	102 W	7197	6163	35.0	35	9	6	3	3	1	17	4	9	1						
35	05-103-08510	O&G	FEES-KIRBY EDISON 28-3	-108.85508	39.6775	28	4 S	102 W	7043	6245	26.0	26	6	5	3	3	1	6	1	12	1						
36	05-045-06096	O&G	PROVIDENT-GOVT3-16-5-102	-108.85092	39.61942	16	5 S	102 W	8794	6210	20.0	20	4	4	2					16	2						
37	05-045-06274	O&G	TENNECO-GOVT 2-33-5-102	-108.84667	39.57556	33	5 S	102 W	7933	6171	12.0	12	4	1	1	3	1	8	2								
38	05-045-06169	O&G	PRVDNT-YOUNG 11-27-5-102	-108.83153	39.59792	27	5 S	102 W	7764	6142	25.0	25	5	5	3					20	2						
39	05-103-08196	O&G	TAIGA FED 1-R-22	-108.82303	39.688	22	4 S	102 W	8046	6141	19.0	19	5	4	3			5	1	10	1						
40	05-045-06082	O&G	SWEET PEA-FED 5-2-5-102	-108.80597	39.64767	2	5 S	102 W	7435	6189	20.0	20	4	4	2			4	1	12	1						
41	05-045-06294	O&G	TENNECO-TENNECO USA 23-9	-108.80464	39.60853	23	5 S	102 W	7717	5974	26.0	26	2					4	1			22	1				
42	05-045-06162	O&G	PALMER-FEDERAL 6-8	-108.80189	39.57025	6	6 S	102 W	6680	5934	16.0	16	3	4	2							12	1				
43	05-045-06291	O&G	DEVON-FED 1-30	-108.80028	39.51	30	6 S	102 W	7395	5695	27.0	27	7	2	1	6	2	19	4								
44	05-045-06962	O&G	TRINITY-BS 23-17-6-102	-108.79172	39.53967	17	6 S	102 W	6238	5688	14.0	14	6	5	4			9	2								
45	05-103-07971	O&G	PROVIDENT K-R 9-36-4-102	-108.78503	39.65911	36	4 S	102 W	7041	6099	24.0	24	4	2	1			10	2	12	1						
46	05-045-06090	O&G	TIPPERARY-CALF CYN2-17-6	-108.78472	39.53403	17	6 S	102 W	6204	5600	13.0	13	3	2	1	3	1			8	1						
47	05-045-06117	O&G	COSEKA-1-A-24-5S-102W	-108.78428	39.61642	24	5 S	102 W	7508	5918	22.0	22	2	2	1							20	1				
48	ERD MS-45	MS	USGS BULL 851	-108.78378	39.44183	20	7 S	102 W			10.3	10.3	1							10.3	1						
49	05-103-08702	O&G	TETON-RED RK CYN FED 7-4	-108.78222	39.71589	7	4 S	101 W	6703	6372	25.0	25	7	8	4			17	3								
50	ERD MS-46	MS	USGS BULL 851	-108.77447	39.46031	16	7 S	102 W			9.1	9.1	2	1.1	1					8	1						
51	ERD MS-47	MS	USGS BULL 851	-108.77131	39.44164	21	7 S	102 W			17.8	17.8	2	1	1							16.8	1				
52	ERD MS-48	MS	USGS BULL 851	-108.77106	39.44097	21	7 S	102 W			20.7	20.7	1									20.7	1				
53	05-045-08371	O&G	COSEKA-ROCK CANYON 9-31	-108.765	39.66833	31	4 S	101 W	7320	6036	31.0	31	5	2	1			11	2	18	2						
54	05-045-60010	O&G	AM RES MNGT- CC 10-1	-108.75747	39.55967	10	6 S	102 W	6544	5608	30.0	30	6	2	1	3	1	14	3			11	1				
55	05-103-08513	O&G	COSEKA-RK CYN 3-32-4-101	-108.75736	39.65214	32	4 S	101 W	8100	6006	36.0	36	6	5	3	3	1			8	1	20	1				

Data point identification: Map No.	Point ID	Type	Source	Data point location: Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	Top Rollins Sandstone Member elev. (ft)	Total coal in Cameo-Fairfield coal group (ft)	Cameo/Wheeler coal zone (Net-coal thickness (ft) and number of coal beds in bed-thickness categories): Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	South Canyon coal zone: Total coal	# beds	Coal Ridge coal zone: Total coal	# beds
56	ERD MS-49	MS	USGS BULL 851	-108.75733	39.43469	22	7 S	102 W			10.7	10.2	3	1.9	1	3.1	1	5.2	1								
57	05-045-06318	O&G	ARM-CALF CNYN 34-2	-108.74564	39.49903	34	6 S	102 W	5822	5192	26.0	26	9	12	6	3	1	11	2								
58	05-045-06336	O&G	ARM-CALF CNYN 23-1A	-108.74053	39.52956	23	6 S	102 W	6144	5400	11	11	4	6	3			5	1								
59	05-045-06134	O&G	TIPPERARY- 3-23G	-108.73939	39.52928	23	6 S	102 W	6135	5396	26.0	26	10	8	5	6	2	12	3								
60	05-045-06405	O&G	AM RES MNGMT-CC-11-4A	-108.73778	39.54722	11	6 S	102 W	6390	5414	26.0	26	2							9	1	17	1				
61	05-045-06334	O&G	COSEKA-ROCKCYN 3-4-5-101	-108.73303	39.64886	4	5 S	101 W	7517	5817	37.0	37	8	6	4			15	3			16	1				
62	05-103-08748	O&G	TETON-FEDERAL 9-4	-108.72919	39.7135	9	4 S	101 W	8250	6318	19.0	19	6	5	3			14	3								
63	05-045-06385	O&G	AM RES MNGMNT-CC 25-3	-108.70939	39.50481	25	6 S	102 W	5981	4930	37.0	37	7	4	2	6	2	5	1	8	1	14	1				
64	05-045-06069	O&G	POTRERO-REYBOS FED 24-3	-108.70842	39.51972	24	6 S	102 W	6113	4991	26.0	26	8	4	3	3	1	19	4								
65	05-045-06055	O&G	POTRERO-REYBOS FED 12-1	-108.70806	39.555	12	6 S	102 W	6474	5319	23.0	23	9	9	6	3	1	4	1	7	1						
66	05-045-06018	O&G	POTRERO-REYBOS #13-1	-108.70694	39.53683	13	6 S	102 W	6275	5185	27.0	27	5	2	1	3	1	9	2			13	1				
67	05-045-06050	O&G	POTRERO-REYBOS-FED 24-1	-108.70686	39.53217	24	6 S	102 W	6228	5108	19.0	19	5	2	1			17	4								
68	05-045-06466	O&G	AM RES MNGT-CC 19-1	-108.70428	39.52383	19	6 S	101 W	6167	5007	26.0	26	8	7	4			19	4								
69	05-103-07968	O&G	AM RES-GOVT 1-14	-108.70386	39.70669	14	4 S	101 W	6848	5992	26.0	26	8	5	3	6	2	9	2	6	1						
70	05-045-06407	O&G	AM RES MNGMT-BG 29-1	-108.69631	39.51117	29	6 S	101 W	6074	4875	19	19	4	4	2			6	1	9	1						
71	05-045-06507	O&G	DYCO-MESAGAR FED 8-1	-108.69142	39.46267	8	7 S	101 W	7335	4803	35.0	35	10	8	5	3	1	15	3	9	1						
72	05-045-06478	O&G	DYCO-MESAGAR FED 20-1	-108.68936	39.43425	20	7 S	101 W	6031	4892	40.0	40	5	5	3	3	1					32	1				
73	05-103-07842	O&G	TIPPERARY-SOLDIER 2-36-C	-108.686	39.66167	36	4 S	101 W	8062	5652	37.0	37	6	7	4			6	1			24	1				
74	05-103-09092	O&G	AM RES-SOLDIER CANY#25-4	-108.68531	39.67108	25	4 S	101 W	8136	5704	41.0	41	12	9	5	9	3	14	3	9	1						
75	05-045-06444	O&G	DYCO-MESAGAR FED 17-1	-108.68381	39.44878	17	7 S	101 W	6281	4779	31.0	31	7	4	2			19	4	8	1						
76	05-045-06061	O&G	POTERERO REYBOS FED 1-1	-108.68236	39.64936	1	5 S	101 W	7896	5382	32.0	32	4			3	1			29	3						
77	05-045-06450	O&G	AM RES MNGMT-BG29-2	-108.68139	39.50778	29	6 S	101 W	6258	4746	25.0	25	7	8	5			7	1	10	1						
78	05-045-06447	O&G	DYCO-MESAGAR FED 21-1	-108.67508	39.43753	21	7 S	101 W	6131	4736	34.0	34	6	9	5							25	1				
79	05-045-06406	O&G	ARM-BEAR GULCH 21-4	-108.67056	39.51861	21	6 S	101 W	6315	4783	32.0	32	8	4	3			18	4	10	1						
80	05-045-06113	O&G	TIPPERARY-4-24-E	-108.668	39.60956	24	5 S	101 W	8858	5046	43.0	43	11	1	1	12	4	17	4	13	2						
81	05-045-06239	O&G	TETON-ALBERTSON 16-1	-108.66753	39.44403	16	7 S	101 W	6193	4640	43.0	43	5	6	3			4	1			33	1				
82	05-045-06492	O&G	DYCO-MESAGAR FED 9-1	-108.66742	39.45803	9	7 S	101 W	7248	4498	40.0	40	8	5	4			16	3			19	1				
83	05-045-06017	O&G	PETRO LWS-COAL GLCH 15-9	-108.66639	39.37	9	8 S	101 W	6560	5496	40.0	40	7	5	3			4	1	31	3						
84	05-103-08212	O&G	AM RES-SOLDIER CYN 30-3	-108.65572	39.66861	30	4 S	100 W	9006	5253	52.0	52	8	1	1	3	1	10	2	38	4						
85	05-103-08053	O&G	TIPPERARY-FED 1-19-D	-108.65278	39.68072	19	4 S	100 W	8980	5150	55.0	55	9	4	2	3	1	14	3	34	3						
86	05-045-06376	O&G	DYCO-ALBERTSON 15-1	-108.64861	39.44756	15	7 S	101 W	6330	4366	45.0	45	11	12	8	3	1	6	1			24	1				
87	05-045-06076	O&G	FUEL RES-FUELCO 1-2 FED	-108.63344	39.47414	2	7 S	101 W	6798	4388	27.0	27	3							27	3						
88	05-103-07747	O&G	TIPPERARY-SLDIER1 33-0-1	-108.62656	39.65594	33	4 S	100 W	8847	4695	41.0	41	6	4	2			6	1	31	3						
89	05-077-05165	O&G	PURE-HUNTER CAN. GOVT 1	-108.61275	39.35114	24	8 S	101 W	6195	5160	26.0	26	3	2	1	3	1					21	1				
90	05-045-06296	O&G	DYCO-MESAGAR FED 25-1	-108.61144	39.42092	25	7 S	101 W	7385	4273	34.0	34	5	4	3			4	1			26	1				
91	05-077-08506	O&G	FEES-HUNTERS CNYN2-24-81	-108.61111	39.34639	24	8 S	101 W	6890	5160	35.0	35	7	7	4			8	2			20	1				
92	05-077-08505	O&G	FEES-HUNTER CANYON 8	-108.594	39.33244	30	8 S	100 W	6772	5261	28.0	28	4	2	1	3	1	4	1			19	1				
93	05-045-06340	O&G	DYCO-ALBERTSON RANCH 7-1	-108.59039	39.463	7	7 S	100 W	7123	3953	23.0	23	6	7	4			4	1	12	1						
94	05-077-08551	O&G	FEES-BELCO FED 19-1-800	-108.58975	39.34408	19	8 S	100 W	7115	5083	29.0	29	7	6	4	3	1	7	1	13	1						
95	05-045-06262	O&G	DYCO-MESAGAR 6-3	-108.58847	39.38406	6	8 S	100 W	7695	4483	20.0	20	10	12	8			8	2								
96	05-045-06329	O&G	DYCO-DOUGHERTY 1	-108.58056	39.45139	17	7 S	100 W	6953	3781	42.0	42	7	5	3	6	2	5	1			26	1				
97	ERD HUNTER MINE	MS	USGS BULL 851	-108.57514	39.30078	5	9 S	100 W			13.2	13.2	2					6.6	1	6.6	1						
98	05-045-06750	O&G	N AM RES-CEDAR BNCH32-29	-108.57422	39.50764	29	6 S	100 W	6758	3809	37.0	37	12	11	6	3	1	23	5								
99	05-045-06688	O&G	N AM RES-CEDAR BNCH40-17	-108.57358	39.52717	17	6 S	100 W	6721	3711	32.0	32	10	5	3	3	1	24	6								
100	05-077-05122	O&G	GRT BASIN-HUNTER CANYN 3	-108.57333	39.325	32	8 S	100 W	5838	5213	17.0	17	2							17	2						
101	05-045-06320	O&G	DYCO-MESAGAR FED 33-1	-108.55028	39.39711	33	7 S	100 W	7192	3886	32.0	32	10	8	6			16	3	8	1						
102	05-077-08518	O&G	KOCH-WINTER FLT 1-10-100	-108.54106	39.28589	10	9 S	100 W	7115	5431	14.0	14	5	8	4			6	1								
103	05-077-08302	O&G	COORS-USA 1-15-L.G.	-108.53639	39.27283	15	9 S	100 W	6872	5648	18.0	18	4			3	1	15	3								
104	05-045-05014	O&G	GRT BASIN PETR-GOVT 1	-108.53297	39.37589	24	8 S	100 W	6989	3963	38.0	38	7	5	3	3	1	9	2			21	1				
105	05-077-08385	O&G	COORS-USA 1-22LG	-108.532	39.26383	22	9 S	100 W	7152	5733	15.0	15	5	6	3			9	2								
106	05-077-08517	O&G	KOCH-WINTER FLTS 1-2-100	-108.52625	39.29733	2	9 S	100 W	6747	4817	13.0	13	5	3	2	6	2	4	1								
107	05-077-08442	O&G	KOCH-WINTER FLTS1-14-100	-108.51825	39.27758	14	9 S	100 W	6862	5190	11.0	11	4	2	2			9	2								
108	05-045-06341	O&G	NUCORP-1-26 TATE FED G	-108.51439	39.50594	26	6 S	100 W	6318	3028	33.0	33	9	8	6			7	1	18	2						
109	05-045-06360	O&G	DYCO-LATHAN 11-1	-108.50697	39.37364	11	8 S	100 W	6787	3779	36.0	36	13	10	7	9	3	17	3								
110	05-077-08154	O&G	KOCH-WINTER FLATS 2	-108.50694	39.28642	12	9 S	100 W	6615	4755	18.0	18	3					18	3								

Data point identification				Data point location						Top Rollins Sandstone Member	Total coal in Cameo-Fairfield coal group	Cameo/Wheeler coal zone: Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	elev. (ft)	(ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
111	ERD MID-FARM 3	MS	USGS BULL 851	-108.50061	39.22558	36	9 S	100 W			12.8	12.1	3	2.4	2					9.7	1						
112	05-045-06422	O&G	NUCORP-TATE 1-25	-108.50022	39.50892	25	6 S	100 W	6224	2817	24.0	24	6	6	3	3	1	7	1	8	1						
113	05-077-08540	O&G	DYCO-MESAGER FED 13-1	-108.49869	39.35858	13	8 S	100 W	6709	3850	28.0	28	12	13	9	3	1	4	1	8	1						
114	05-045-06728	O&G	NARCO CEDAR BENCH UN33-1	-108.49844	39.56208	1	6 S	100 W	6267	2529	40.0	40	8	6	3			13	3	21	2						
115	05-045-06445	O&G	DYCO-LATHAM 12-1	-108.49222	39.37083	12	8 S	100 W	6727	3641	36.0	36	9	10	6	3	1	4	1			19	1				
116	05-045-06739	O&G	NARCO-CEDAR BENCH 32-7	-108.48033	39.55122	7	6 S	99 W	6222	2267	44.0	44	14	14	9	3	1	13	3	14	1						
117	05-045-05075	O&G	EL PASO-STANDARD SHALE	-108.47742	39.48189	6	7 S	99 W	8256	2650	31.0	31	10	10	5	6	2	15	3								
118	05-045-06347	O&G	NUCORP ENRGY G-1-30 TATE	-108.47611	39.51117	30	6 S	99 W	6090	2450	40.0	40	9	3	2	12	4	4	1	21	2						
119	05-077-08317	O&G	DYCO-LATHAM 18-1	-108.47564	39.361	18	8 S	99 W	6495	3591	30.0	30	8	6	4			14	3	10	1						
120	05-077-05141	O&G	F.L.COOPER-GOV'T 1	-108.47531	39.33678	30	8 S	99 W	6350	3815	13.0	13	4	6	3			7	1								
121	05-077-08502	O&G	KOCH-WINTER FLTS 1-18-99	-108.47397	39.27728	18	9 S	99 W	6316	4591	27.0	27	10	6	5	12	4			9	1						
122	ERD MS-53	MS	USGS BULL 851	-108.47128	39.198	7	10 S	99 W			29.2	29.2	2							7.9	1	21.3	1				
123	05-045-06332	O&G	NUCORP-SHEFFIELD 1-17	-108.46608	39.53286	17	6 S	99 W	6080	2180	43.0	43	11	6	4	3	1	24	5	10	1						
124	ERD MS-54	MS	USGS BULL 851	-108.46475	39.18364	3	1 N	001 E			3.8	3	2	1	1	2	1										
125	05-045-06218	O&G	COORS-ACCO 1-29 USA-DF	-108.46217	39.41783	29	7 S	99 W	6516	2816	23.0	23	4	2	1	6	2					15	1				
126	ERD MS-55	MS	USGS BULL 851	-108.45811	39.17956	2	1 N	001 E			3.8	3.8	1					3.8	1								
127	05-077-08415	O&G	COORS-USA 1 8 MR	-108.45764	39.20422	8	10 S	99 W	6472	5024	12.0	12	4	6	3			6	1								
128	05-077-07334	O&G	SUNRAY-RED ROCK PT 1	-108.455	39.28586	8	9 S	99 W	6269	4259	17.0	17	4	2	1	6	2			9	1						
129	ERD MS-56	MS	USGS BULL 851	-108.45164	39.17358	11	1 N	001 E			2.5	2	1			2	1										
130	ERD MS-57	MS	USGS BULL 851	-108.44969	39.17133	11	1 N	001 E			13.6	13.6	2					6.4	1	7.2	1						
131	05-045-06373	O&G	COORS-USA 1-33	-108.44864	39.40978	33	7 S	99 W	6581	2687	30.0	30	11	13	8			9	2	8	1						
132	05-045-06593	O&G	CHEVRON-CHEVRON 1-25A	-108.44667	39.67661	25	4 S	99 W	8443	1533	35.0	35	12	9	6	3	1	23	5								
133	05-045-06608	O&G	CHEVRON CHEVRON 65-12D	-108.44567	39.63292	12	5 S	99 W	8190	1162	31.0	31	10	9	5	9	3	13	2								
134	05-077-08457	O&G	KOCH-WINTER FLTS 1-16-99	-108.44022	39.27553	16	9 S	99 W	6070	4278	25.0	25	7	7	5			4	1	14	1						
135	ERD MS-58	MS	USGS BULL 851	-108.4375	39.16383	13	1 N	001 E			6.3	6.3	1					6.3	1								
136	05-045-06616	O&G	AA PROD-2A-27 TEXACO FEE	-108.43503	39.50469	27	6 S	99 W	5839	1949	41.0	41	11	10	6	6	2	12	2	13	1						
137	05-077-08455	O&G	KOCH-WINTER FLTS 1-10-99	-108.42914	39.285	10	9 S	99 W	6187	3987	31.0	31	8	7	5			4	1	20	2						
138	ERD MS-59	MS	USGS BULL 851	-108.42606	39.15678	13	1 N	001 E			1.0	1	1	1	1												
139	ERD MS-60	MS	USGS BULL 851	-108.42397	39.15472	13	1 N	001 E			9.6	9.6	1							9.6	1						
140	05-045-06757	O&G	AA PRODUCTION-FED 10-1	-108.42064	39.55433	10	6 S	99 W	6087	1427	51.0	51	12	10	5	9	3	15	3			17	1				
141	05-077-65350	O&G	MARATHON-DEBEQUE UNIT 2	-108.42042	39.32128	34	8 S	99 W	7276	3726	29.0	29	11	10	6	6	2	13	3								
142	05-077-08596	O&G	ANADARKO-WINTER FED 2-14	-108.41342	39.29736	2	9 S	99 W	6151	3681	33.0	33	9	7	4	3	1	15	3	8	1						
143	05-077-08464	O&G	KOCH-WINTER FLATS1-11-99	-108.41147	39.285	11	9 S	99 W	7005	4770	29.0	29	9	13	7	3	1					13	1				
144	05-077-08301	O&G	COORS-USA 1-26 HG	-108.40547	39.32878	26	8 S	99 W	7024	3480	30.0	30	9	10	6	3	1	5	1	12	1						
145	05-045-06705	O&G	AA PROD-SAVAGE 1-25	-108.40419	39.50461	26	6 S	99 W	5766	1536	44.0	44	14	13	8	6	2	17	3	8	1						
146	05-045-06756	O&G	AA PRODUCTION FED 14-1	-108.40314	39.53497	14	6 S	99 W	5920	1334	42.0	42	12	15	8			10	2	17	2						
147	05-077-08373	O&G	DOME-CAMEO FED 3-36	-108.39614	39.22761	36	9 S	99 W	6388	4793	20.0	20	9	11	7			9	2								
148	05-045-06310	O&G	COORS-SPEARS 2-36 DF	-108.39275	39.40389	36	7 S	99 W	5961	2381	49.0	49	15	14	10			20	4			15	1				
149	05-045-06303	O&G	TETON-ALBERTSON RNCH13-4	-108.38814	39.44503	13	7 S	99 W	5874	1908	42.0	42	14	14	9			13	3	15	2						
150	05-077-08155	O&G	KOCH-HANCOCK GULCH #1	-108.3875	39.36425	13	8 S	99 W	5800	2753	36.0	36	7	4	3			10	2	22	2						
151	05-045-06621	O&G	AA PROD-1-25 TEXACO FEE	-108.38733	39.50689	25	6 S	99 W	5794	1324	40.0	40	11	11	6			12	3	17	2						
152	05-077-05045	O&G	UNITED-FED 5-6	-108.37739	39.22075	6	10 S	98 W	6200	4392	15.0	15	3			3	1	4	1	8	1						
153	05-077-05058	O&G	UNITED-FED 3-31	-108.37344	39.22808	31	9 S	98 W	6680	4602	14.0	14	4			6	2	8	2								
154	05-077-08493	O&G	COORS-USA1-18JACKSON CYN	-108.3715	39.26986	18	9 S	98 W	6023	3829	31.0	31	11	12	8	3	1	7	1	9	1						
155	05-045-06743	O&G	CONQUEST-S.SHALE RDG10-7	-108.36733	39.37297	7	8 S	98 W	5658	2421	35.0	35	11	8	6	3	1	12	3	12	1						
156	05-077-05114	O&G	PHILLIPS-DEBEQUE 1	-108.36133	39.31703	31	8 S	98 W	5869	3519	43.0	43	10	6	4	3	1	16	3	18	2						
157	05-077-08314	O&G	COORS-USA 1-17 JC	-108.35764	39.27458	17	9 S	98 W	5829	3599	35.0	35	10	10	6			8	2	17	2						
158	05-077-08386	O&G	DOME-DOME ALBERTSON 1-32	-108.35564	39.2335	32	9 S	98 W	6350	4378	20.0	20	8	4	4	3	1	13	3								
159	05-077-08371	O&G	COORS-1-20 JC	-108.35031	39.26311	20	9 S	98 W	5932	3702	28.0	28	8	4	3	6	2	9	2	9	1						
160	05-077-05056	O&G	UNITED-FED 4-32	-108.35003	39.22856	32	9 S	98 W	6283	4407	15.0	15	5	2	1	9	3	4	1								
161	05-045-06609	O&G	CELSIUS-MCLISH FED 8-1	-108.34794	39.37586	8	8 S	98 W	5590	2275	48.0	48	16	10	9	3	1	24	5	11	1						
162	05-045-05201	O&G	CHEVRON CHEV-PACIFIC 1	-108.34489	39.61533	13	5 S	98 W	7815	500	24.0	24	5	2	1	3	1	11	2	8	1						
163	05-077-08610	O&G	CONQUEST-S.SHALE RDG9-17	-108.34372	39.35586	17	8 S	98 W	6448	2565	46.0	46	12	5	5	9	3	12	2	20	2						
164	05-045-06727	O&G	BARRETT-1-36 TOM CREEK	-108.34228	39.57425	36	5 S	98 W	6060	322	43.0	43	8	6	3			4	1	33	4						
165	05-077-08510	O&G	COORS-USA 1-9C	-108.34114	39.20439	9	10 S	98 W	5926	4011	22.0	22	6	6	4			6	1	10	1						

Data point identification				Data point location						Top Rollins Sandstone Member elev. (ft)	Total coal in Cameo-Fairfield coal group (ft)	Cameo/Wheeler coal zone — Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)			Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
166	05-045-06581	O&G	CHEVRON-CHEVRON 4-28H	-108.33922	39.49844	28	6 S	98 W	6269	858	55.0	55	14	9	7	6	2	13	3	8	1	19	1				
167	05-077-05065	O&G	UNITED-U CARBN 1-34 GOVT	-108.31792	39.23242	34	9 S	98 W	5702	4020	25.0	25	8	7	4	6	2	12	2								
168	05-077-07230	O&G	MCAULIFFE-WILDCAT 1	-108.31708	39.32144	34	8 S	98 W	5100	2642	33.0	33	7	1	1	6	2	10	2	16	2						
169	05-077-08614	O&G	CONQUEST-S.SHALE RDG5-23	-108.30281	39.34519	23	8 S	98 W	6258	2433	39.0	39	12	10	8			10	2	19	2						
170	05-077-05079	O&G	UNITED-FED 2-23	-108.29947	39.25767	23	9 S	98 W	5657	3389	38.0	38	9	2	1	6	2	24	5	6	1						
171	05-077-08420	O&G	TETON-FED 35-2	-108.29761	39.31722	35	8 S	98 W	5297	2733	48.0	48	11	8	6			4	1	36	4						
172	05-077-08673	O&G	MARALEX-SUL GUL9-98-14-1	-108.29547	39.27392	14	9 S	98 W	5306	2988	44.0	44	16	13	9	12	4	9	2	10	1						
173	CA-77-1	ROT	USGS OF 78-540	-108.2945	39.16997	23	10 S	98 W	4800	4235	26.0	26	8	7.5	5			11	2	7.5	1						
174	05-077-08606	O&G	DEKALB-WAGON TR FED44-11	-108.29225	39.28267	11	9 S	98 W	5156	2822	39.0	39	12	10	5	12	4	8	2	9	1						
175	05-077-08601	O&G	CONQUEST-S.SHALE RDG4-13	-108.28753	39.36592	13	8 S	98 W	5418	1995	55.0	55	18	13	10	6	2	19	4	17	2						
176	05-077-08249	O&G	TETON-HARVEY/FED36-3COON	-108.28264	39.31144	36	8 S	98 W	5186	2464	50.0	50	14	11	8	3	1	18	3	18	2						
177	05-045-06442	O&G	COORS-USA 1-12LW	-108.28175	39.37811	12	8 S	98 W	5381	1789	61.0	61	18	11	9	6	2	16	4	28	3						
178	05-077-08410	O&G	TETON-ROAN CRK FED 25-3	-108.28011	39.32503	25	8 S	98 W	5268	2542	53.0	53	12	7	6	3	1	10	2	19	2	14	1				
179	05-045-06435	O&G	COORS-USA 1-1LW	-108.27889	39.38894	1	8 S	98 W	5360	1704	59.0	59	12	6	3	9	3	13	3	31	3						
180	05-077-08613	O&G	CONQUEST-S.SHALE RDG7-24	-108.27603	39.34892	24	8 S	98 W	5790	2184	40.0	40	10	5	4	6	2	10	2	19	2						
181	PA-77-1	ROT	USGS OF 78-540	-108.27483	39.01336	18	12 S	97 W	6840	6710.5	3.0	3	1			3	1										
182	CA-77-2	ROT	USGS OF 78-540	-108.27167	39.18011	13	10 S	98 W	4840	3952	28.5	28.5	9	5.5	4	5.5	2	8.5	2	9	1						
183	05-045-06305	O&G	COORS-COWPERTHWAITE2-6LS	-108.26544	39.39033	6	8 S	97 W	5150	1542	41.0	41	10	12	6	3	1			26	3						
184	05-045-06362	O&G	COORS-USA 1-31LW	-108.25417	39.4015	31	7 S	97 W	5408	1230	37.0	37	10	4	3	12	4	10	2	11	1						
185	05-077-08520	O&G	KOCH-HORSESHOE CNYN 2-31	-108.25278	39.22719	31	9 S	97 W	5662	3580	15.0	15	10	12	9	3	1										
186	05-077-05038	O&G	BIGHORN PDR RIV-FED A 1	-108.25169	39.20747	7	10 S	97 W	5288	3484	38.0	38	10	5	3	12	4	13	2	8	1						
187	05-077-05054	O&G	TEXACO-MEFFELMIRE GOVT 1	-108.24789	39.22489	32	9 S	97 W	5648	3598	16.0	16	5	4	2	6	2	6	1								
188	05-077-08408	O&G	ALTA-FED 32-1	-108.24775	39.23194	32	9 S	97 W	5748	3506	33.0	33	11	13	7			20	4								
189	IP-77-1	ROT	USGS OF 78-540	-108.24233	38.99503	21	12 S	97 W	7230	6683	31.0	31	8	5.5	4	5	2	3.5	1			17	1				
190	05-077-08483	O&G	COORS-DEBEQUE 1-8	-108.24081	39.28653	8	9 S	97 W	4881	2367	61.0	61	11	9	5	3	1	9	2	16	2	24	1				
191	05-045-06326	O&G	COORS-USA 1-5-LW	-108.23889	39.38889	5	8 S	97 W	5395	1329	46.0	46	8	6	3	3	1	15	3			22	1				
192	05-077-05041	O&G	TEXACO-ROBERTS CANYN U1	-108.23875	39.21386	5	10 S	97 W	5755	3610	28.0	28	9	10	5	3	1	15	3								
193	05-077-08143	O&G	KOCH-HORSESHOE CYN FED 1	-108.23803	39.24803	29	9 S	97 W	5387	3091	36.0	36	14	15	11	3	1	4	1	14	1						
194	05-077-08335	O&G	KOCH-SILVEY FLATS 1-8`	-108.23761	39.19786	8	10 S	97 W	5338	3458	40.0	40	14	13	10			15	3			12	1				
195	05-077-08549	O&G	KOCH-HORSHU 1-17	-108.23639	39.27083	17	9 S	97 W	5442	2600	52.0	52	10	6	4	6	2	7	1	17	2	16	1				
196	05-077-08459	O&G	COORS-PRATHER 1-5	-108.23583	39.29694	5	9 S	97 W	4951	2151	52.0	52	11	5	4	6	2	10	2	16	2	15	1				
197	05-077-05139	O&G	GULF-MULROONEY 1	-108.23519	39.33631	29	8 S	97 W	5014	2100	39.0	39	7	4	2			17	3	18	2						
198	05-077-08232	O&G	KOCH-HORSESHEO CYN UNIT3	-108.22958	39.23914	28	9 S	97 W	5616	3231	40.0	40	14	14	9	6	2	12	2	8	1						
199	05-077-05055	O&G	TEXACO-ROBERTS CANYON 2	-108.22503	39.22653	33	9 S	97 W	5664	3448	37.0	37	11	7	4	9	3	14	3	7	1						
200	05-077-08486	O&G	KOCH-HORSESHOE CNYN 4-21	-108.21986	39.262	21	9 S	97 W	5351	2651	44.0	44	13	14	9			10	2	20	2						
201	05-077-08231	O&G	KOCH-HORSESHOE CANYON 4	-108.21553	39.23361	33	9 S	97 W	5597	3287	32.0	32	12	12	6	12	4	8	2								
202	05-077-08361	O&G	COORS-USA 1-34-CM	-108.206	39.14936	34	10 S	97 W	7147	3847	27.0	27	8	3	3	6	2	9	2	9	1						
203	05-077-08393	O&G	COORS-USA 1-27 CM	-108.20278	39.16167	27	10 S	97 W	6685	3610	27.0	27	8	6	3	6	2	15	3								
204	05-077-08338	O&G	COORS-NICHOLS 1-15 CM	-108.20075	39.18767	15	10 S	97 W	5938	3210	35.0	35	8	2	1	9	3	24	4								
205	05-077-08271	O&G	DYCO-SOMERVILLE #1	-108.2	39.06056	26	11 S	97 W	10009	5219	30.0	30	7	2	1	9	3	9	2	10	1						
206	05-077-08230	O&G	KOCH-HORSESHOE CYN UNIT5	-108.19956	39.22961	34	9 S	97 W	5673	3189	33.0	33	10	7	4	6	2	20	4								
207	05-077-08184	O&G	NORRIS-FED 3-1	-108.19894	39.21981	3	10 S	97 W	5779	3264	56.0	56	13	2	1	12	4	34	7	8	1						
208	05-077-08254	O&G	COORS-NICHOLS 1-22 CM	-108.19875	39.17519	22	10 S	97 W	6286	3366	31.0	31	9	7	4	3	1	21	4								
209	05-077-08524	O&G	ALTA-ALTA 23-1	-108.19236	39.25558	23	9 S	97 W	5311	2711	29.0	29	11	11	7	3	1	15	3								
210	05-077-08592	O&G	BARRETT-DCB 2-23	-108.18892	39.35022	23	8 S	97 W	5014	1480	41.0	41	11	9	5	3	1	19	4	10	1						
211	05-077-08011	O&G	GASCO-SHIRE GULCH 2-A	-108.18842	39.22192	2	10 S	97 W	5710	3212	40.0	40	15	18	9	9	3	13	3								
212	05-077-05062	O&G	PACIFIC-SHIRE GLCH 23-35	-108.18747	39.22883	35	9 S	97 W	5687	3103	32.0	32	13	12	7	15	5	5	1								
213	05-077-08333	O&G	COORS-NICHOLS 1-14 CM	-108.18706	39.18803	14	10 S	97 W	5775	3125	43.0	43	12	9	5	6	2	13	3	15	2						
214	05-077-08332	O&G	COORS-NICHOLS 2-26 CM	-108.18392	39.16247	26	10 S	97 W	6346	3440	41.0	41	8	5	3			8	2	28	3						
215	05-077-08494	O&G	NORRIS-FED 26-1	-108.17958	39.24197	26	9 S	97 W	5386	2826	39.0	39	14	14	8	9	3	8	2	8	1						
216	05-077-08548	O&G	JN-JN KULP LYON #1	-108.17236	39.26961	13	9 S	97 W	6116	2351	39.0	39	11	11	7	3	1	10	2			15	1				
217	05-077-08134	O&G	NORRIS-FED 36-1	-108.17164	39.23522	36	9 S	97 W	5562	2877	55.0	55	14	9	5	12	4	23	4	11	1						
218	05-077-05046	O&G	COMPASS-GOVT WILLIAMS #1	-108.17	39.221	1	10 S	97 W	5830	3116	51.0	51	15	9	5	15	5	19	4	8	1						
219	05-077-08118	O&G	TETON-FEE NO. 1	-108.16528	39.32967	25	8 S	97 W	5634	1497	47.0	47	11	9	5			21	4	17	2						
220	05-077-08157	O&G	NORRIS-FED 36-2	-108.16417	39.22903	36	9 S	97 W	5562	2940	47.0	47	8	3	2	3	1	17	3	11	1	13	1				

Data point identification: Map No.	Point ID	Type	Source	Data point location: Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	Top Rollins Sandstone Member elev. (ft)	Total coal in Cameo-Fairfield coal group (ft)	Cameo/Wheeler coal zone (Net-coal thickness (ft) and number of coal beds in bed-thickness categories): Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	South Canyon coal zone: Total coal	# beds	Coal Ridge coal zone: Total coal	# beds
221	05-077-08436	O&G	COORS-HARVEY 2-25	-108.16322	39.16119	25	10 S	97 W	5932	3296	42.0	42	9	4	3			24	5			14	1				
222	05-045-05007	O&G	OROCO OIL-FED 1	-108.16031	39.37297	12	8 S	97 W	5177	915	56.0	56	10	2	1	6	2	29	5	19	2						
223	05-077-08100	O&G	COORS-DAVIS 1-24	-108.15936	39.17536	24	10 S	97 W	5569	3081	39.0	39	13	10	7			29	6								
224	05-077-05044	O&G	COMPASS-SHIRE GULCH #1	-108.15586	39.22058	6	10 S	96 W	5423	3039	43.0	43	14	14	8	9	3	12	2	8	1						
225	05-045-06755	O&G	BARRETT-MV 17-06	-108.154	39.46978	6	7 S	96 W	6411	-389	60.0	60	13	13	7	3	1	8	2	9	1	27	2				
226	05-077-05073	O&G	PACIFIC-SHIRE 14-30-3	-108.15317	39.24056	30	9 S	96 W	5623	2669	47.0	47	15	15	8	9	3	14	3	9	1						
227	IP-77-2A	ROT	USGS OF 78-540	-108.14739	38.88108	32	13 S	96 W	8700	7654	15.5	15.5	6	6.5	4			9	2								
228	05-077-08475	O&G	COORS-BEVAN 1-30	-108.14564	39.15833	30	10 S	96 W	5777	3217	34.0	34	10	6	4	6	2	13	3	9	1						
229	05-045-06823	O&G	BARRETT-MV 58-19	-108.144	39.50344	19	6 S	96 W	6046	-964	38.0	38	14	15	10			16	3	7	1						
230	05-077-08531	O&G	COORS-WOOD 4-32	-108.13286	39.14564	32	10 S	96 W	5957	3325	34.0	34	9	6	3	12	4	5	1	11	1						
231	05-077-08409	O&G	COORS-BORUCH 1-4	-108.13178	39.12761	4	11 S	96 W	6329	3583	41.0	41	12	16	8			15	3	10	1						
232	IP-77-3	ROT	USGS OF 78-540	-108.13039	38.87767	33	13 S	96 W	8450	7665.5	15.0	15	5	3	2	6	2	6	1								
233	05-077-08197	O&G	CHANDLER-PLATEAU CR11-32	-108.12947	39.22986	32	9 S	96 W	6272	2632	48.0	48	16	12	10	3	1	19	4	14	1						
234	05-045-06749	O&G	BARRETT-MV 34-05	-108.12667	39.46222	5	7 S	96 W	5996	-462	58.0	58	11	10	5			14	3	19	2	15	1				
235	05-077-08206	O&G	CHANDLER-KUEHN 15-17	-108.12617	39.18231	17	10 S	96 W	5471	2828	42.0	42	13	6	4	12	4	24	5								
236	05-077-08543	O&G	NORRIS-ZAHM #29-3	-108.12233	39.16222	29	10 S	96 W	5676	3074	39.0	39	10	6	4	3	1	15	3	15	2						
237	05-077-08108	O&G	COORS-TRAHERN 1-20	-108.12167	39.17111	20	10 S	96 W	5546	2931	43.0	43	9	3	2	9	3	12	2	19	2						
238	05-077-08358	O&G	KENAI-BULL BASIN FED15-3	-108.11547	39.08897	15	11 S	96 W	7750	4194	36.0	36	14	18	10			18	4								
239	05-045-07119	O&G	BARRETT-GM 201-4	-108.11333	39.46667	4	7 S	96 W	5682	-760	35.0	35	10	8	4	3	1	24	5								
240	05-077-05019	O&G	HAMMONDS-US PICKENS 33-1	-108.11242	39.14603	33	10 S	96 W	6350	3226	38.0	38	8	6	3	6	2	4	1	22	2						
241	HK-77-1	ROT	USGS OF 78-540	-108.11172	38.88131	34	13 S	96 W	8030	7446.5	34.5	34.5	9	9	6			10	2			15.5	1				
242	05-077-05021	O&G	LANDAUER-GOV'T #1	-108.10756	39.16081	28	10 S	96 W	6007	3036	51.0	51	9	5	4	3	1			15	2	28	2				
243	05-077-08151	O&G	CHANDLER-WOODRING 15-16	-108.10617	39.18383	16	10 S	96 W	5358	2742	37.0	37	13	12	7	12	4	4	1	9	1						
244	05-077-08105	O&G	NORRIS FED #21-22	-108.10267	39.17128	21	10 S	96 W	5816	2825	43.0	43	10	6	3	12	4	6	1	19	2						
245	05-077-08042	O&G	NORRIS-MORAN 2-27	-108.09808	39.15756	27	10 S	96 W	5985	3008	44.0	44	9	6	4			14	3	24	2						
246	05-045-06789	O&G	BARRETT-GR 1-3SH FED	-108.096	39.46503	3	7 S	96 W	5675	-767	37.0	37	11	7	4	9	3	13	3	8	1						
247	05-077-08205	O&G	CHANDLER-6-22 BARNARD	-108.09344	39.17472	22	10 S	96 W	5584	2724	45.0	45	11	12	6	6	2	6	1	21	2						
248	05-077-08107	O&G	FLYING DIAMOND-FED 10-1	-108.09303	39.20419	10	10 S	96 W	5661	2487	42.0	42	13	6	4	9	3	27	6								
249	05-077-08519	O&G	NORRIS-PALLAORO 15-2	-108.09261	39.18531	15	10 S	96 W	5482	2654	39.0	39	11	12	7	3	1	5	1	19	2						
250	05-045-06786	O&G	BARRETT-MV 45-10	-108.092	39.45697	10	7 S	96 W	5879	-621	56.0	56	7	4	2			16	3			36	2				
251	05-045-06730	O&G	BARRETT-GV 33-22	-108.092	39.41747	22	7 S	96 W	5123	17	47.0	47	11	5	3	9	3	20	4	13	1						
252	05-077-05155	O&G	ROUNDS-KENNON 1	-108.08792	39.34461	15	8 S	96 W	5762	828	45.0	45	11	10	5	3	1	21	4	11	1						
253	05-077-08113	O&G	MTN FUEL-BUL BSN FED1-35	-108.07861	39.15025	35	10 S	96 W	6247	2992	36.0	36	11	10	6	3	1	8	2	15	2						
254	05-045-06811	O&G	BARRETT-GR 23-11-V	-108.078	39.45006	11	7 S	96 W	5805	-651	51.0	51	13	17	9			10	2	11	1	13	1				
255	HK-77-2	ROT	USGS OF 78-540	-108.07711	38.89339	25	13 S	96 W	7390	7179	16.5	16.5	4	4.5	3					12	1						
256	05-077-05022	O&G	HAMMONDS-US MORAN 26-1	-108.07447	39.16042	26	10 S	96 W	6007	2844	38.0	38	8	5	3			15	3	18	2						
257	05-045-07050	O&G	BARRETT-GM 34-2	-108.074	39.46114	2	7 S	96 W	5251	-884	53.0	53	11	8	4	9	3	10	2	26	2						
258	05-077-05060	O&G	POOL-COREY 1	-108.07397	39.22814	35	9 S	96 W	6074.7	2104.7	67.0	67	12	3	2	6	2	23	5	20	2	15	1				
259	HK-77-3	ROT	USGS OF 78-540	-108.07283	38.90742	24	13 S	96 W	7660	6963.5	23.5	23.5	9	9	7			5.5	1	9	1						
260	05-077-05029	O&G	HAMMONDS-JOHNSON #23-1	-108.07197	39.17503	23	10 S	96 W	5703	2613	52.0	52	11	12	6	6	2	4	1	14	1	16	1				
261	05-077-08363	O&G	TETON-BULL BASIN 1-3	-108.07061	39.11964	1	11 S	96 W	8014	3427	54.0	54	13	11	7			20	4	7	1	16	1				
262	05-077-08004	O&G	GASCO-WALKER #1	-108.06828	39.20094	11	10 S	96 W	6096	2402	31.0	31	10	8	5	6	2	8	2	9	1						
263	05-077-08104	O&G	NORRIS-CURRIER 14-2	-108.06725	39.19333	14	10 S	96 W	5420	2450	48.0	48	16	15	8	9	3	24	5								
264	05-077-08286	O&G	SKYLINE-HITTLE DUCRAY 3	-108.06583	39.22	2	10 S	96 W	6066	2166	42.0	42	14	10	5	15	5	17	4								
265	05-045-07056	O&G	BARRETT-GM 13-1	-108.06444	39.46528	1	7 S	96 W	5542	-1086	47.0	47	11	8	5	3	1	8	2	28	3						
266	05-077-08068	O&G	NORRIS-NORRIS 25-3	-108.05617	39.16428	25	10 S	96 W	6552	2702	37.0	37	13	10	6	9	3	18	4								
267	LEE-MS-2(20)	MS	USGS BULL 510	-108.05472	38.91111	19	13 S	95 W			19.5	19.5	3					9	2	10.5	1						
268	05-077-05028	O&G	LA CIMA-MILLHOLLAND SR 1	-108.0525	39.17333	24	10 S	96 W	6326	2558	42.0	42	11	8	4	3	1	23	5	8	1						
269	FAIRLAMB75-2	ROT	USGS OF 79-327	-108.0525	38.91992	18	13 S	95 W	7670	6674.5	40.5	40	10	8.5	6			10	2	21.5	2						
270	05-077-08098	O&G	FLYING D-MIL25-1	-108.05111	39.15494	25	10 S	96 W	6700	2828	27.0	27	7	6	4			11	2	10	1						
271	05-077-05050	O&G	EL PASO-RUSHMORE FED 1	-108.05092	39.22172	1	10 S	96 W	6063	2078	56.0	56	9	2	1	6	2	14	3	19	2	15	1				
272	05-077-08091	O&G	FLYING DMND-NICHOLAS13-1	-108.05083	39.18078	13	10 S	96 W	5835	2404	44.0	44	18	11	8	21	7	12	3								
273	05-077-08532	O&G	ALTA-DOLLEY 36-1	-108.05053	39.22639	36	9 S	96 W	6006	2022	51.0	51	13	12	7	6	2	4	1	29	3						
274	05-077-08135	O&G	NORRIS-FINCH 13-3	-108.04931	39.19353	13	10 S	96 W	5584	2291	49.0	49	16	18	9	3	1	28	6								
275	05-077-05011	O&G	PACIFIC-SMITH 1-C	-108.04617	39.06228	30	11 S	95 W	10191	4126	31.0	31	4	2	1			4	1	25	2						

Data point identification				Data point location						Top Rollins Sandstone Member	Total coal in Cameo-Fairfield coal group	Cameo/Wheeler coal zone — Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	elev. (ft)	(ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
276	05-045-06485	O&G	SUPERIOR-FEDERAL 30-11	-108.044	39.41261	30	7 S	95 W	6137	-348	54.0	54	12	9	6			23	4	22	2						
277	05-077-05033	O&G	APACHE-THOMAS #1	-108.04214	39.18603	18	10 S	95 W	5970	2270	38.0	38	10	4	2	9	3	25	5								
278	05-077-08090	O&G	FLYING DMND-CURRIER 30-1	-108.04189	39.16297	30	10 S	95 W	6456	2646	45.0	45	15	15	10	3	1	18	3	9	1						
279	05-077-08567	O&G	ROUNDUP-SHEAR 30-4	-108.04106	39.25125	30	9 S	95 W	6212	1617	68.0	68	13	7	4	6	2	9	2	46	5						
280	05-077-08237	O&G	COORS-BOREN 1-7	-108.03947	39.20556	7	10 S	95 W	5553	2119	57.0	57	13	14	8	3	1	5	1	19	2	16	1				
281	05-077-08089	O&G	FLYING DMND-19-3 CURRIER	-108.0385	39.16964	19	10 S	95 W	6355	2530	46.0	46	16	16	9	12	4	18	3								
282	05-077-08411	O&G	EXXON-RODGERS FEDERAL #1	-108.03675	39.22217	6	10 S	95 W	5954	1949	62.0	62	21	26	15	3	1	22	4	11	1						
283	05-045-06763	O&G	BARRETT-MV 43-31	-108.033	39.47578	31	6 S	95 W	5262	-1352	44.0	44	11	11	6	3	1	8	2	9	1	13	1				
284	05-077-08099	O&G	COORS-ACCO/NICHOLS 1-31	-108.03286	39.14244	31	10 S	95 W	7264	2958	41.0	41	11	11	6	3	1	15	3			12	1				
285	HK-77-4	ROT	USGS OF 78-540	-108.03067	38.94147	8	13 S	95 W	6970	6193.5	30.0	30	10	5	3	10	4	7.5	2	7.5	1						
286	05-077-08354	O&G	TETON-KNOX 19-1	-108.02928	39.35444	19	8 S	95 W	6783	243	42.0	42	10	6	4	3	1	21	4	12	1						
287	05-077-08458	O&G	COORS-SWETLAND 1-5	-108.02853	39.12903	5	11 S	95 W	7457	3167	51.0	51	10	6	3	6	2	15	3	8	1	16	1				
288	05-045-06679	O&G	BARRETT-GV 81-5	-108.028	39.47203	5	7 S	95 W	5171	-1311	47.0	47	10	7	5			12	3	12	1	16	1				
289	05-077-08087	O&G	FLYING DMND-1-19 CURRIER	-108.02744	39.17886	19	10 S	95 W	6251	2325	51.0	51	19	22	12	12	4	17	3								
290	05-077-08269	O&G	COORS-BIG CRK CATTLE 2-7	-108.02689	39.20797	7	10 S	95 W	6229	2006	62.0	62	10	8	4	3	1	5	1	30	3	16	1				
291	HK-77-5	ROT	USGS OF 78-540	-108.02661	38.92561	16	13 S	95 W	6760	6414.5	27.5	27.5	7	4.5	4			5	1	18	2						
292	05-045-06685	O&G	BARRETT-GV 39-32	-108.026	39.47828	32	6 S	95 W	5194	-1303	63.0	63	15	12	7	9	3	15	3	11	1	16	1				
293	05-077-08445	O&G	COORS-NICHOLS 1-29	-108.02292	39.15603	29	10 S	95 W	6786	2720	35.0	35	13	12	7	6	2	17	4								
294	05-077-08331	O&G	COORS-NICHOLS 2-5	-108.02275	39.22228	5	10 S	95 W	5664	1877	64.0	64	15	12	6	6	2	26	5	20	2						
295	05-077-08288	O&G	BOW VALLEY-REED 20-3	-108.02236	39.16961	20	10 S	95 W	6458	2506	38.0	38	11	11	7			9	2	18	2						
296	05-077-08511	O&G	COORS-NICHOLS #1-32	-108.022	39.14761	32	10 S	95 W	7097	2837	45.0	45	10	4	2	9	3	13	3	19	2						
297	05-077-08572	O&G	ROUNDUP-SHEAR 20-14	-108.01611	39.25583	20	9 S	95 W	6038	1355	57.0	57	14	14	8	6	2	10	2	27	2						
298	05-077-08193	O&G	BOW VALLEY-WISSEL 17-2	-108.01381	39.18414	17	10 S	95 W	6813	2263	45.5	45.5	8	2	1	6	2	13.5	3	24	2						
299	05-077-08162	O&G	CHANDLER-V. PUETT 15-29	-108.01303	39.24172	29	9 S	95 W	6024	1544	52.0	52	12	9	6	6	2	4	1	33	3						
300	05-045-06677	O&G	BARRETT-GV 40-33	-108.008	39.47772	33	6 S	95 W	5180	-1505	48.0	48	12	10	7	3	1	4	1	31	3						
301	05-045-06413	O&G	NORTHWEST-BATTLEMENT 1	-108.00514	39.45667	9	7 S	95 W	5724	-1126	36.0	34	12	15	9	3	1			16	2					2	1
302	05-045-06668	O&G	BARRETT-GV 48-4	-108.001	39.47211	4	7 S	95 W	5172	-1443	64.0	64	14	8	6	3	1	20	4	33	3						
303	05-077-08110	O&G	FLYING DIAMOND-BIGCRK9-1	-108.00017	39.2	9	10 S	95 W	6268	2026	58.0	58	8	7	4			5	1	13	1	33	2				
304	05-077-08172	O&G	CHANDLER-STITES 15-33	-107.99528	39.22706	33	9 S	95 W	6037	1672	42.0	42	14	13	10			10	2	19	2						
305	05-077-08477	O&G	COORS-WEBB #3-4	-107.99356	39.21236	4	10 S	95 W	6346	1866	62.0	62	19	22	13	9	3	4	1	10	1	17	1				
306	05-029-06007	O&G	PETRO LWIS-HAWKINS 16-10	-107.99133	38.93222	10	13 S	95 W	6497	6292	22.0	22	4			9	3			13	1						
307	CE-77-1	ROT	USGS OF 78-540	-107.98814	38.94811	2	13 S	95 W	6800	5955.5	48.5	48.5	13	5.5	5	5.5	2	19	4	18.5	2						
308	CE-77-2	ROT	USGS OF 79-327	-107.98647	38.93367	11	13 S	95 W	6700	6263.5	42.0	42	14	11.5	9	8.5	3	4.5	1			17.5	1				
309	05-077-08359	O&G	TETON-COLO WATER 15-2	-107.98525	39.19408	15	10 S	95 W	6732	2070	56.0	56	10	4	2	6	2	14	3	32	3						
310	05-077-05042	O&G	MCCULLOCH-WEBB 1	-107.98067	39.21214	3	10 S	95 W	6302	1807	45.0	45	7	5	3	3	1			10	1	27	2				
311	05-077-08111	O&G	TETON-KATHLYN YOUNG 4-15	-107.97522	39.18636	15	10 S	95 W	6950	2112	61.0	61	11	4	3	9	3	9	2	22	2	17	1				
312	05-077-08485	O&G	COORS-MOONEY #2-10	-107.97353	39.20839	10	10 S	95 W	6458	1814	52.0	52	17	24	14			6	1	22	2						
313	05-045-05055	O&G	SOUTHERN UNION-FED 14-95	-107.97164	39.44092	14	7 S	95 W	6834	-1248	28.0	28	7	6	3			14	3	8	1						
314	05-077-08259	O&G	TETON-WALCK 23-2	-107.96789	39.17908	23	10 S	95 W	7028	2204	67.0	67	18	19	10	6	2	19	4	23	2						
315	05-045-06703	O&G	BARRETT-GV 86-2	-107.967	39.46506	2	7 S	95 W	5829	-1551	60.0	56	10	4	2	6	2	20	4	11	1	15	1	2	1	2	1
316	05-077-08424	O&G	EXXON-A.M. KULP 1	-107.96617	39.22958	35	9 S	95 W	6185	1485	53.0	53	8	4	3	3	1	6	1	17	2	23	1				
317	05-077-08369	O&G	TETON-LYONS 14-2	-107.96586	39.19211	14	10 S	95 W	6794	1990	58.0	58	12	10	6			15	3	33	3						
318	DUN-6A	LL	USGS MAP C-116	-107.96194	38.9375	12	13 S	95 W	6470	6145	34.0	34	10	5	5	3	1	17	3	9	1						
319	05-077-08379	O&G	EXXON-C.H. FOUR 1	-107.95758	39.26589	23	9 S	95 W	6541	942	57.0	57	8	8	5					20	2	29	1				
320	05-077-08425	O&G	EXXON-KENNEY ESTATE 1	-107.95486	39.28797	11	9 S	95 W	7029	437	62.0	62	12	6	4	12	4	4	1	22	2	18	1				
321	05-077-08294	O&G	EXXON-OLD MAN MTN #2	-107.9485	39.14869	36	10 S	95 W	7956	2526	41.0	41	9	7	4	3	1	9	2	22	2						
322	05-077-05037	O&G	PAN AM-WALCK 1	-107.94808	39.20761	12	10 S	95 W	6589	1689	66.0	66	15	14	8	6	2	13	2	33	3						
323	05-045-06696	O&G	BARRETT-GV 87-36	-107.943	39.47864	36	6 S	95 W	5344	-2261	66.0	61	9	4	2	6	2	6	1	30	3	15	1	5	3		
324	05-045-06700	O&G	BARRETT-GV 88-1	-107.942	39.46278	1	7 S	95 W	6247	-1894	82.0	70	10	5	3	3	1	10	2	35	3	17	1	10	4	2	1
325	05-077-08422	O&G	TETON-DAVIS DOLLEY 36-1	-107.9405	39.23989	36	9 S	95 W	6179	1189	68.0	68	12	8	5	9	3	4	1	20	2	27	1				
326	05-077-08243	O&G	TETON-SPARKS 36-4	-107.94003	39.22928	36	9 S	95 W	6294	1312	65.0	65	10	6	3	3	1	19	4	8	1	29	1				
327	05-077-08419	O&G	EXXON-E. GUNDERSON 1	-107.93647	39.25292	25	9 S	95 W	6319	979	59.0	59	13	12	6	6	2	18	3	23	2						
328	05-029-06068	O&G	TXP-YOUNGS CRK,SCOTT19-1	-107.93325	39.00006	19	12 S	94 W	8485	4977	52.0	52	11	6	4	3	1	15	3	28	3						
329	05-077-08219	O&G	TETON-ANDERSON 7-3	-107.92928	39.19956	7	10 S	94 W	6716	1713	61.0	61	11	6	4	3	1	14	3	10	1	28	2				
330	05-077-08218	O&G	TETON-WILLIAMS 18-3	-107.92736	39.18708	18	10 S	94 W	6886	1878	56.0	56	9	7	4			6	1	43	4						

Data point identification				Data point location						Top Rollins Sandstone Member	Total coal in Cameo-Fairfield coal group	Cameo/Wheeler coal zone: Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	elev. (ft)	(ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
331	05-077-05091	O&G	POOLE-DONALD 1	-107.92203	39.27303	18	9 S	94 W	6631	631	55.0	55	4					5	1	24	2	26	1				
332	DUN-7A	LL	USGS MAP C-116	-107.92167	38.93333	8	13 S	94 W	6731	6152	70.0	70	11	7	4	3	1	21	4	8	1	31	1				
333	05-077-05080	O&G	FRED POOL-HUDSON 1	-107.91892	39.25836	19	9 S	94 W	6464	779	52.0	52	9	4	2	3	1	20	4	25	2						
334	05-077-08390	O&G	TETON-ZIEGAL 7-1	-107.91653	39.207	7	10 S	94 W	6773	1548	69.0	69	15	12	7	9	3	9	2	23	2	16	1				
335	05-045-06975	O&G	BARRETT-RM 40-20	-107.913	39.512	20	6 S	94 W	5457	-2482	85.0	62	13	13	8			6	1	43	4			19	8	4	2
336	05-077-08416	O&G	NORRIS-HILL 29-2	-107.90828	39.24383	29	9 S	94 W	6554	894	46.0	46	12	11	7			12	3	8	1	15	1				
337	05-077-05089	O&G	PAN AM-LOWTHER GOVT 1	-107.90322	39.27528	17	9 S	94 W	6822	543	63.0	63	6	2	1	3	1	13	2	10	1	35	1				
338	05-077-07362	O&G	POOLE-MOSS 1	-107.903	39.264	20	9 S	94 W	6530	682	54.0	54	7	4	2			11	2	22	2	17	1				
339	05-077-05017	O&G	WESTERN FRNTR-BIG CRK 1	-107.90175	39.12242	4	11 S	94 W	9464	2856	39.0	39	10	10	5			20	4	9	1						
340	05-077-08461	O&G	BEARTOOTH-COLO LAND #2	-107.90103	39.18581	17	10 S	94 W	7144	1752	60.0	60	14	15	8	3	1	13	3	9	1	20	1				
341	05-077-05075	O&G	FRED POOL-CLYDE 1	-107.90086	39.24764	29	9 S	94 W	6561	800	52.0	52	9	6	3	3	1	14	3	11	1	18	1				
342	05-045-06178	O&G	NORTHWEST EXPL-CLOUGH #2	-107.89703	39.50631	21	6 S	94 W	5289	-2379	86.0	59	15	17	9	3	1	10	2	29	3			20	7	7	4
343	05-045-06721	O&G	BARRETT-GV 9-33	-107.887	39.48522	33	6 S	94 W	5333	-2137	96.0	87	18	17	10			16	3	54	5			2	1	7	3
344	05-029-05031	O&G	APACHE-MICHELSON 2	-107.88661	39.06178	34	11 S	94 W	10133	3903	61.0	61	6	4	2	3	1	5	1	8	1	41	1				
345	05-045-06877	O&G	BARRETT-RULISON DEEP 1	-107.881	39.49072	27	6 S	94 W	5365	-2127	98.0	85	14	12	6	3	1	12	2	42	4	16	1	6	3	7	3
346	05-077-08188	O&G	EXXON-OLD MAN MTN #1	-107.87972	39.13839	33	10 S	94 W	10043	2293	43.0	43	12	12	7	3	1	8	2	20	2						
347	05-045-06009	O&G	ARCO-NORTH RIFLE #1	-107.87942	39.65194	31	4 S	93 W	6488	-866	106.0	39	4	2	1					37	3			48	4	19	4
348	CE-77-3	ROT	USGS OF 79-327	-107.87942	38.93025	15	13 S	94 W	7170	6872	40.5	39	8	3	2			11.5	3	24.5	3						
349	05-077-08598	O&G	FUELCO-FEE E-22-10-94-S	-107.87486	39.17894	22	10 S	94 W	7929	1441	48.0	48	12	8	5	6	2	24	4	10	1						
350	05-045-05078	O&G	S UNION-JUHAN FED 1	-107.86061	39.48639	35	6 S	94 W	5449	-2162	94.0	68	11	6	3	3	1	23	4	10	1	26	2	26	4		
351	05-077-05035	O&G	FRED POOLE-ROBBINS #1	-107.85086	39.20169	11	10 S	94 W	7603	983	72.0	72	9	4	2	6	2	4	1	19	2	39	2				
352	WS-2	ROT	USGS OF 79-327	-107.84956	38.94006	12	13 S	94 W	7020	6722	44.5	44.5	7	3.5	2			18	3	8.5	1	14.5	1				
353	WS-1	ROT	USGS OF 79-327	-107.84942	38.93731	12	13 S	94 W	6960	6793	11.0	11	3	1.5	1			9.5	2								
354	DC77-2	ROT	USGS OF 78-540	-107.8455	38.95172	1	13 S	94 W	7400	6452.5	43.0	43	8	2	2	3	1	4.5	1	33.5	4						
355	05-077-08444	O&G	KENAI-STARNER 26-32	-107.84425	39.25097	26	9 S	94 W	7379	327	66.0	66	11	7	4	3	1	19	4	8	1	29	1				
356	05-077-08345	O&G	TERRA-BRSH CRK MCDAN1-11	-107.84417	39.28978	11	9 S	94 W	7426	-1	68.0	68	9	7	4			5	1	26	3	30	1				
357	05-077-08573	O&G	ROUNDUP-GRIFFITH 14-2	-107.84411	39.28203	14	9 S	94 W	7289	20	69.0	69	9	3	2	3	1	17	3	19	2	27	1				
358	05-045-06731	O&G	BARRETT-GV 20-25	-107.84	39.49317	25	6 S	94 W	6141	-2279	107.0	76	14	16	10					31	3	29	1	22	8	9	3
359	05-045-06702	O&G	BARRETT-GV-15-36	-107.84	39.4855	36	6 S	94 W	6393	-2160	100.0	63	12	9	6			18	3	36	3			27	10	10	3
360	05-077-08043	O&G	MOBIL-BEAR CRK 1-25	-107.83967	39.33339	25	8 S	94 W	8430	-356	74.0	55	6	2	1	3	1	4	1	25	2	21	1	14	6	5	3
361	DC77-1	ROT	USGS OF 78-540	-107.83336	38.93994	7	13 S	93 W	7040	6765.5	37.0	37	7	5	3			7.5	2	9.5	1	15	1				
362	05-077-07360	O&G	ALPINE OIL-GOVT 1	-107.83089	39.18153	24	10 S	94 W	8512	1213	71.0	68	9	6	3	6	2	6	1			50	3			3	1
363	05-045-06046	O&G	MAGUIRE-NORTH RIFLE #3	-107.82444	39.62242	10	5 S	93 W	6001	-2695	98.0	49	7	2	1	6	2	9	2			32	2	22	2	27	9
364	DC77-3	ROT	USGS OF 78-540	-107.8125	38.94261	8	13 S	93 W	6960	6664.5	45.5	45.5	9	5.5	4			10	2	30	3						
365	05-045-06211	O&G	NORWESTERN EXPL-CLOUGH 9	-107.81178	39.54375	7	6 S	93 W	5561	-3439	77.0	38	3					9	2			29	1	27	8	12	3
366	05-077-05026	O&G	EL PASO-LEON CRK 1	-107.79828	39.16478	29	10 S	93 W	9062	1444	37.0	35	5			3	1	11	2	21	2					2	1
367	05-077-05085	O&G	UNION-1 GUNDERSON	-107.78783	39.26881	20	9 S	93 W	7144	-186	73.0	57	5	4	2			6	1	14	1	33	1	16	2		
368	05-077-08295	O&G	EXXON-KENNY CREEK #1	-107.7875	39.11528	9	11 S	93 W	9577	2372	50.0	50	5					9	2	22	2	19	1				
369	DC77-4	ROT	USGS OF 78-540	-107.78089	38.92847	16	13 S	93 W	7480	6942.5	58.5	58.5	9	3.5	2	2.5	1	21.5	5			31	1				
370	05-077-08096	O&G	EXXON-VEGA 1	-107.77047	39.21017	9	10 S	93 W	8167	607	58.0	55	5	2	1	3	1	6	1	13	1	31	1	3	2		
371	DC77-5	ROT	USGS OF 78-540	-107.76669	38.935	10	13 S	93 W	7680	6841	17.5	17.5	2					5	1			12.5	1				
372	MS-RIFLE GAP	MS	USGS OF 82-590;PP 1485	-107.76667	39.62167	7	5 S	92 W				44	5	4	2			10	2			30	1				
373	05-045-06377	O&G	EXXON-RH RANCH #1	-107.76478	39.47953	34	6 S	93 W	6747	-2109	84.0	47	4	3	2					11	1	33	1	23	6	14	4
374	LEE-MS-30	MS	USGS BULL 510	-107.76028	38.91056	23	13 S	93 W			23.5	23.5	4					13.5	3	10	1						
375	05-077-08132	O&G	EXXON-VEGA UNIT 2	-107.75989	39.23128	34	9 S	93 W	8154	54	67.0	54	4					13	2			41	2	9	3	4	2
376	05-077-08179	O&G	EXXON-VEGA UNIT #3	-107.75447	39.20575	10	10 S	93 W	8304	652	79.0	70	8	5	3	3	1	5	1	10	1	47	2	2	1	7	3
377	GR-77-1	ROT	USGS OF 78-540	-107.74156	38.90828	24	13 S	93 W	8310	7282	57.0	57	11	6.5	5			3.5	1	32.5	4	14.5	1				
378	05-077-07331	O&G	UNION-BUZZARD CRK UNIT 2	-107.73917	39.27744	14	9 S	93 W	7310	-264	77.0	63	6	1	1			11	2	24	2	27	1	14	4		
379	05-077-08189	O&G	EXXON-VESA #4	-107.73894	39.23	35	9 S	93 W	8088	-18	67.0	64	6					13	3	8	1	43	2	3	1		
380	05-077-08395	O&G	BV-CARLTON CURRIER 2-1	-107.73472	39.22083	2	10 S	93 W	8052	171	70.0	57	5			3	1	5	1	12	1	37	2	9	4	4	3
381	05-077-08022	O&G	PETR0 LEWIS-CURRIER 7-2	-107.73264	39.30875	2	9 S	93 W	7760	-612	79.0	54	3					6	1			48	2	18	10	7	3
382	05-077-08289	O&G	BOW VALLEY-CURRIER 23-4	-107.73231	39.25658	23	9 S	93 W	7559	-391	63.0	55	5	1	1			4	1	13	1	37	2	4	1	4	2
383	MS-HAAS SECTION	MS	USGS PP 1485	-107.73167	39.61667	17	5 S	92 W				16	2					4	1	12	1			12	1		
384	05-045-05064	O&G	CALIFORNIA-SHAEFFER 1	-107.73083	39.46597	12	7 S	93 W	6223	-1407	86.0	52	5	1	1			7	1	22	2	22	1	30	4	4	3
385	GR-77-2	ROT	USGS OF 78-540	-107.729	38.894	25	13 S	93 W	8120	7591.5	19.5	19.5	2					6	1	13.5	1						

Data point identification				Data point location						Top Rollins Sandstone Member	Total coal in Cameo-Fairfield coal group	Cameo/Wheeler coal zone — Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	elev. (ft)	(ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
386	05-077-05106	O&G	UNION CAL-TGT BZRD CRK 1	-107.72622	39.29658	12	9 S	93 W	7604	-391	61.0	47	2									47	2	14	4		
387	05-045-06053	O&G	ARCO-ARCO,EXXON 1-36	-107.72197	39.48933	36	6 S	93 W	5864	-1586	138.0	82	6	4	2	3	1	4	1			71	2	35	7	21	7
388	05-045-06851	O&G	SNYDER-SHIDELER 25-10	-107.72036	39.41447	25	7 S	93 W	6686	-1368	95.0	80	4			3	1					77	3	15	5		
389	05-045-06954	O&G	SNYDER-COURY#13-16	-107.71758	39.44011	13	7 S	93 W	6329	-965	101.0	59	5	2	1					34	3	23	1	42	11		
390	GR-77-3	ROT	USGS OF 78-540	-107.71325	38.90278	19	13 S	92 W	8230	7308.5	44.0	44	7	1	1	3	1	14	3	7.5	1	18.5	1				
391	05-045-05004	O&G	WACKER-GOVT 1	-107.70861	39.36597	18	8 S	92 W	6945	-1475	62.0	25	2	2	1							23	1	27	4	10	5
392	05-045-07039	O&G	SNYDER-KRK 7-10	-107.70367	39.45919	7	7 S	92 W	6117	-630	105.0	61	4	2	1	3	1					56	2	36	11	8	4
393	05-029-05001	O&G	SUNRAY-COLO FED C-1	-107.69861	39.01908	8	12 S	92 W	9825	4805	81.0	81	10	2	1	3	1	20	4	20	2	36	2				
394	05-077-05097	O&G	EL PASO CONOCO GOVT 1	-107.69756	39.28253	8	9 S	92 W	7665	-115	89.0	70	3					7	1			63	2	15	3	4	1
395	05-077-05108	O&G	APACHE CORP-RUSHMORE 1	-107.69633	39.29686	5	9 S	92 W	7617	-311	87.0	63	2									63	2	18	4	6	2
396	05-045-06419	O&G	KOCH-MOBIL MC 11-20	-107.69303	39.50917	20	6 S	92 W	5605	-1492	105.0	62	3					5	1			57	2	31	7	12	6
397	GR-77-4	ROT	USGS OF 78-540	-107.693	38.896	29	13 S	92 W	8060	7380	47.0	47	7	1	1	2.5	1	15.5	3	11	1	17	1				
398	05-077-07352	O&G	NORDON-GOVT 1	-107.692	39.261	20	9 S	92 W	7610	-141	66.0	54	7	7	4			4	1			43	2	5	3	7	3
399	05-045-06689	O&G	MOBIL-MAMM RANCH T45-20P	-107.68983	39.43017	20	7 S	92 W	6356	-265	77.0	43	5	4	2	3	1			14	1	22	1	31	8	3	1
400	GR-77-5	ROT	USGS OF 78-540	-107.68675	38.90842	20	13 S	92 W	8320	7057.5	56.0	53	11	4.5	4	2.5	1	18.5	4	9	1	18.5	1			3	1
401	05-045-06744	O&G	MOBIL-SAMPLE T65-17P	-107.68581	39.44464	17	7 S	92 W	6187	-133	93.0	60	4	2	1			5	1			53	2	29	8	4	1
402	05-077-08435	O&G	COORS-USA 1-16 SC	-107.67528	39.27861	16	9 S	92 W	7850	40	91.0	68	4	2	1			5	1			61	2	13	3	10	5
403	GR-77-6	ROT	USGS OF 78-540	-107.673	38.896	28	13 S	92 W	8170			27	7	7	4			9.5	2	10.5	1						
404	05-077-08616	O&G	ORYX-ACAPULCO FED HD#1	-107.67281	39.35908	16	8 S	92 W	7437	-626	90.0	41	4					12	2	10	1	19	1	37	8	12	4
405	MS-HARVEY GAP	MS	WARNER(1964);USGS PP1485	-107.66333	39.60333	24	5 S	92 W			89.9	29.4	1									29.4	1	45.5	2	15	2
406	05-045-06723	O&G	MOBIL-O'CONNEL F11X-34P	-107.65969	39.40803	34	7 S	92 W	6583	590	100.0	51	4			3	1	5	1	14	1	29	1	42	8	7	3
407	05-045-06410	O&G	KOCH-FRI PORT 14-22	-107.65494	39.50878	22	6 S	92 W	5755	-1427	93.0	48	4	4	2							44	2	36	9	9	4
408	DUN-2	LL	USGS MAP C-115	-107.65278	38.91694	15	13 S	092 W	8046	6923	74.5	65	8	2	1	3	1	14	3	9	1	37	2	4	2	5.5	3
409	05-077-05150	O&G	EL PASO-HELLS GLCH U 1	-107.64572	39.341	22	8 S	92 W	7126	-154	91.0	57	6					9	2	17	2	31	2	21	3	13	2
410	GR-77-7	ROT	USGS OF 78-540	-107.64269	38.91942	14	13 S	92 W	7460	6796.5	57.0	53.5	12	10.5	6			14	3	17	2	12	1	3.5	3		
411	05-045-06078	O&G	MTN FUEL-FAIRVIEW 1	-107.63997	39.42739	23	7 S	92 W	6343	1203	119.0	69	5	2	1			8	2			59	2	41	11	9	3
412	05-045-06395	O&G	KOCH-FRICK MC 11-26	-107.63603	39.49689	26	6 S	92 W	6030	-1092	92.0	58	5	4	2					8	1	46	2	32	8	2	1
413	05-045-06840	O&G	SNYDER-ROWE 11-7	-107.63111	39.37664	11	8 S	92 W	6780	1096	104.0	59	6	2	1	3	1	4	1			50	3	40	7	5	2
414	05-077-07337	O&G	SUNRAY DX-COLO FED F-1	-107.63075	39.33247	26	8 S	92 W	7504	509	52.0	40	10	6	3	18	6					16	1	8	3	4	2
415	05-077-05111	O&G	PACIFIC-E BUZZRD CRK31-2	-107.62908	39.30747	2	9 S	92 W	7729	279	87.0	55	4							23	2	32	2	22	5	10	2
416	05-077-08545	O&G	CELERON PORTER MT FD35-1	-107.62722	39.23453	35	9 S	92 W	8267	657	95.0	55	3			3	1			8	1	44	1	24	8	16	2
417	05-029-06056	O&G	DYCO-MORRELL #1	-107.62508	38.92969	12	13 S	92 W	7782	6582	61.0	47	12	8	5	3	1	28	5	8	1			8	5	6	2
418	DUN-4	LL	USGS MAP C-115	-107.62483	38.92439	13	13 S	092 W	7676	6728	60.5	60.5	9	2	1	3	1	24.5	5	11	1	20	1				
419	05-045-05049	O&G	MTN STATES-STARBUCK 1	-107.62167	39.42339	25	7 S	92 W	6369	1759	79.0	50	6	3	2			9	2	14	1	24	1	29	6		
420	05-045-05044	O&G	SUN OIL- PHILPOTT 1	-107.62044	39.40828	36	7 S	92 W	6517	1962	86.0	56	5			3	1	10	2	8	1	35	1	30	6		
421	05-077-08575	O&G	AMOCO-RUTH MTN #1	-107.61647	39.18703	13	10 S	92 W	8711	861	97.0	60	7	4	2			9	2	18	2	29	1	21	7	16	5
422	05-029-05000	O&G	UNION-OVERLAND GOV'T 1	-107.61003	39.106	13	11 S	92 W	9421	2631	66.0	44	3	2	1			5	1			37	1	14	4	8	2
423	DUN-5	LL	USGS MAP C-115	-107.60917	38.92917	12	13 S	092 W	8331	6612	62.0	62	10			12	4	19	4	9	1	22	1				
424	05-029-06001	O&G	PAN AM-USA MARVIN WOLF 1	-107.60042	39.12897	6	11 S	91 W	8899	2169	82.0	57	5	2	1			9	2	10	1	36	1	25	3		
425	05-045-07032	O&G	VESSELS-GIBSON GLCH14-19	-107.59883	39.50683	19	6 S	91 W	5833															26	6	7	4
426	DUN-6	LL	USGS MAP C-115	-107.59503	38.92928	7	13 S	091 W	8196	6523	78.0	59	6			6	2	4	1			49	3	15	6	4	1
427	DUN-7	LL	USGS MAP C-115	-107.58858	38.93589	8	13 S	091 W	7720	6446	81.0	54	10			18	6	14	3			22	1	19	4	8	3
428	05-045-06355	O&G	SNYDER-SNYDER JOLLY 1-8	-107.57894	39.53567	8	6 S	91 W	6505	-571	101.0	64	7	4	3			5	1	10	1	45	2	18	7	19	6
429	DUN-8	LL	USGS MAP C-115	-107.5775	38.94933	5	13 S	091 W	7155	6231	68.0	26	3					8	2			18	1	26	4	16	3
430	05-045-06397	O&G	AMOCO-AMOCO JOLLY #1	-107.575	39.52989	17	6 S	91 W	6176	-649	113.0	61	4	1	1							60	3	27	5	25	8
431	05-045-06449	O&G	PIUTE-HOFFMST 15-20-7-91	-107.57361	39.43925	20	7 S	91 W	6739	1883	108.0	74	6	2	1	3	1			18	2	51	2	24	4	10	4
432	05-045-05202	O&G	DERBY ROBERTS-DIV CRK N1	-107.57247	39.41769	29	7 S	91 W	7721	3458	81.0	45	7			6	2	17	4			22	1	28	7	8	3
433	05-077-05164	O&G	SUN-DIVIDE CRK 16A	-107.57242	39.35	20	8 S	91 W	7553	2353	84.0	50	8	2	1	6	2	14	2	28	3			27	5	7	3
434	05-045-65361	O&G	SUN OIL-DIVIDE CREEK 14	-107.56919	39.39869	32	7 S	91 W	7594	4353	77.0	44	8	4	3			23	4			17	1	33	5		
435	G-16	R/C	U.S. STEEL	-107.56544	38.95108	4	13 S	091 W	7340	6231.4	74.4	40.9	5	1	1	3.2	1			20.6	2	16.1	1	19.2	5	12.9	3
436	05-077-05074	O&G	MTN STATES-28-1 GOV'T	-107.56033	39.24308	28	9 S	91 W	9180	1250	94.0	57	6	2	1	3	1	15	3			37	1	35	5	2	1
437	05-077-05177	O&G	SUN-DIVIDE CRK 19	-107.55944	39.36333	16	8 S	91 W	8595	4959	101.0	64	4					5	1	17	2	42	1	35	2	2	1
438	MS-NEW CASTLE	MS	USGS BULL 415	-107.55833	39.56667	36	5 S	91 W			94.0	61	2									61	2	19	2	14	5
439	05-029-05083	O&G	VICTOR DRLG-GOVT #1	-107.55767	39.13117	4	11 S	91 W	8538	169	94.0	62	4					6	1	21	2	35	1	27	5	5	1
440	05-045-05208	O&G	SUN OIL-DIVIDE CRK UNIT	-107.55764	39.37542	9	8 S	91 W	8955	5035	123.0	72	7	4	2			4	1	18	2	46	2	43	4	8	3

Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	Top Rollins Sandstone Member elev. (ft)	Total coal in Cameo-Fairfield coal group (ft)	Cameo/Wheeler coal zone: Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	South Canyon coal zone: Total coal	# beds	Coal Ridge coal zone: Total coal	# beds
Data point identification				Data point location								Net-coal thickness (ft) and number of coal beds in bed-thickness categories															
441	05-077-05175	O&G	SUN- DIVIDE CRK 7	-107.54625	39.36178	15	8 S	91 W	9431	5303	114.0	79	6					16	3	20	2	43	1	7	1	26	3
442	05-045-06461	O&G	ENERGETICS-ENERG30-10FED	-107.54586	39.53853	10	6 S	91 W	6023	64	106.0	65	3							9	1	56	2	18	2	22	9
443	05-045-06036	O&G	MORISON-MUNSON SMITH 1	-107.54244	39.43683	22	7 S	91 W	6914	612	97.0	54	9	4	2			28	5	22	2			30	5	13	3
444	05-045-06273	O&G	ARKLA-MESA FEDERAL 1-10	-107.54103	39.46078	10	7 S	91 W	7084	-512	96.0	58	7	2	1			11	2	29	3	16	1	20	4	18	4
445	05-045-05011	O&G	SUN-DIVIDE CRK 5	-107.54003	39.37333	10	8 S	91 W	9146	5296	120.0	69	8	4	2	3	1	11	2	10	1	41	2	7	2	44	4
446	05-045-06390	O&G	PIUTE ENGY FED 6-27-7-91	-107.54	39.417	27	7 S	91 W	7547	1577	110.0	75	9	6	3	6	2	8	2			55	2	27	4	8	2
447	05-077-05167	O&G	SUN-DIVIDE CRK UNIT 19	-107.53883	39.35261	22	8 S	91 W	9493	5703	79.0	53	9	6	3	6	2	10	2	8	1	23	1	15	2	11	3
448	G-12	R/C	U.S. STEEL	-107.53856	38.94769	3	13 S	091 W	7265	6173	95.7	57	6	4.1	3			7.4	1	9.4	1	36.1	1	24.2	2	12.3	5
449	05-029-06027	O&G	AMOCO-BOWIE UNIT #1	-107.53383	39.01669	15	12 S	91 W	7699	4449	62.0	26	7	5	3	6	2	6	1	9	1			19	5	17	4
450	05-077-05172	O&G	SUN-DIVIDE CRK 4	-107.52956	39.36033	14	8 S	91 W	9509	5659	84.0	52	4					12	2	10	1	30	1	24	3	8	2
451	05-077-05160	O&G	SUN-DIVIDE CRK UNIT 3	-107.52803	39.34694	23	8 S	91 W	9795	5715	101.0	65	13	5	3	12	4	20	3	28	3			7	1	29	5
452	05-045-06127	O&G	MUNSON-MUNSON BOULTON 1	-107.52736	39.43797	23	7 S	91 W	7137	157	80.0	47	9	8	4	6	2	12	2			21	1	22	3	11	4
453	05-045-06213	O&G	TETON-GARFIELD 2 FED26-3	-107.52717	39.41625	26	7 S	91 W	7913	1327	92.0	50	8	6	3			13	3	12	1	19	1	34	4	8	4
454	MS-CORYELL MINE	MS	USGS BULL 415	-107.525	39.5625	32	5 S	90 W				25	2			3	1					22	1	7	1	16.5	3
455	05-077-05362	O&G	SUN-DIVIDE CRK 13	-107.52431	39.30383	2	9 S	91 W	8650	4350	92.0	72	6			3	1	11	2			58	3	17	3	3	1
456	05-077-07356	O&G	DUN-DIVIDE CRK UNIT 11	-107.52422	39.31975	35	8 S	91 W	9480	5910	108.0	67	6					17	3	13	1	37	2	30	3	11	5
457	NOT PROVIDED																										
458	DUN-11	LL	USGS MAP C-115	-107.51931	38.94886	2	13 S	091 W	6469	5949		47	5			6	2	8	2			33	1	16	2		
459	05-077-05135	O&G	SUN-DIVIDE CRK 2	-107.51636	39.33306	26	8 S	91 W	10482	6368	77.0	66	6					18	3			48	3	5	1	6	3
460	05-029-06069	O&G	AMOCO-ELECTRIC MTN U.#1	-107.51167	39.09444	13	11 S	91 W	8216	2854	73.0	32	5					14	3	18	2			29	5	12	4
461	NOT PROVIDED																										
462	05-077-08060	O&G	SUN-DIVIDE CRK 20	-107.50847	39.32453	25	8 S	91 W	10225	6371	67.0	51	5					10	2	8	1	33	2	6	1	10	2
463	DUN-33	LL	USGS MAP C-115	-107.50556	38.96917	36	12 S	91 W	7206	5634	65.0	36	3					11	2			25	1	19.5	4	9.5	2
464	DUN-34	LL	USGS MAP C-115	-107.50167	38.95608	1	13 S	091 W	6894	5828	70.0	39	4	2	1			12	2			25	1	23	4	8	2
465	05-077-05124	O&G	SUN-DIVIDE CRK 17	-107.49658	39.31997	36	8 S	91 W	9887	5504	67.0	55	6	2	2			5	1	8	1	40	2	4	1	8	3
466	DUN-12	LL	USGS MAP C-115	-107.49408	38.95022	1	13 S	091 W	6907	5827	64.0	29	1									29	1	27	5	8	3
467	05-051-06043	O&G	PETRO-FED 1-25-10-91	-107.49297	39.15547	25	10 S	91 W	8195	1925	74.0	45	3	2	1					12	1	31	1	27	8	2	1
468	DUN-37	LL	USGS MAP C-115	-107.4875	38.89444	30	13 S	90 W	7864	6808	87.0	47	4					6	1	16	2	25	1	35	5	5	1
469	DUN-38	LL	USGS MAP C-115	-107.48694	38.88667	30	13 S	90 W	8044	7066	83.0	48	5	2	1			13	2	9	1	24	1	30	2	5	1
470	DUN-36	UND	USGS C-115	-107.48658	38.90117	19	13 S	90 W	7076	6595	80.0	47	6	2	2			16	3			29	1	33	6		
471	05-077-07357	O&G	CLARK-#1 FEDERAL	-107.48556	39.27722	18	9 S	90 W	8081	4271	97.0	68	8	1	1	3	1			64	6			22	4	7	3
472	05-051-06008	O&G	RALSTON-PETRLWS 11-90-7	-107.48417	39.12028	7	11 S	90 W	8181	2389	74.0	40	6	3	2	3	1	4	1	8	1	22	1	22	6	12	5
473	05-051-06009	O&G	RALSTON-FED 31	-107.47939	39.14411	31	10 S	90 W	7901	2165	73.0	45	3	2	1					12	1	31	1	23	4	5	2
474	LEE-MS-47	MS	USGS BULL 510	-107.4775	38.86167	5	14 S	90 W			54.0	27	7	3	2	3	1	21	4					10	1	16	2
475	NOT PROVIDED																										
476	DUN-40	LL	USGS MAP C-115	-107.47111	38.86278	5	14 S	90 W	8109	7174	76.0	33	6			6	2	10	2	17	2			29	2	14	2
477	NOT PROVIDED																										
478	NOT PROVIDED																										
479	S-01	COR	U.S. STEEL	-107.46992	38.94272	5	13 S	90 W	6198.9	5837.5	62.9	38.5	3					5.2	1	9	1	24.3	1	23.5	2		
480	05-051-06024	O&G	PIUTE-COAL BSN10-8-11-90	-107.46944	39.11742	8	11 S	90 W	7918	2506	78.0	40	7	3	2	6	2	12	2			19	1	27	6	11	4
481	05-045-06175	O&G	DOME-BALDY CRK 1-17	-107.46686	39.44708	17	7 S	90 W	7939	-1181	81.0	48	5	4	2					7	1	37	2	11	2	22	7
482	NOT PROVIDED																										
483	05-051-06035	O&G	AMOCO-SUMERSET #2	-107.46544	39.02875	8	12 S	90 W	8515	4089	85.0	40	4			3	1	5	1	10	1	22	1	29	4	16	3
484	05-051-06007	O&G	RALSTON-PETRLWS 11-90-17	-107.46533	39.09867	17	11 S	90 W	8101	2993	55.0	26	8	9	5	3	1	6	1	8	1			16	4	13	5
485	05-045-05056	O&G	CALIFORNIA-1 BALDY CRK U	-107.46442	39.44397	17	7 S	90 W	8011	-1049	70.0	46	3					6	1			40	2	14	3	10	2
486	G-09	COR	U.S. STEEL	-107.46433	38.94542	5	13 S	90 W	6632	5716.6	66.2	29.7	3			5.8	2					23.9	1	18.1	3	15.4	5
487	S-04	COR	U.S. STEEL	-107.46164	38.93492	8	13 S	90 W	6335.2	5938.7	51.6	36.8	3					5	1	8.3	1	23.5	1	14.5	4		
488	05-045-06263	O&G	DOME-BALKY CRK 2-20	-107.4615	39.43528	20	7 S	90 W	8336	-624	63.0	42	4					9	2	10	1	23	1	19	3	2	1
489	DUN-41	LL	USGS MAP C-115	-107.46	38.85611	9	14 S	90 W	8256	7252	77.0	32	5			3	1	15	3	14	1			29	2	16	3
490	LH-2-33	R/C	USBM TP 721	-107.45947	38.87931	33	13 S	90 W	7504	6841.7	74.9	27.6	4	1.1	1			3.6	1	7.9	1	15	1	34.9	6	9.7	2
491	LH-5-33	R/C	USBM TP 721	-107.45758	38.87164	33	13 S	90 W	7636	6962.9	64.5	25.1	5	1.2	1	3.1	1	9.6	2	11.2	1			28.9	3	6.3	1
492	05-051-06021	O&G	AMOCO-SUMERSET #1	-107.45756	39.03128	9	12 S	90 W	8441	4041	87.0	39	4			3	1	5	1	10	1	21	1	30	4	18	2
493	05-051-06010	O&G	RALSTON-RALSTON 10-90-32	-107.45744	39.14203	32	10 S	90 W	7711			9	2			3	1	6	1					23	4	6	4
494	LH-1-33	R/C	USBM TP 721	-107.45739	38.87164	33	13 S	90 W	7643	6959.7	73.7	27.7	5	1	1	3	1	3.7	1	20	2			33.3	6	7.3	3
495	LH-3-4	R/C	USBM TP 721	-107.45667	38.86558	4	14 S	90 W	7765	7009.5	50.0	13.6	4	1.2	1	2.5	1	9.9	2					23	4	12.3	4

Data point identification: Map No.	Point ID	Type	Source	Data point location: Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	Top Rollins Sandstone Member elev. (ft)	Total coal in Cameo-Fairfield coal group (ft)	Cameo/Wheeler coal zone, Net-coal thickness (ft) and number of coal beds in bed-thickness categories: Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	South Canyon coal zone: Total coal	# beds	Coal Ridge coal zone: Total coal	# beds
496	05-045-06280	O&G	DOME-BALDY CRK 3-28	-107.45147	39.41889	28	7 S	90 W	8810	-70	66.0	45	5					5	1	40	4			17	3	4	2
497	S-03	COR	U.S. STEEL	-107.45042	38.93886	9	13 S	90 W	6176.5	5779.8	48.9	34.8	3	2.1	1					7.5	1	25.2	1	12.4	4		
498	05-051-05007	O&G	POOL-HENDERSON 1	-107.4485	39.11806	9	11 S	90 W	7532	3119	35.0	30	6			6	2	15	3	9	1			5	1		
499	05-045-06350	O&G	SNYDER-BARTN PORTIER1-16	-107.44828	39.52381	16	6 S	90 W	6935	317	60.0	47	7	8	4	3	1					36	2	7	2	6	2
500	S-02	COR	U.S. STEEL	-107.44761	38.943	4	13 S	90 W	5775.6	5663.6		38	3			3.4	1			9.3	1	25.3	1				
501	G-05	COR	U.S. STEEL	-107.44758	38.92992	9	13 S	90 W	6120.6	5883.9		34	4	1	1			4.6	1	7.5	1	20.9	1				
502	DUN-50	UND	USGS C-115	-107.44711	38.91706	16	13 S	90 W	7355	6095	77.0	38	3					4	1	10	1	24	1	22	3	16	3
503	DUN-42	LL	USGS MAP C-115	-107.44667	38.83944	16	14 S	90 W	7678	7296		20	3	1	1			4	1			15	1	17	2		
504	DUN-52	UND	USGS MAP C-115	-107.44331	38.89461	28	13 S	90 W	7092	6405	81.0	31	4	4	2	3	1					24	1	34	5	16	4
505	DUN-51	UND	USGS MAP C-115	-107.44272	38.90539	21	13 S	90 W	6765	6222	71.0	35	4			3	1	9	2			23	1	24	2	12	2
506	DUN-43	LL	USGS MAP C-115	-107.4425	38.83167	15	14 S	90 W	8442	7374	79.0	43	3					4	1			39	2	26	2	10	2
507	DUN-44	LL	USGS MAP C-115	-107.4425	38.82056	22	14 S	90 W	8484	7647	78.0	34	3			3	1			8	1	23	1	33	3	11	2
508	05-051-06011	O&G	RALSTON-FED33 (10-90-33)	-107.43794	39.14511	33	10 S	90 W	7561	2645	55.0	31	5	5	3			6	1			20	1	16	3	8	4
509	05-051-06013	O&G	RALSTON-HENDRSN 11-90-10	-107.43764	39.11386	10	11 S	90 W	7550	3377	31.0	25	8	10	5			15	3					6	2		
510	DUN-53	UND	USGS MAP C-115	-107.43675	38.88839	27	13 S	90 W	7597	6442	62.0	21	3	4	2							17	1	28	4	13	3
511	G-03	R/C	U.S. STEEL	-107.43586	38.93347	10	13 S	90 W	6486	5676	62.1	29.9	5	3.7	2	2.4	1			8.9	1	14.9	1	16.9	6	10.5	2
512	05-051-06023	O&G	PIUTE-RAGGED MTN FED16-4	-107.43533	39.18561	16	10 S	90 W	8238	3198	44.0	34	5	3	2	3	1			8	1	20	1	6	2	4	2
513	05-097-05068	O&G	VESSELS-CABOT FED #1	-107.43433	39.30756	4	9 S	90 W	9640	5365	110.0	72	8	2	1	3	1	12	2	32	3	23	1	20	2	18	4
514	05-051-06014	O&G	RALSTON-10-90-34-SW	-107.43203	39.14431	34	10 S	90 W	7490	2726	51.0	30	4	4	2			6	1			20	1	15	1	6	4
515	DUN-57	LL	USGS MAP C-115	-107.43167	38.86	3	14 S	90 W	8292		47.0	13	2					5	1	8	1			27	3	7	2
516	E25A	R/C	U.S. STEEL	-107.43106	38.93803	10	13 S	90 W	7355.8	5606.9	69.2	32	3	1.1	1			5.6	1			25.3	1	20	5	17.2	4
517	LH-4-10	R/C	USBM TP 721	-107.431	38.854	10	14 S	90 W	8041	6905.1	46.2	10.9	4	2.4	2	3.2	1	5.3	1					18.6	3	15.1	5
518	G-08	R/C	U.S. STEEL	-107.43	38.94408	3	13 S	90 W	7690	5495.9	62.1	31.8	3	2.1	1					7.8	1	21.9	1	2	2	24.9	6
519	DUN-56	LL	USGS MAP C-115	-107.42917	38.87139	34	13 S	90 W	8051		77.0	31	6	4	2	3	1	10	2	14	1			35	4	11	2
520	DUN-58	LL	USGS MAP C-115	-107.42889	38.85167	10	14 S	90 W	8156		62.0	22	5			6	2	8	2	8	1			20	2	20	3
521	WSC-04	R/C	WESTERN SLOPE CARBON	-107.426	38.94433	3	13 S	90 W	7940	5467.6	61.0	30.5	2					6.9	1			23.6	1	2.5	2	26.1	7
522	DUN-54	UND	USGS MAP C-115	-107.42544	38.88636	27	13 S	90 W	7955	6443	57.0	18	2	2	1							16	1	20	2	19	5
523	DUN-55	LL	USGS MAP C-115	-107.42539	38.87856	34	13 S	90 W	8114	6587	65.0	18	3			6	2			12	1			33	3	14	2
524	MS-SOUTH	MS	USGS BULL 415	-107.425	39.52667	14	6 S	90 W		3724	96.0	68.5	5					8.5	2	14	1	46	2	18.5	2	9	2
525	05-051-05006	O&G	DELHI/TAYLOR-SPATAFORE 1	-107.425	39.07686	27	11 S	90 W	7459	3724	46.0	16	3			6	2			10	1			19	3	11	3
526	05-045-05012	O&G	CALIFORNIA-WOLF CRK U 3	-107.42483	39.321	34	8 S	90 W	9405	5640	91.0	51	6	2	1	3	1	7	1	18	2	21	1	31	5	9	3
527	G-06	COR	U.S. STEEL	-107.42483	38.92972	10	13 S	90 W	6150	5741.3	51.7	29.9	2					6.6	1			23.3	1	21.6	3		
528	05-077-07370	O&G	VESSELS-BELCO FED #1	-107.42142	39.278	15	9 S	90 W	9505	4953	52.0	39	5			3	1	9	2	10	1	17	1	13	2		
529	05-051-06001	O&G	SUNRAY-S.WOLF CRK UNIT 1	-107.41792	39.22683	34	9 S	90 W	9170	4652	48.0	30	4					17	3	13	1			12	4	6	3
530	05-051-06003	O&G	PETRO LWS-HOTCHKISS 3-11	-107.41686	39.03431	11	12 S	90 W	7043	4173	63.0	37	3			3	1			12	1	22	1	21	4	5	2
531	WSC-02	R/C	WESTERN SLOPE	-107.41572	38.94286	2	13 S	90 W	7666	5593		28.3	2					6.3	1			22	1	20.1	4	15.6	5
532	G-04A	R/C	U.S. STEEL	-107.41497	38.93267	11	13 S	90 W	6188	5718	61.7	31.1	2							7.5	1	23.6	1	30.3	5		
533	05-097-06001	O&G	SUNRAY-WOLF CRK UNIT 7	-107.4135	39.31342	35	8 S	90 W	9937	5792	82.0	53	8			6	2	17	3	30	3			19	1	10	2
534	05-045-06221	O&G	RIO COLO-1 CACTUS VALLEY	-107.41308	39.52011	23	6 S	90 W	6689	2559	84.0	48	11	9	5	6	2	13	3			20	1	8	2	28	6
535	05-097-05014	O&G	UTEX-WOLF CRK UNIT 1	-107.41136	39.33583	26	8 S	90 W	9240	5340	73.0	42	6					28	5			14	1	14	2	17	4
536	WSC-05	COR	WESTERN SLOPE CARBON	-107.41078	38.93817	11	13 S	90 W	6048	5612.3	56.1	28.2	4	1.2	1			13.1	2	13.9	1			27.5	5	0	0
537	WSC-07	COR	WESTERN SLOPE CARBON	-107.40692	38.93883	11	13 S	90 W	6037	5602.5	44.4	27	4	1.1	1			13.2	2	12.7	1			17.4	4		
538	05-045-06511	O&G	TRW-S.CANYON KRENGER #1	-107.40678	39.50436	26	6 S	90 W	7142	942	89.0	46	8	3	2	6	2	9	2	10	1	18	1	10	2	33	11
539	05-097-06002	O&G	SUNRAY-WOLF CRK UNIT #8	-107.40675	39.30364	2	9 S	90 W	10250	5930	63.0	33	6	2	1	3	1	19	3	9	1			22	2	8	2
540	WSC-22	COR	WESTERN SLOPE CARBON	-107.40633	38.94486	1	13 S	90 W	7944.8	5496.5	69.1	27.6	4	1.3	1			13.1	2	13.2	1			26.8	5	14.7	3
541	05-097-05015	O&G	CALIFORNIA-WOLF CRK UNIT	-107.40589	39.34883	23	8 S	90 W	9539	4384	66.0	46	5					13	2	15	2	18	1	10	2	10	3
542	WSC-01	R/C	WESTERN SLOPE	-107.40544	38.93592	12	13 S	90 W	6530	5647	73.6	29.9	4	1.2	1			7.3	1	21.4	2			29.8	5	14	4
543	05-097-05013	O&G	SUNRAY-WOLF CRK UNIT 4	-107.40197	39.32475	26	8 S	90 W	9630	5830	67.0	43	10	4	2	12	4	9	2	18	2			17	4	7	2
544	WSC-08	COR	WESTERN SLOPE CARBON	-107.39856	38.94269	1	13 S	90 W	5984	5551.7	59.2	33.5	3					6.8	1	12	1	14.7	1	23.9	3	1.3	1
545	05-097-06003	O&G	SUNRAY-WOLF CRK UNIT 9	-107.39294	39.31383	36	8 S	90 W	10172	6042	68.0	45	6	4	2			13	2	8	1	20	1	18	3	5	2
546	05-097-05069	O&G	SUNRAY-WOLF CRK UNIT #6	-107.38778	39.28883	12	9 S	90 W	10038	6018	54.0	37	3					4	1	14	1	19	1	13	2	4	1
547	05-097-05067	O&G	SUNRAY-WOLF CRK UNIT #5	-107.38556	39.30428	1	9 S	90 W	10294	5936	60.0	35	4			3	1	6	1	11	1	15	1	11	2	14	4
548	05-051-06026	O&G	DYCO-FANSLER #7-1	-107.38289	38.93789	7	13 S	89 W	6255	5565	46.0	32	5	2	1			12	2	18	2			4	1	10	4
549	05-097-06004	O&G	PRENALTA-GOVT 12-7-9-89C	-107.37425	39.28906	7	9 S	89 W	9892	6018	45.0	33	5	4	2			9	2			20	1	6	2	6	2
550	LH-24-7	R/C	USBM BULL 501	-107.37036	38.93972	7	13 S	89 W	6266	5683.1	8.7	2.8	2	2.8	2									2	1	0	0

Data point identification				Data point location						Top	Total coal	Cameo/Wheeler coal zone												South Canyon coal zone		Coal Ridge coal zone	
										Rollins Sandstone	in Cameo-Fairfield	Net-coal thickness (ft) and number of coal beds in bed-thickness categories															
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	Member elev. (ft)	coal group (ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
551	05-051-06042	O&G	YOUNG UNITED-JACOBS 29-1	-107.36667	39.07694	29	11 S	89 W	6994															6	1	8	4
552	ELLIS-106/59/35	MS	USGS MAP C-97-B	-107.365	39.21	4	10 S	89 W			48.5	28	1									28	1	13	2	7.5	4
553	DUN-76	LL	USGS MAP C-115	-107.36131	39.14925	31	10 S	89 W	9060	6508	47.0	21	2	2	1							19	1	18	2	8	1
554	ELLIS-104/57/33	MS	USGS MAP C-97-B	-107.36111	39.22528	32	9 S	89 W			49.0	18.5	3					10.5	2	8	1			7	2	23.5	10
555	05-051-06038	O&G	AMOCO-MEGAS #1	-107.36036	39.00033	20	12 S	89 W	6565	4285	37.0	16	3	1	1	3	1			12	1			19	3	2	1
556	LH-7-8	R/C	USBM BULL 501	-107.35786	38.94072	8	13 S	89 W	6276	5557	14.0	8.1	3	3.8	2			4.3	1					3.9	3	0	0
557	05-051-05005	O&G	DELHI/TAYLOR-MCLAUGHLIN1	-107.35778	39.00883	17	12 S	89 W	6766	4200	37.0	19	2					5	1	14	1			16	3	2	1
558	DUN-62	O&G	USGS MAP C-115	-107.35556	38.99917	20	12 S	89 W	6530	4283	31.0	12	1							12	1			17	4	2	1
559	DUN-78	LL	USGS MAP C-115	-107.35	39.15222	32	10 S	89 W	9530	7254	51.0	21	3					5	1	16	2			24	3	6	1
560	LH-11-9	R/C	USBM BULL 501	-107.34992	38.92189	9	13 S	89 W	6385	5648.8	18.2	12	4	2.8	2	2.9	1	6.3	1					2.4	1	0	0
561	KENT MS-9	MS	USGS OF 80-709	-107.34989	39.19494	17	10 S	89 W			54.1	23.1	3					8.8	2			14.3	1	15	2	16	9
562	DUN-60	LL	USGS MAP C-115	-107.34908	39.14272	32	10 S	89 W	9040	6550	47.0	20	2	2	1							18	1	22	2	5	1
563	DUN-MS-59	MS	USGS MAP C-115	-107.34833	39.18972	17	10 S	89 W		-740	65.0	32	1									32	1	25	2	8	1
564	LEE-MS-71/69/68	MS	USGS BULL 510	-107.34833	38.7775	4	15 S	89 W		-740	56.4	29.2	5	2.7	2			3.5	1	7.5	1	15.5	1	21.2	2	6	1
565	LH-22-4	R/C	USBM BULL 501	-107.34714	38.94406	4	13 S	89 W	6304	5408.8	16.5	12.9	5	5.4	3	2.8	1	4.7	1							0	0
566	05-045-06500	O&G	TRW-SUNLIGHT FED #2	-107.34317	39.4065	32	7 S	89 W	8421	3564	72.0	29	4					10	2	19	2			3	1	40	14
567	LH-6-16	R/C	USBM BULL 501	-107.34275	38.9275	16	13 S	89 W	6358	5655.1	24.4	18.5	4	1.5	1			17	3					4.2	2	0	0
568	LH-23-4	R/C	USBM BULL 501	-107.34083	38.95322	4	13 S	89 W	6348	5189	12.3	10.1	4	4.4	3			5.7	1								
569	DUN-79	LL	USGS MAP C-115	-107.33717	39.15242	33	10 S	89 W	9640	7638	36.0	19	4	4	2			7	1	8	1			13	2	4	1
570	LH-19-28	R/C	USBM BULL 501	-107.33597	38.89428	28	13 S	89 W	6560	6077.2	18.2	15.6	3	1.7	1	2.8	1			11.1	1			2.4	1		
571	LH-8-9	R/C	USBM BULL 501	-107.33514	38.93311	9	13 S	89 W	6447	5483.8	25.2	19.3	3					11.8	2	7.5	1			2.4	2	0	0
572	LH-16-21	R/C	USBM BULL 501	-107.33397	38.91314	21	13 S	89 W	6440	5803	19.0	16	2			3.2	1					12.8	1			0	0
573	LH-9-16	R/C	USBM BULL 501	-107.33381	38.92189	16	13 S	89 W	6400	5662	17.7	16	3	1.4	1			7.4	1	7.2	1					1.5	1
574	LH-18-21	R/C	USBM BULL 501	-107.33353	38.90431	21	13 S	89 W	6500	5930	18.5	14.8	3	1.6	1	3	1			10.2	1			3.1	1		
575	ELLIS-111/63/43	MS	USGS MAP C-97-B	-107.33167	39.17361	21	10 S	89 W			32.0	19	3					9.5	2	9.5	1			2	1	11	2
576	LH-14-15	R/C	USBM BULL 501	-107.32722	38.91856	15	13 S	89 W	6534	5653.1	23.2	17.6	3	3.1	2							14.5	1	1.5	1	2.4	2
577	KENT MS-2	MS	USGS OF 80-709	-107.3245	39.40547	33	7 S	89 W			76.5	38	6	2	2			4	1	32	3					38.5	7
578	LH-12-10	R/C	USBM BULL 501	-107.32394	38.93508	10	13 S	89 W	6492	5339.8	22.4	16.9	4	1	1			15.9	3					3.8	3	1	1
579	LH-27-3	R/C	USBM BULL 501	-107.323	38.943	3	13 S	89 W	7375	5194.5	18.2	13.6	4	3.4	2			10.2	2					3.2	2	0	0
580	DUN-68	LL	USGS MAP C-115	-107.32167	38.8625	3	14 S	89 W	7236	6419	24.5	13.5	3	2	1	2.5	1			9	1					11	2
581	05-045-06532	O&G	TRW-NTCA #1	-107.32131	39.36861	10	8 S	89 W	8425	6139	53.0	23	6	3	2			20	4							30	11
582	ELLIS-100/99/54	MS	USGS MAP C-97-B	-107.32	39.22889	34	9 S	89 W			46.0	7	3	2.5	2			4.5	1					3	1	36	11
583	LM-1	R/C	LARSON MINING CO.	-107.31972	39.3175	34	8 S	89 W	7796		26.4	19.6	5	2.8	2	2.5	1	5.1	1	9.2	1					6.1	3
584	LH-15-22	R/C	USBM BULL 501	-107.31953	38.91344	22	13 S	89 W	6650	5658.6	19.7	18.1	2			2.8	1					15.3	1			0	0
585	LM-3	COR	USGS MAP C-97B;91	-107.31683	39.26686	15	9 S	89 W	8881	6866	22.7	4.2	2	4.2	2											14.5	4
586	LH-20-15	R/C	USBM BULL 501	-107.316	38.924	15	13 S	89 W	7635	5456.7	21.9	17.2	2					4.3	1	12.9	1			2.6	2	1	1
587	KENT MS-3	MS	USGS OF 80-709	-107.31456	39.37011	10	8 S	89 W			32.0	12	4	4	2			8	2							20	7
588	LEE-MS-64	MS	USGS BULL 510	-107.31278	38.81083	26	14 S	89 W			40.5	16.1	3					16.1	3					6	1	18.4	3
589	LH-13-11	R/C	USBM BULL 501	-107.31225	38.93856	11	13 S	89 W	6530	5194.6	23.5	18.3	3					10.7	2	7.6	1			1.7	1	1.2	1
590	CR-3	R/C	USGS MAP C-97-B;18,84	-107.31189	39.28883	10	9 S	89 W	8194	6471.9	26.3	10.8	3	3.9	2			6.9	1							12.6	3
591	CR-4	R/C	USGS MAP C-97-B;19,87	-107.31172	39.27825	15	9 S	89 W	8556	6847.8	26.4	9.1	3	2	1	2.6	1	4.5	1							16	5
592	DUN-69	LL	USGS MAP C-115	-107.31111	38.84917	11	14 S	89 W	7600	6518	20.0	11	5	5.5	3	5.5	2									9	2
593	CR-1	COR	USGS MAP C-97-B;13,79	-107.31083	39.31511	34	8 S	89 W	7781		55.8	18.6	5	3.4	3			5.2	1	10	1					36.5	10
594	LH-17-23	R/C	USBM BULL 501	-107.30906	38.90922	23	13 S	89 W	6740	5596.4	24.7	18.8	3	3.2	2							15.6	1	2.2	1	0	0
595	KENT MS-4	MS	USGS OF 80-709	-107.30833	39.31917	34	8 S	89 W			49.1	18.1	3					10.1	2	8	1					30	6
596	ELLIS-MS-129	MS	USGS MAP C-97-B	-107.30806	39.07333	26	11 S	89 W			13.0															13	4
597	KENT DH-3	UND	USGS OF 80-507	-107.30753	39.30978	34	8 S	89 W	8697	6916	27.0	11	3	1	1	3	1			7	1					16	8
598	CR-10	COR	USGS MAP C-97-B;15,81	-107.30753	39.301	3	9 S	89 W	8497	6923.7	32.4	12.4	3	1.3	1	2.7	1			8.4	1					19.3	8
599	KENT MS-5	MS	USGS OF 80-709	-107.30689	39.29719	3	9 S	89 W			35.5	13	3	1	1			4	1	8	1					22.5	10
600	KENT MS-8	MS	USGS OF 80-709	-107.30472	39.22239	2	10 S	89 W			27.7	8	3	2	1	6	2							4	1	15.2	6
601	LH-25-14	R/C	USBM BULL 501	-107.304	38.922	14	13 S	89 W	7540	5360.2	22.2	15.2	2	1.7	1					13.5	1			5.3	3	0	0
602	ELLIS-DH-95/24	ROT	USGS MAP C-97-B	-107.30333	39.24	26	9 S	89 W		-1327.5	28.5	7.5	3	3	2			4.5	1							21	7
603	DUN-71	LL	USGS MAP C-115	-107.30167	38.79861	35	14 S	89 W	8562	8201.5	20.5	13.5	4	3.5	2			10	2					3	1	4	1
604	DUN-72	LL	USGS MAP C-115	-107.3	38.78917	35	14 S	89 W	8854	8282	26.0	13	2			3	1			10	1			5	2	8	3
605	LH-21-23	R/C	USBM BULL 501	-107.29878	38.90811	23	13 S	89 W	6940	5497.7	18.7	14.7	2	2	1					12.7	1			2.1	2	0	0

Data point identification				Data point location						Top Rollins Sandstone Member	Total coal in Cameo-Fairfield coal group	Cameo/Wheeler coal zone: Net-coal thickness (ft) and number of coal beds in bed-thickness categories												South Canyon coal zone		Coal Ridge coal zone	
Map No.	Point ID	Type	Source	Longitude	Latitude	Sec.	Township	Range	Kelly bsh elev. (ft)	elev. (ft)	(ft)	Total coal	# beds	1.0-2.3	# beds	2.3-3.5	# beds	3.5-7	# beds	7-14	# beds	>14	# beds	Total coal	# beds	Total coal	# beds
606	ELLIS-DH-92/22	ROT	USGS MAP C-97-B	-107.29833	39.25639	23	9 S	89 W		-1251	20.5	2.5	2	2.5	2											18	7
607	ELLIS-113/64/45	MS	USGS MAP C-97-B	-107.29833	39.16972	21	10 S	89 W		-1251	26.0	11	1							11	1			4.5	2	10.5	3
608	KENT MS-6	MS	USGS OF 80-709	-107.29725	39.28414	11	9 S	89 W			25.3	8.5	3	2	1	2.5	1	4	1							16	5
609	KENT MS-7	MS	USGS OF 80-709	-107.29558	39.266	14	9 S	89 W			34.3	15.1	2	2.1	1					13	1					17	7
610	ELLIS-117/66/49	MS	USGS MAP C-97-B	-107.29083	39.17361	23	10 S	89 W			15.5	7.5	2			3	1	4.5	1					3.5	1	4.5	1
611	ELLIS-MS-128	MS	USGS MAP C-97-B	-107.29	39.07667	25	11 S	89 W			5.0															5	3
612	ELLIS-MS-118/50	MS	USGS MAP C-97-B	-107.27833	39.1675	24	10 S	89 W				11	2			3	1			8	1					24	1
613	ELLIS-MS-127	MS	USGS MAP C-97-B	-107.27	39.08389	20	11 S	88 W			5.0															5	1
614	KENT MS-10	MS	USGS OF 80-709	-107.26444	39.1425	31	10 S	88 W			17.3	6.3	3	3.3	2	3	1							1	1	10	5
615	GASKILL-MS-1	MS	USGS MAP GQ-1604	-107.24917	38.99333	29	12 S	88 W			7.1																
616	ELLIS-MS-123	MS	USGS MAP C-97-B	-107.2475	39.12917	5	11 S	88 W			7.0																
617	ELLIS-MS-126	MS	USGS MAP C-97-B	-107.24417	39.085	19	11 S	88 W			4.0																
618	ELLIS-MS-124	MS	USGS MAP C-97-B	-107.20556	39.10944	10	11 S	88 W			1.0																
619	ELLIS-MS-125	MS	USGS MAP C-97-B	-107.195	39.09	23	11 S	88 W			5.0																
620	LEE-MS-125	MS	USGS BULL 510	-107.07139	38.93917	12	13 S	87 W			3.0																
621	LEE-MS-123	MS	USGS BULL 510	-107.03722	38.90333	20	13 S	86 W			4.0																
622	LEE-MS-122	MS	USGS BULL 510	-107.02583	38.90056	29	13 S	86 W			6.0																
623	LEE-MS-127	MS	USGS BULL 510	-107.02167	38.91472	20	13 S	86 W			11.0																
624	GASKILL-MS-4	MS	USGS MAP GQ-1604	-107.00667	38.775	4	15 S	86 W			14.0																
625	LEE-MS-121	MS	USGS BULL 510	-107.00444	38.89139	28	13 S	86 W			10.0																
626	LEE-MS-115	MS	USGS BULL 510	-106.97778	38.84972	11	14 S	86 W			26.8																
627	LEE-MS-117	MS	USGS BULL 510	-106.97528	38.85611	11	14 S	86 W			23.7																

Appendix 2—Summary of Coal Quality

Appendix 2 provides ranges of ash yield, sulfur content, and calorific values for coal in prominent coal fields within the southern part of the Piceance Basin. The first table in this appendix summarizes values by coal zone and coal field, based reported analyses of Toenges and others (1949, 1952), Hornbaker and others (1976), Murray and others (1977), and Tremain and others (1995) and includes analyses in the U.S. Geological Survey USCHEM database that were provided by R.H. Affolter (written commun., 1998). The remaining tables provide coal quality data as reported in the USCHEM database and the other cited publications, and assigns the beds to coal zones used in this report. Some of the analyses have been cited in several publications as well as the USCHEM database.

Summary of ash yield, sulfur content, and calorific values for coal zones in coal fields of the southern Piceance Basin based on an as-received analyses reported by Toenges and others (1949, 1952), Hornbaker and others (1976), Murray and others (1977), Tremain and others (1995), and as-received analyses in the U.S. Geological Survey USCHEM database provided by R.H. Affolter (written commun., 1998).

Coal field	Coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
	Carbonera	7.2-17.4	0.4-0.8	9,940-11,150
Book Cliffs	Cameo	5.2-15.5	0.5-1.3	10,410-12,460
	Anchor and Palisade	4.9-17.4	0.5-1.7	10,710-13,560
Grand Mesa	Cameo	2.1-23.3	0.4-2.2	8,300-13,490
	Palisade	7.4	1.7	12,330
Somerset (west part)	Coal Ridge and South Canyon	4.3-13.9	0.3-0.8	8,160-10,610
	Cameo-Wheeler	2.4-13.5	0.4-0.8	9,820-12,600
Somerset (east part)	Coal Ridge and South Canyon	2.7-29.9	0.3-1.7	10,230-13,450
	Cameo-Wheeler	2.4-25.9	0.4-3.2	9,220-14,380
Crested Butte	middle and upper	3.2-9.1	0.4-1.9	11,080-14,440
Carbondale (Coal Basin area)	South Canyon	3.4-10.0	0.3-1.5	12,470-15,190
	Wheeler	3.4-9.7	0.4-1.5	12,610-15,090
	Coal Ridge	6.0-8.3	0.5-0.7	13,030-14,310
Carbondale (north of Coal Basin)	South Canyon	5.1	0.5	13,250
	Wheeler	3.5-16.2	0.6-2.1	10,160-13,740
	Palisade	2.1-9.2	0.5-1.4	10,360-12,310
	Keystone	5.4-9.2	0.3-0.4	11,020-13,120
	South Canyon	3.9-7.9	0.4-0.7	11,290-13,270
Grand Hogback	Wheeler	4.9-11.3	0.3-0.8	11,220-13,120
	Palisade	3.7	0.6	11,970
	uncorrelated beds	3.1-10.4	0.4-0.9	11,440-12,700

Ranges of ash yield, sulfur content, and calorific values for coal in the southern part of the Piceance Basin; based on values in the U.S. Geological Survey USCHEM database provided by R.H. Affolter (written commun., 1998). Page 1 of 2.

Coal bed and sample number in the U.S. Geological Survey USCHEM database	Coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
Book Cliffs coal field				
unnamed bed (D216400)	Carbonera	17.4	0.8	9,940
unnamed beds D216401-D216404)	Cameo	8.1-12.6	0.6-0.7	10,710-11,260
unnamed beds (D216410-D216414) **[see footnote 1]**	Anchor	9.8-16.9	0.5-1.2	10,710-11,600
Grand Mesa coal field (west part, between Colorado River and Kahnah Creek)				
Cameo B bed (D180095 and D184656), unnamed beds (D203083-D203088) **[see footnote 2]**	Cameo	7.3-23.3	0.5-2.2	9,060-13,490
Grand Mesa coal field (east part, along south flank of the Grand Mesa)				
unnamed beds (D191607, D194454-D194456, D203089-D203099, D203106-D203112) **[see footnote 3]**	Cameo	5.5-18.7	0.4-1.6	8,300-11,420
Somerset coal field (west part , between Leroux Creek and the town of Bowie)				
unnamed beds (D194452, D194453, D194457, D203113-D203121) **[see footnote 4]**	Cameo	3.2-11.7	0.4-0.8	9,820-11,340
Somerset coal field (east part, east of the town of Bowie)				
Wild (D216415, D216422-D216426); D (D177516, D177517, D177526, D216416, D216427); E (D177502, D177506, D177515, D177525, D177530, D184652, D184653, D216420); and F (177501, D177505, D177509, D177514, D177524, D177528)	Coal Ridge and South Canyon	2.7-29.9	0.5-1.3	10,410-13,450
A (D177523, D177532, D216431); B (D177504, D177508, D177511, D177519, D184647); Lower B (D216419, D216430); Upper B (D216418, D216429); and C (D177518, D177527, D184650, D216417, D216428)	Cameo-Wheeler	5.2-25.9	0.4-1.3	9,220-13,670

1 D216400-D216404 and D216410-D216414 were collected from core from USGS drill hole CBBC-1; location is provided in appendix 1.

2 D180095 and D184656 were collected from the Cameo B bed in the E 1/2 of sec. 34, T. 10 S., R. 98 W at the C.M.C. mine. D203083-D203086 were collected from USGS drill hole CA-77-2; D203087 and D203088 were collected from USGS drill hole IP-77-1. Drill hole locations are provided in appendix 1 and geophysical logs are provided by Eager (1978).

3 D191607 was collected at the Landerth mine. D194454-D194456 were channel samples. The following samples were collected from core retrieved from USGS drill holes shown in parenthesis and drill hole locations are provided in appendix 1: D203089 and D203090 (IP-77-2), D203091-D203094 (HK-77-1), D203095 (HK-77-4), D203096-D203099 (HK-77-2), D203106-D203108 (DC-77-2), and D203109-D203112 (DC-77-3). Geophysical logs form each drill hole are provided by Eager (1978).

4 D194452, D194453, and D194457 were channel samples. The following samples were collected from core retrieved from USGS drill holes shown in parenthesis and drill hole locations are provided in appendix 1: D203113-D203115 (GR-77-3), D203116-D203119 (GR-77-5), D203120 and D203121 (GR-77-1). Geophysical logs form each drill hole are provided by Eager (1978).

Ranges of ash yield, sulfur content, and calorific values for coal in the southern part of the Piceance Basin; based on values in the U.S. Geological Survey USCHEM database and provided by R.H. Affolter (written commun., 1998). Page 2 of 2.

Coal bed and sample number in the U.S. Geological Survey USCHEM database	Coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
	Crested Butte coal field			
C bed (D208586), Cheyenne bed (D208587), unnamed bed (D208588) **[see footnote 5]**	middle	4.4-5.6	0.5-0.6	11,080 (D208586), 14,310-14,440 (D208587, D208588)
	Carbondale coal field (at Coal Basin)			
Dutch Creek bed (D196219 and D196220)	South Canyon	5.7-8.5	0.3-1.3	14,070-14,670
B seam (D184637), Coal Basin B seam (D196221-D196223) **[see footnote 6]**	Wheeler	3.9-7.6	0.4-0.5	14,490-15,090
	Carbondale coal field (approximately 8 miles north of Coal Basin)			
Upper Sunshine bed (D208590)	Coal Ridge	6.0	0.6	14,310
A bed (D208589) **[see footnote 7]**	Wheeler	11.3	0.6	13,450
	Grand Hogback coal field			
E bed (D196214-D196217), Sunnyridge bed (D196218) **[see footnote 8]**	unknown	6.1-10.4	0.4-0.7	12,060-12,580

5 D208586 was collected from the O-C mine No. 2. D208587 and D208588 were grab samples collected at the Horace and Peanut mines, respectively.

6 D184637 was collected at the Dutch Creek No. 1 mine. D196221 and D196222 were collected at the Coal Basin mine. D196223 was collected at the L.S. Wood mine. D196219 and D196220 were collected at the Dutch Creek No. 2 mine.

7 D208590 was collected from the Thompson Creek No. 3 mine. D208589 was collected from the Thompson Creek No. 1 mine.

8 D196214-D196217 were collected at the Eastside mine. D196218 was collected at the Nu-Gap No. 3 mine.

Ranges of ash yield, sulfur content, and calorific values for coal in the southern part of the Piceance Basin modified from Tremain and others (1995). Values were reported on an as-received basis.

Coal beds reported by Tremain and others (1995)	coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
	Book Cliffs coal field			
Carbonera, Cameo, Palisade, Thomas, and Anchor Mine seams	Carbonera, Cameo, Palisade, Anchor	4.9-23.3	0.4-1.7	9,833-13,560
	Grand Mesa coal field			
6-8 beds in Mt. Garfield Formation	Cameo	2.1-17.9	0.5-2.2	8,298-13,489
	Somerset coal field			
Williams Fork Formation (A, B, C, D, E, and F beds)	Cameo-Wheeler, South Canyon, and Coal Ridge	3.2-11.4	0.5-0.8	10,040-13,453
	Crested Butte coal field			
Paonia Member (6 beds)	middle and upper coal zones	3.2-9.1	0.4-1.9	11,400-14,170
	Carbondale coal field			
Dutch Creek, Allen, Anderson	South Canyon	3.4-10.0	0.3-1.3	12,470-15,190
A, B, C, D, Coal Basin A-B	Wheeler	3.4-6.7	0.4-1.5	12,609-15,088
	Grand Hogback coal field			
E, Sunnyridge	undetermined	6.1-10.4	0.6-0.7	12,060-12,581

Ranges of ash yield, sulfur content, and calorific values for coal in the southern part of the Piceance Basin; modified from Murray and others (1977). Ash and sulfur values were reported on an as-received basis. Page 1 of 2.

Coal beds reported by Murray and others (1977)	coal zone (this report)	Ash (%)	Sulfur (%)	Btu (as received)	Btu/lb (MMMF)
	Book Cliffs coal field				
Palisade **[see footnote 1]**	Palisade	9.3	0.9	12,000	13,240
	Grand Mesa coal field (west part, near Colorado River)				
Cameo	Cameo	10.2-11.2	0.6-0.8	11,540-11,840	13,000-13,230
Palisade **[see footnote 2]**	Palisade	7.4	1.7	12,330	13,360
	Grand Mesa coal field (east part, along south flank of Grand Mesa)				
uncorrelated beds, No. 2, Rollins, Rollins No. 1, Green Valley **[see footnote 3]**	Cameo	6.2-12.5	0.6-1.4	10,170-11,030	11,500-11,950
	Somerset coal field (west part: west of the town of Bowie)				
uncorrelated bed and "C" bed **[see footnote 4]**	Cameo-Wheeler	4.3-13.5	0.6-0.7	10,390-12,380	11,940-12,930
	Somerset coal field (east part: east of the town of Bowie)				
"E", Oliver ("D" ?)	Coal Ridge and South Canyon	4.1-7.4	0.5-0.7	12,500-13,100	13,520-13,800
Coal Basin "B" (Juanita "C"), Brookside, "B", "1B", "C", "3C"	Cameo-Wheeler	4.6-9.6	0.4-0.6	12,410-13,400	13,560-14,080
uncorrelated, various **[see footnote 5]**		4.1-10.8	0.5-0.6	12,120-13,200	13,490-14,140

1 The Palisade bed was sampled at the Palisade mine (Murray and others, 1977).

2 The Cameo bed was sampled at Blue Flame, Winger, and Roadside mines and the Palisade bed was sampled at the Midwest Red Arrow mine (Murray and others, 1977).

3 Uncorrelated beds were sampled at the Black Diamond, Green Valley No. 1, Green Valley No. 2, , Raven, , Red Mountain mines; the No. 2 bed was sampled at the Independent No. 2 mine; the Rollins bed was sampled at the Red Canon No. 1 mine; the Rollins No. 1 bed was sampled at the States mine; and the Green Valley bed was sampled at the Tomahawk and Top mines (Murray and others, 1977).

4 The "C" bed and an uncorrelated bed were sampled at the Emmons and Delta W mines, respectively (Murray and others, 1977).

5 The "E" bed was sampled at the Black Beauty, Hawks Nest, Hawks Nest East (No. 2), Hawks Nest West (No. 3), and Oliver No. 3 mines; the Oliver ("D" ?) bed was sampled at the Oliver No. 1 and Oliver No. 2 mines; the Coal Basin "B" (Juanita "C"), "B", "1B", "C", and "3C" beds were sampled at the Bear, Edwards, and Somerset mines; the Brookside bed was sampled at the King mine; and uncorrelated beds were sampled at the Blue Ribbon and King mines (Murray and others, 1977). Coal that was determined to have coking properties include the Coal Basin "B" (Juanita "C") at the Bear mine; the "B" and "C" beds at the Edwards mine; the "E" bed at the Hawks Nest, Hawks Nest East (No. 2), and Hawks Nest West (No. 3) mines; and the "3C" bed at the Somerset mine (Murray and others, 1977).

Ranges of ash yield, sulfur content, and calorific values for coal in the southern part of the Piceance Basin; modified from Murray and others (1977). Ash and sulfur values were reported on an as-received basis. Page 2 of 2.

Coal beds reported by Murray and others (1977)	coal zone (this report)	Ash (%)	Sulfur (%)	Btu (as received)	Btu/lb (MMMF)
		Crested Butte coal field			
Kubler	upper (?)	6.3	0.5	13,510	14,500
uncorrelated beds, Crested Butte, No. 2 (lower Baldwin) **[see footnote 6]**	middle	5.0-7.1	0.4-1.1	11,330-13,350	12,050-14,140
		Carbondale coal field (at Coal Basin)			
Dutch Creek	South Canyon	4.0	1.5	14,576	15,261
Coal Basin B and C **[see footnote 7]**	Wheeler	4.6-9.7	0.5-0.8	13,600-14,680	15,150-15,280
		Carbondale coal field (north of Coal Basin)			
Sunshine	Coal Ridge	7.9-8.3	0.5-0.7	13,030-13,750	14,270-15,020
Anderson	South Canyon	5.1	0.5	13,250	14,000
A, B, uncorrelated	Wheeler	6.7-14.1	0.9-1.3	11,230-13,740	12,020-15,210
A, B, C, Allen, Anderson, Sunshine **[see footnote 8]**	Combined zones	6.4	0.5	14,150	not reported
		Grand Hogback coal field			
Allen,	South Canyon	5.2-5.4	0.5-0.7	11,290-12,625	11,920-13,590
Wheeler,	Wheeler	8.2-10.3	0.5-0.7	11,740-12,490	13,110-13,650
uncorrelated beds **[see footnote 9]**		3.1-9.1	0.5-0.9	11,440-12,700	12,580-13,130

6 The Crested Butte bed was sampled at the Crested Butte mine; the No. 2 (lower Baldwin) bed was sampled at the Alpine mine; the Kubler bed was sampled at the Richardson mine; and uncorrelated beds were sampled at the Baldwin (New), Baldwin Star, Nu-mine, Nu-mine No.2, Ohio Creek No.1, Ohio Creek No. 2 (old) and O.C. No. 2 (new) mines (Murray and others, 1977). Coal that was determined to have coking properties include the Crested Butte bed at the Crested Butte mine, the Kubler bed at the Richardson mine, and uncorrelated beds at the Ohio Creek No.1 and Ohio Creek No. 2 (old) mines (Murray and others, 1977).

7 The Coal Basin B and C beds were sampled at the Bear Creek, Coal Basin, Dutch Creek No. 1, and L.S. Wood mines and the Dutch Creek bed was sampled at the Dutch Creek No. 2 mine (Murray and others, 1977). All beds were reported to have coking properties at the sampled localities (Murray and others, 1977).

8 The Sunshine bed was sampled at the Aspen Gulch and Thompson Creek No. 3 mines; the Anderson bed was sampled at the Marion-Kilroy and Sunlight (Four Mile) mines; the A and B beds were sampled at the Thompson Creek No 1 and No. 2 mines; and uncorrelated seams were collected at the Diamond mine (Murray and others, 1977). Combined analyses were reported from the Sunshine bed, Anderson and Allen beds, and A, B, and C beds at the Spring Gulch mine (Murray and others, 1977).

9 The Allen bed was sampled at the Coryell, New Castle-Vulcan, Rex, and Vulcan mines; the Wheeler bed was sampled at the New Castle and South Canon No. 1 mines; and uncorrelated beds were sampled at the New South Canon, South Canon No. 1, South Canon No. 2, and Zemlock mines (Murray and others, 1977).

Ranges of ash yield, sulfur content, and calorific values for coal in the southern part of the Piceance Basin; modified from Hornbaker and others (1976). Values were reported on an as-received basis.

Coal beds reported by Hornbaker and others (1976)	Coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
	Book Cliffs coal field			
Carbonera seam	Carbonera	7.2-14.4	0.4-0.6	10,470-11,150
Cameo seam	Cameo	5.2-15.5	0.5-1.3	10,410-12,460
Palisade seam	Palisade	4.9-17.4	0.5-1.6	10,950-13,560
Anchor seam at Nearing (Farmer's) mine	Anchor	5.9-9.8	1.0-1.7	11,910-12,330
	Grand Mesa coal field			
"A" to "F", #1, #2	Cameo	2.1-16.1	0.5-1.8	9,360-11,670
	Somerset coal field (western part of field)			
Paonia Shale upper group	Coal Ridge and South Canyon	4.3-13.9	0.3-0.8	8,160-10,610
Bowie Shale lower group	Cameo-Wheeler	2.4-11.4	0.5-0.8	10,040-12,600
	Somerset coal field (eastern part: at and east of the town of Somerset)			
Paonia Shale upper group, "D" or Oliver ,and "E" or Hawks Nest	Coal Ridge and South Canyon	2.8-10.4	0.4-0.9	12,090-13,400
Bowie Shale lower group, "B" (Somerset, Juanita, and King) , and the upper or "C" seam	Cameo-Wheeler	2.8-12.0	0.4-0.7	12,070-13,900
	Crested Butte coal field			
#1-#6, Kubler	middle and upper	3.2-9.1	0.4-1.9	11,400-14,170
	Carbondale coal field (near Coal Basin, includes areas where coal has been effected metamorphism)			
Allen (Sunshine), "B", Palcita, and "Coal Basin" seam	Coal Ridge, South Canyon, and Wheeler	3.4-10.0	0.5-0.7	12,470-15,190
	Carbondale coal field (north of Coal Basin, includes areas where coal was not strongly affected by metamorphism)			
D, Allen, Anderson	South Canyon and Wheeler	1.9-10.5	0.4-1.5	11,840-13,530
A, B, C	Wheeler	3.5-16.2	0.6-2.1	10,160-12,820
Black Diamond seam	Palisade	2.1-9.2	0.5-1.4	10,360-12,310
	Grand Hogback coal field			
Keystone #1-#4	Keystone	5.4-9.2	0.3-0.4	11,020-13,120
Allen seam	South Canyon	3.9-7.9	0.4-0.5	11,600-13,270
Wheeler seam	Wheeler	4.9-11.3	0.3-0.8	11,220-13,120
Black Diamond group	Palisade ?	3.7	0.6	11,970

Ranges of ash yield, sulfur content, and heating values for coal zones in the eastern part of the Somerset coal field based on an as-received analyses reported by Toenges and others (1949, 1952).

[Values are based on samples collected from cores of coal retrieved from 25 drill holes]

Coal beds reported by Toenges and others (1949, 1952)	Coal zone (this report)	Ash (%)	Sulfur (%)	Btu/lb
F, D, E, and unnamed beds	Coal Ridge and South Canyon	2.7-19.6	0.3-1.7	10,230-12,360
lower, middle, upper, A, B, and C	Cameo-Wheeler	2.4-17.4	0.4-3.2	11,060-14,380

Analyses are from core retrieved from drill holes LH-6-16, LH-7-8, LH-8-9, LH-9-16, LH-11-9, LH-12-10, LH-13-11, LH-14-15, LH-15-22, LH-16-21, LH-17-23, LH-18-21, LH-19-28, LH-20-15, LH-21-23, LH-22-4, LH-23-4, LH-24-7, LH-25-14, and LH-27-3 (Toenges and others, 1949), and LH-1-33, LH-2-33, LH-3-4, LH-4-10, and LH-5-33 (Toenges and others, 1952). Locations of the drill holes are provided in Appendix 1.

Appendix 3— Coal Tonnage Tables for Quadrangles, Townships, and Areas of Ownership

Appendix 3 contains tables that report coal resources and other occurrences of coal for each 7.5′ quadrangle and township that is underlain by the Cameo-Fairfield coal group in the southern part of the Piceance Basin, Colorado. Appendix 3 also contains tables that report coal resources and other occurrences of coal by surface and coal ownership. Coal tonnages are reported in overburden categories and in millions of short tons. Reported resource are rounded to two significant figures, and some categories in the resource tables do not equal the sum of their components because of independent rounding. Tonnage was not calculated for coal that might be folded over the flanks of laccoliths or that might be buried beneath laccoliths. Figures showing 7.5′ quadrangle names, township grids, and areas of surface and mineral ownership are provided in Appendix 4.

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by 7.5-minute quadrangle (in millions of short tons). Page 1 of 3.

Quadrangle name	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
Anvil Points						1,200	2,200	3,400
Baxter Pass	150	190	340	250				930
Big Foundation Creek	1	180	700	190				1,100
Big Soap Park	57	4.3						61
Bowie	290	380	780	350	250			2,100
Brushy Point		57	520	560	650			1,800
Bull Fork						580		580
Bull Mountain				39	1,800	3.9		1,900
Calf Canyon		43	430	750	860			2,100
Cameo	92	180	1,000	200				1,500
Carbonera	390	65	48					500
Cattle Creek	65	58	110	120	280	180		810
Cedaredge	300	400	600	440	360			2,100
Center Mountain				0.4	140	2,600	110	2,900
Chair Mountain		0.18	17	330	270			610
Chalk Mountain					1,400	2,800		4,200
Circle Dot Gulch						2,200	14	2,200
Collbran					2,600	890		3,500
Corcoran Peak	89	100	520	230	160			1,100
Corcoran Point	11	6.1	13					29
Cutoff Gulch						370	260	640
Davis Canyon			140	99				240
De Beque				720	2,300			3,000
Desert Gulch					1,400	1,300		2,700
Douglas Pass	15	250	800	270	4			1,300
Dry Creek	310	280	360	390	460			1,800
East Evacuation Creek			460	230				690
Electric Mountain				51	1,500	950		2,500

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by 7.5-minute quadrangle (in millions of short tons). Page 2 of 3.

Quadrangle name	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
Elk Knob			2.1	100	1,700	520		2,300
Figure Four Spring					190	1,300		1,500
Flatiron Mountain				62	2,400	1,400		3,900
Forked Gulch						1,200	1,300	2,500
Garvey Canyon	110	220	900	710	200			2,100
Gibson Gulch					1,800	2,000		3,800
Glenwood Springs	7	7.7	11	3.5				29
Grand Mesa					1,300	1,900		3,300
Gray Reservoir	260	340	700	770	1,200			3,200
Hawxhurst Creek					590	2,500	560	3,700
Hells Kitchen	120	170	330	470	920			2,000
Henderson Ridge				140	2,200			2,300
Highline Lake	0.15							0.15
Hightower Mountain					3.9	3,400	2.5	3,400
Horse Mountain	35	21	43	57	190	150	7.4	500
Housetop Mountain					2,300	1,200		3,500
Howard Canyon	280	200	72					550
Hunter Mesa					880	3,000	1.5	3,900
Indian Point	190	160	430	550	290			1,600
Jim Canyon	92	57	100					250
Juniata Reservoir	12							12
Lands End	0.5	5.3	33	340	1,700			2,100
Leon Peak					1,400	2,400		3,800
Long Point					3,000	470		3,400
Mccarthy Gulch						13	1,100	1,100
Mesa			170	1,900	350			2,500
Mesa Lakes					2,100	500		2,600

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by 7.5-minute quadrangle (in millions of short tons). Page 3 of 3.

Quadrangle name	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
Middle Dry Fork			30	71	1900			2,000
Minnesota Pass	180	120	210	130				640
Molina				360	2,800			3,100
Mount Blaine					420	2,200		2,700
New Castle	120	79	170	150	490	1,200		2,200
North Delta	2.3							2.3
North Mamm Peak						2,600	1,300	3,900
Palisade	25	30	85	110	29			280
Paonia Reservoir		42	240	380	47			710
Parachute					1,000	2,000		3,000
Placita	50	52	210	290	28			620
Point Creek	13	1.5						14
Porter Mountain						3,700		3,700
Quaker Mesa					2,900	300		3,200
Rat Hole Ridge		6.5	62	220	2.4			290
Razorback Ridge				37	2,200	25		2,200
Red Pinnacle					1,300	2,200		3,500
Rifle	0.28	2.2	7.4	13	100	2,300	680	3,100
Rio Blanco	12	7.8	23	34	140	240	1,100	1,500
Round Mountain	26	78	510	0.74				620
Ruby Lee Reservoir	190	290	120					600
Rulison						2,700	900	3,600
Silt	49	44	91	95	450	1,800		2,600
Somerset	160	340	570	330	530			1,900
South Mamm Peak						2,900	790	3,700
Spruce Mountain					58	3,800		3,800
Stony Ridge	25	22	52	61	580	130		860
Storm King Mountain	54	48	86	80	250	440		960
The Meadows						3,600		3,600
The Saddle					2,200	110		2,300
Wagon Track Ridge			57	1,700	1,000			2,800
West Beckwith Mountain	240	120	98	83	7.6			550
Winter Flats			470	560	710			1,700
Grand total (pages 1 through 3)	4,000	4,600	13,000	15,000	58,000	67,000	10,000	170,000

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by township (in millions of short tons). Page 1 of 4.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
10S 100W	3.4	2.1	1.6					7
10S 88W	2.9	0.66	0.38					3.9
10S 89W	33	36	180	180	2.2			440
10S 90W			0.74	76	970	310		1,400
10S 91W					7.5	2,100		2,100
10S 92W						2,200		2,200
10S 93W						2,200		2,200
10S 94W					660	1,700		2,400
10S 95W					2,100	17		2,200
10S 96W				820	900			1,700
10S 97W			310	980	140			1,400
10S 98W	72	160	590	32				850
10S 99W	14	52	220					290
11S 88W	2.3	3.4	16	2.6				25
11S 89W			3.3	320	200			520
11S 90W					1,000	16		1,000
11S 91W					660	1,200		1,800
11S 92W					110	2,400		2,500
11S 93W					16	2400		2,400
11S 94W					86	2,000		2,100
11S 95W					800	1,100		1,900
11S 96W				290	1,500	20		1,800
11S 97W		0.2	29	240	720			990
11S 98W	34	39	54	0.98				130
12S 88W		1.6	13	2.9	0.44			18
12S 89W			5.8	200	260			470
12S 90W			11	150	1,200			1,400
12S 91W	0.99	36	230	350	860			1,500
12S 92W			18	200	2,300	360		2,900
12S 93W			90	310	1,700	160		2,200
12S 94W			330	430	1,500	75		2,400
12S 95W			140	300	1,200	140		1,800
12S 96W			71	160	1,300	4		1,600
12S 97W	130	96	190	160	290			870
12S 98W	0.12	0.05						0.18
13S 88W		1.3	10	51	3.4			65
13S 89W		61	280	280	2.6			620
13S 90W	140	310	520	160	3			1,100
13S 91W	290	350	400	37				1,100

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by township (in millions of short tons). Page 2 of 4.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
13S 92W	250	300	700	430	60			1,700
13S 93W	250	270	290	100				910
13S 94W	280	350	210					840
13S 95W	170	220	270	40				690
13S 96W	78	87	180	580	310			1,200
13S 97W	71	64	160	34				330
14S 88W	4.4	9.9	8.7	4.2	5.8			33
14S 89W	110	84	94	89	1.7			380
14S 90W	180	99	170	100				540
14S 96W	3.9							3.9
15S 88W	3.6	15						19
15S 89W	180	12						200
1N 1E	7.5	16	4.5					28
1S 2E	2.7	1.8						4.5
4S 100W			13	140	1,400			1,600
4S 101W	1	86	580	260	17			950
4S 102W		150	390	91				630
4S 103W			290	48				340
4S 104W			96	45				140
4S 93W	16	7.5	15	20	46	11		120
4S 94W	9.4	6.7	21	30	130	190	510	890
4S 95W							690	690
4S 96W						90	280	370
4S 97W						260	0.05	260
4S 98W						630		630
4S 99W					810	530		1,300
5S 100W				120	1,400			1,500
5S 101W			220	720	290			1,200
5S 102W		65	450	280				790
5S 103W		24	260	330				620
5S 104W			12	150	2.4			170
5S 90W	1.5							1.5
5S 91W	120	73	130	91	120			540
5S 92W	27	29	72	80	300	310		810
5S 93W	14	12	29	41	210	690	760	1,800
5S 94W						19	1,800	1,900
5S 95W						350	1,100	1,500
5S 96W						880	130	1,000
5S 97W						1,100		1,100
5S 98W					190	1,200		1,400
5S 99W					1,100	510		1,600

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by township (in millions of short tons). Page 3 of 4.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
6S 100W				97	1,100			1,200
6S 101W			170	380	520			1,100
6S 102W	14	230	610	52				900
6S 103W	180	230	270	0.65				680
6S 104W	71	55	150	84				360
6S 105W			21	22				43
6S 89W	29	23	41	36	24			150
6S 90W	48	45	77	70	290	800	13	1,300
6S 91W	25	27	76	94	380	1,700	4.2	2,300
6S 92W					210	2,000		2,200
6S 93W						2,200		2,200
6S 94W						2,300	190	2,500
6S 95W						1,400	940	2,300
6S 96W						1,300	210	1,500
6S 97W					22	1,700		1,700
6S 98W					700	1,200		1,900
6S 99W					1,300	330		1,600
7S 100W					1,300			1,300
7S 101W		23	360	550	340			1,300
7S 102W	150	140	260	98				650
7S 103W	240	76	11					330
7S 104W	210	85	110					400
7S 105W	19	7.5	14					40
7S 89W	41	40	79	81	240	170		640
7S 90W					21	1,600	87	1,700
7S 91W					860	1,300	7	2,100
7S 92W					1,100	1,100		2,200
7S 93W						1,700	300	2,000
7S 94W						1,500	1,100	2,700
7S 95W					84	1,500	110	1,700
7S 96W					970	1,200		2,100
7S 97W					830	1,300		2,100
7S 98W					1,900	200		2,100
7S 99W					1,300	88		1,400
8.5S 93W						74		74
8.5S 94W						23		23

Coal resources and other occurrences of coal in the Cameo-Wheeler coal zone by township (in millions of short tons). Page 4 of 4.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
8S 100W		11	230	240	480			960
8S 101W	240	420	530	49	9.6			1,300
8S 102W	110	34	3.1					150
8S 103W	6.3							6.3
8S 104W	3.5							3.5
8S 105W	3.6							3.6
8S 89W	18	19	36	49	410	240		770
8S 90W					1,200	640		1,900
8S 91W				62	2,100	170		2,300
8S 92W					280	1,600		1,900
8S 93W						1,200	830	2,000
8S 94W						910	890	1,800
8S 95W					3.8	1,400	280	1,700
8S 96W					1,800	170		2,000
8S 97W				180	1,600			1,800
8S 98W				400	1,400			1,800
8S 99W				200	1,000			1,200
9S 100W	57	40	220	53				370
9S 101W	5.2	4.8						9.9
9S 89W	23	20	50	56	310			460
9S 90W					1,900	51		1,900
9S 91W					1,100	1,500		2,600
9S 92W						2,300		2,300
9S 93W						2,300		2,300
9S 94W					360	2,200		2,600
9S 95W					1,400	980		2,400
9S 96W				45	1,900	120		2,000
9S 97W			92	1,200	410			1,700
9S 98W			250	1,100	19			1,300
9S 99W			660	280	13			950
Grand total (pages 1 through 4)	4,000	4,600	13,000	15,000	58,000	67,000	10,000	170,000

Coal resources of the Cameo-Wheeler coal zone by coal ownership (in millions of short tons).

Coal ownership	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Federal	3,100	3,800	12,000	13,000	43,000	75,000
Non-Federal	880	800	950	2,000	15,000	20,000
Grand total	4,000	4,600	13,000	15,000	58,000	95,000

Other occurrences of coal in the Cameo-Wheeler coal zone (at depths greater than 6,000 ft) by coal ownership (in millions of short tons).

Coal ownership	Overburden (ft)		Grand total
	6,000-10,000	>10,000	
Federal	41,000	7,800	48,000
Non-Federal	27,000	2,600	29,000
Grand total	67,000	10,000	78,000

Coal resources of the Cameo-Wheeler coal zone by surface ownership (in millions of short tons).

Surface ownership	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Federal	2,700	2,800	9,300	10,000	37,000	62,000
Non-Federal	1,300	1,800	3,400	5,000	21,000	33,000
Grand total	4,000	4,600	13,000	15,000	58,000	95,000

Other occurrences of coal in the Cameo-Wheeler coal zone (at depths greater than 6,000 ft) by surface ownership (in millions of short tons).

Surface ownership	Overburden (ft)		Grand total
	6,000-10,000	>10,000	
Federal	36,000	6,900	43,000
Non-Federal	32,000	3,500	35,000
Grand total	67,000	10,000	78,000

Coal resources and other occurrences of coal in the South Canyon coal zone by 7.5′ quadrangle (in millions of short tons).

Quadrangle	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
Anvil Points						430	1,100	1,500
Big Soap Park		0.68						0.68
Bowie	120	150	310	160	84			820
Bull Mountain				190	1,100			1,300
Cattle Creek	3.5	4.1	10	9.9	31	20		78
Center Mountain				2.4	85	720		800
Chair Mountain	0.11	2.6	62	300	41			410
Chalk Mountain					110	180		290
Electric Mountain			7	87	1,000	230		1,300
Elk Knob			20	140	770	110		1,000
Flatiron Mountain				140	890	540		1,600
Forked Gulch						31	110	150
Gibson Gulch				170	950	600		1,700
Glenwood Springs	0.67	0.53	0.6					1.8
Gray Reservoir	5.2	11	28	58	62			160
Hawxhurst Creek						55	47	100
Hightower Mountain					19	1,300		1,300
Horse Mountain	15	15	34	47	130	100		350
Hunter Mesa					770	1,300		2,100
Leon Peak						1.2		1.2
Mccarthy Gulch							210	210
Minnesota Pass	74	140	180	83				480
New Castle	34	40	65	63	180	410		790
North Mamm Peak						1,000	220	1,200
Paonia Reservoir	2.4	13	88	110	16			230
Parachute						1.4		1.4
Placita	22	25	170	110	3.3			340
Porter Mountain						600		600
Quaker Mesa				55	880	31		960
Rifle	0.63	1.1	3	6	34	1,300	250	1,500
Rio Blanco	13	14	47	55	220	330	970	1,600
Rulison						250	92	340
Silt	50	54	91	87	370	1,000		1,600
Somerset	170	280	380	170	240			1,200
South Mamm Peak						640	160	790
Spruce Mountain					110	1,800		1,900
Stony Ridge			0.5	4	76	11		92
Storm King Mountain	9.7	8.7	16	15	50	66		170
The Meadows						110		110
West Beckwith Mountain	66	34	35	26				160
Grand total	590	790	1,600	2,100	8,200	13,000	3,100	29,000

Coal resources and other occurrences of coal in the South Canyon coal zone by township (in millions of short tons). Page 1 of 2.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
10S 88W	0.11	0.05						0.15
10S 89W	17	21	150	57				250
10S 90W			14	91	430	64		600
10S 91W					47	1,000		1,100
10S 92W						540		540
10S 93W						97		97
10S 94W						4.1		4.1
11S 88W	0.61	3	2.6	0.2				6.3
11S 89W		0.11	61	260	11			330
11S 90W				68	630			700
11S 91W					690	340		1,000
11S 92W					58	290		350
11S 93W						13		13
12S 88W	0.68	0.79	3.7	1.3	0.21			6.6
12S 89W			27	260	93			380
12S 90W			16	200	660			870
12S 91W	9.8	23	160	250	420			860
12S 92W			15	45	220	3.6		280
13S 88W		0.01	1.5	2.9				4.3
13S 89W	3.2	25	110	37	0.25			170
13S 90W	150	280	360	25				820
13S 91W	130	130	120					380
13S 92W	6.9	16	56	26	0.61			110
14S 89W	33	36	35	43				150
14S 90W	70	110	140	56				380
15S 88W	2.3	2.8						5.1
15S 89W	30							30
4S 93W	9.2	8.7	20	26	51	8.1		120
4S 94W	11	12	42	51	200	260	510	1,100
4S 95W							180	180
5S 91W	48	46	68	57	63			280
5S 92W	30	39	69	64	210	130		540
5S 93W	6.2	7.1	19	26	120	480	300	960
5S 94W						38	1,200	1,300
5S 95W						13	200	210
6S 89W	2.1	2.1	4.4	4	0.44			13
6S 90W	9.1	7.9	14	14	64	130		240
6S 91W	7.3	10	23	35	120	540		740
6S 92W				0.63	200	1,100		1,300
6S 93W						1,100		1,100
6S 94W						830	50	880
6S 95W						140	150	280
7S 89W	2.2	2.7	6.5	7.9	28	21		68
7S 90W					8.4	490		490
7S 91W				46	500	410		950
7S 92W					840	360		1,200
7S 93W						700	44	740
7S 94W						320	170	490

Coal resources and other occurrences of coal in the South Canyon coal zone by township (in millions of short tons). Page 2 of 2.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
7S 95W						49	0.26	49
8.5S 93W						24		24
8.5S 94W						2.7		2.7
8S 89W	0.01	0.14	1.1	2.5	64	25		93
8S 90W				0.01	460	100		560
8S 91W				260	670	21		960
8S 92W					250	860		1,100
8S 93W						600	150	750
8S 94W						160	140	290
8S 95W						13	11	24
9S 89W	3.7	3.4	9.1	11	39			66
9S 90W				56	600			650
9S 91W				2	480	670		1,100
9S 92W						650		650
9S 93W						460		460
9S 94W						41		41
Grand total (pages 1 and 2)	590	790	1,600	2,100	8,200	13,000	3,100	29,000

Coal resources of the South Canyon coal zone by coal ownership (in millions of short tons).

Coal ownership	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Federal	400	590	1,400	1,900	6,100	10,000
Non-Federal	180	200	160	190	2,100	2,800
Grand total	590	790	1,600	2,100	8,200	13,000

Other occurrences of coal in the South Canyon coal zone (at depths greater than 6,000 ft) by coal ownership (in millions of short tons).

Coal ownership	Overburden (ft)		Grand total
	6,000-10,000	>10,000	
Federal	8,300	2,800	11,000
Non-Federal	4,700	340	5,000
Grand total	13,000	3,100	16,000

Coal resources or the South Canyon coal zone by surface ownership (in millions of short tons).

Surface owner	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Federal	310	480	1,200	1,300	5,300	8,600
Non-Federal	280	310	390	750	2,900	4,600
Grand total	590	790	1,600	2,100	8,200	13,000

Other occurrences of coal in the South Canyon coal zone (at depths greater than 6,000 ft) by surface ownership (in millions of short tons).

Surface owner	Overburden (ft)		Grand total
	6,000-10,000	>10,000	
Federal	7,300	2,600	9,900
Non-Federal	5,800	510	6,300
Grand total	13,000	3,100	16,000

Coal resources and other occurrences of coal in the Coal Ridge coal zone by 7.5′ quadrangle (in millions of short tons).

Quadrangle	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3000	3,000-6,000	6,000-10,000	>10,000	
Anvil Points						120	330	440
Big Soap Park		0.01						0.01
Bowie	69	80	170	110	46			480
Bull Mountain			0.1	130	590			730
Cattle Creek	62	60	120	100	270	94		720
Center Mountain			1.5	25	230	960		1,200
Chair Mountain	9.1	9.4	120	200	0.46			340
Chalk Mountain					130	130		260
Electric Mountain			12	110	650	43		810
Elk Knob			7.8	79	230	2.8		320
Flatiron Mountain			7.7	160	190	130		490
Forked Gulch						7	23	30
Gibson Gulch			0.58	57	360	320		740
Glenwood Springs	5.4	4.1	2.2					12
Gray Reservoir	20	19	45	59	40			180
Hawxhurst Creek						24	11	35
Hightower Mountain					15	570		580
Horse Mountain	13	13	30	39	100	63		260
Hunter Mesa					190	260		450
Leon Peak						3		3
Mccarthy Gulch							62	62
Minnesota Pass	48	56	88	46				240
New Castle	27	25	44	46	170	280		590
North Mamm Peak						410	55	470
Paonia Reservoir	9.4	14	76	27	0.96			130
Parachute					2.1	1.3		3.4
Placita	61	63	220	56	3.8			400
Porter Mountain						690		690
Quaker Mesa				150	460	36		640
Rifle	1.8	2.4	7.1	14	67	880	120	1,100
Rio Blanco	5.2	6.8	20	22	81	120	300	550
Rulison					0.37	120	25	150
Silt	28	25	56	51	210	460		840
Somerset	82	130	200	170	190			780
South Mamm Peak						200	32	240
Spruce Mountain					32	400		430
Stony Ridge	36	38	110	120	240	28		570
Storm King Mountain	16	17	35	33	99	97		300
The Meadows						140		140
West Beckwith Mountain	84	56	73	32	2.2			250
Grand total	580	620	1,500	1,800	4,600	6,600	950	17,000

Coal resources and other occurrences of coal in the Coal Ridge coal zone by township (in millions of short tons). Page 1 of 2.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
10S 88W	0.67							0.67
10S 89W	31	34	98	9.1				170
10S 90W			6	42	110	1		160
10S 91W					10	170		180
10S 92W						510		510
10S 93W						200		200
10S 94W						12		12
11S 88W	12	8.5	3.6					24
11S 89W		2.5	130	170	1.2			310
11S 90W				80	360			440
11S 91W					400	46		450
11S 92W					77	210		280
11S 93W						24		24
12S 88W	3.1	3.3	11	1.4	0.11			19
12S 89W			30	90	5.5			120
12S 90W			19	150	400			570
12S 91W	9.8	25	120	220	280			650
12S 92W			22	54	180	0.16		260
13S 88W	0.17	1.8	3.9	6.7	0.18			13
13S 89W	11	21	95	9.7				140
13S 90W	79	130	160	41				410
13S 91W	62	50	37					150
13S 92W	22	25	48	16				110
14S 88W	8.3	5.8	5.6	8.2	2.2			30
14S 89W	58	48	59	39				200
14S 90W	42	45	73	29				190
15S 88W	7.1	2.4						9.5
15S 89W	9							9
4S 93W	4.4	4.3	10	13	21	2		54
4S 94W	4.5	6	18	20	74	88	150	360
4S 95W							55	55
5S 91W	20	16	26	21	15			98
5S 92W	26	24	54	50	160	110		420
5S 93W	7.5	8.8	22	31	130	470	140	800
5S 94W						21	400	420
5S 95W						3.3	51	54
6S 89W	21	19	35	21	0.13			97
6S 90W	13	13	27	34	180	250		520
6S 91W	13	14	29	36	140	440		670
6S 92W				2.6	130	300		430
6S 93W						660		660
6S 94W						300	9.1	310
6S 95W					0.09	29	23	52
7S 89W	43	42	87	89	240	110		600
7S 90W					55	650		710
7S 91W				14	220	190		430
7S 92W				1.8	180	40		220
7S 93W						170	6.3	180
7S 94W						140	48	180

Coal resources and other occurrences of coal in the Coal Ridge coal zone by township (in millions of short tons). Page 2 of 2.

Township	Overburden (ft)							Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	6,000-10,000	>10,000	
7S 95W					2.4	17		19
8.5S 93W						8.5		8.5
8.5S 94W						0.92		0.92
8S 89W	28	27	56	61	230	77		480
8S 90W				53	300	86		440
8S 91W			8.3	200	240	1.7		450
8S 92W				0.69	48	290		330
8S 93W						250	30	280
8S 94W						69	38	110
8S 95W						3.5	1.3	4.8
9S 89W	40	44	150	120	96			450
9S 90W				95	240			340
9S 91W				8.3	68	110		180
9S 92W						420		420
9S 93W						130		130
9S 94W						7.3		7.3
Grand total (pages 1 and 2)	580	620	1,500	1,800	4,600	6,600	950	17,000

Coal resources of the Coal Ridge coal zone by coal ownership (in millions of short tons).

Coal ownership	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Federal	350	430	1,200	1,700	3,800	7,500
Non-Federal	230	190	200	160	800	1,600
Grand total	580	620	1,500	1,800	4,600	9,100

Other occurrences of coal (at depths greater than 6,000 ft) in the Coal Ridge coal zone by coal ownership (in millions of short tons).

Coal ownership	Overburden (ft)		Grand total
	6,000-10,000	>10,000	
Federal	4,400	860	5,300
Non-Federal	2,200	89	2,300
Grand total	6,600	950	7,600

Coal resources of the Coal Ridge coal zone by surface ownership (in millions of short tons).

Surface owner	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Federal	290	360	1,100	1,300	3,300	6,400
Non-Federal	290	260	380	500	1,300	2,700
Grand total	580	620	1,500	1,800	4,600	9,100

Other occurrences of coal (at depths greater than 6,000 ft) in the Coal Ridge coal zone by surface ownership (in millions of short tons).

Surface owner	Overburden (ft)		Grand total
	6,000-10,000	>10,000	
Federal	3,700	810	4,500
Non-Federal	2,900	140	3,100
Grand total	6,600	950	7,600

Coal resources of the Cameo-Fairfield coal group east of long 107° 15′W. in the West Elk Mountains-Crested Butte area. Resources are reported by 7.5′ quadrangle (in millions of short tons).

Quadrangle	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
Anthracite Range		2.9	44	12	7.7	67
Crested Butte	270	140	35	0.34		440
Flat Top	60					60
Gothic	2.7					2.7
Marble	9.5	14	31	9.2	1.3	66
Marcellina Mountain	16	27	46	36	33	160
Mount Axtell	73	75	91	54	1.1	290
Oh-Be-Joyful	24	20	8.9	0.18		53
Redstone	1.2	4.6	0.39			6.1
Squirrel Creek	31	12	22	6.4	0.94	72
West Elk Peak		5.2	36	39	16	96
Grand total	480	300	310	160	60	1,300

Coal resources of the Cameo-Fairfield coal group east of long 107° 15′W. in the West Elk Mountains-Crested Butte area. Resources are reported by township (in millions of short tons).

Township	Overburden (ft)					Grand total
	0-500	500-1,000	1,000-2,000	2,000-3,000	3,000-6,000	
11S 88W	5.6	17	25			48
12S 87W	0.73	1	0.52			2.3
12S 88W	15	19	31	9.3	1.3	75
13S 86W	25	19	5.1			48
13S 87W	3.6	3.6	5.1	0.2		12
13S 88W	5.5	8.2	22	36	34	110
14S 85W	4.6					4.6
14S 86W	70	120	88	46	0.44	320
14S 87W		0.46	13	8.9	0.62	23
14S 88W		0.22	2.7		5	7.9
15S 85W	60	12				72
15S 86W	270	64	6.3			340
15S 87W	24	28	58	21	4.9	140
15S 88W		7.9	59	37	14	120
Grand total	480	300	310	160	60	1,300

Coal resources of the Cameo-Fairfield coal group east of long 107° 15′W. in the West Elk Mountains-Crested Butte area. Resources are reported by coal ownership (in millions of short tons).

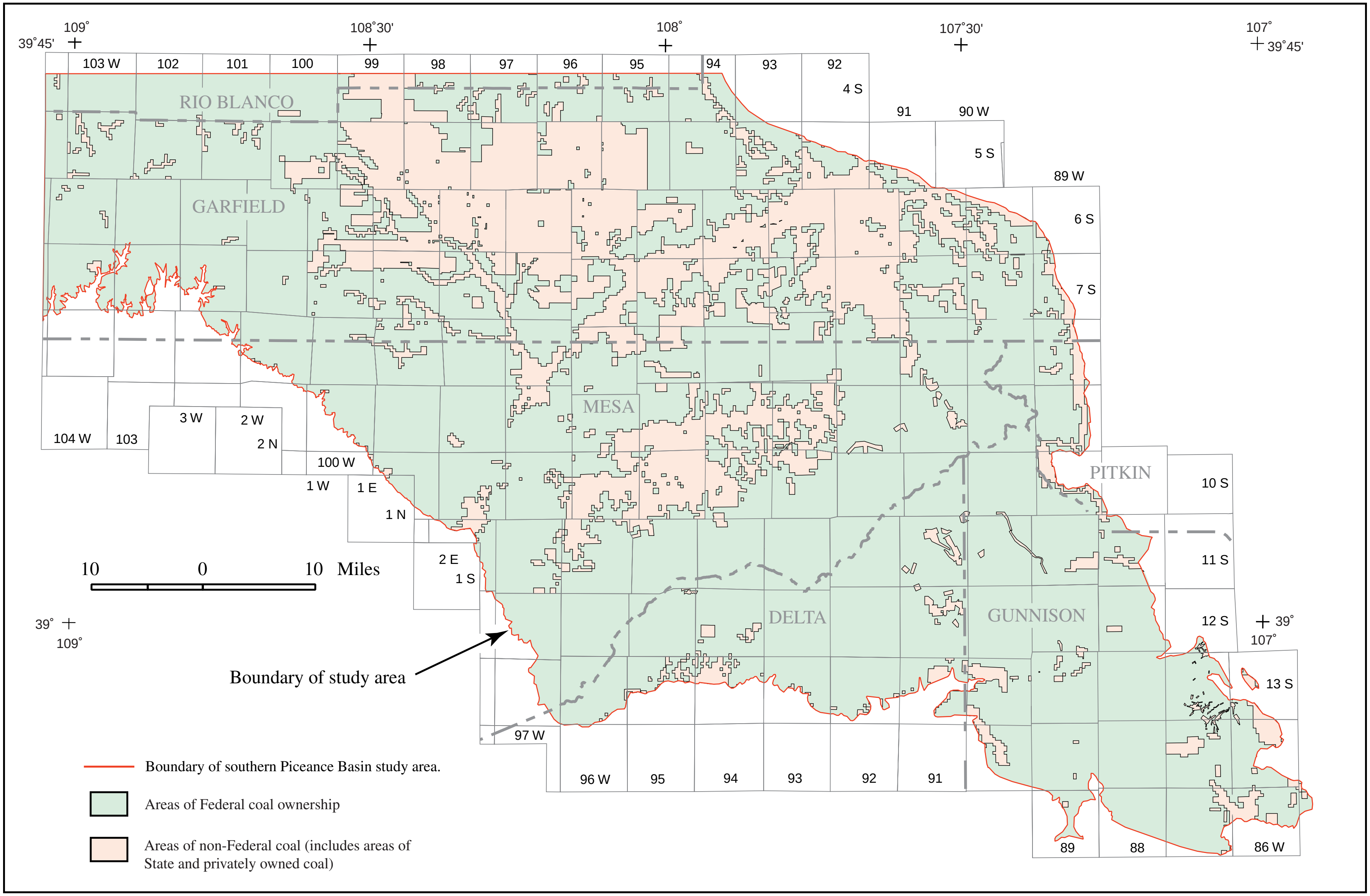
Coal ownership	Grand total
Federal	1,000
Non-Federal	300
Grand total	1,300

Coal resources of the Cameo-Fairfield coal group east of long 107° 15′W. in the West Elk Mountains-Crested Butte area. Resources are reported by surface ownership (in millions of short tons).

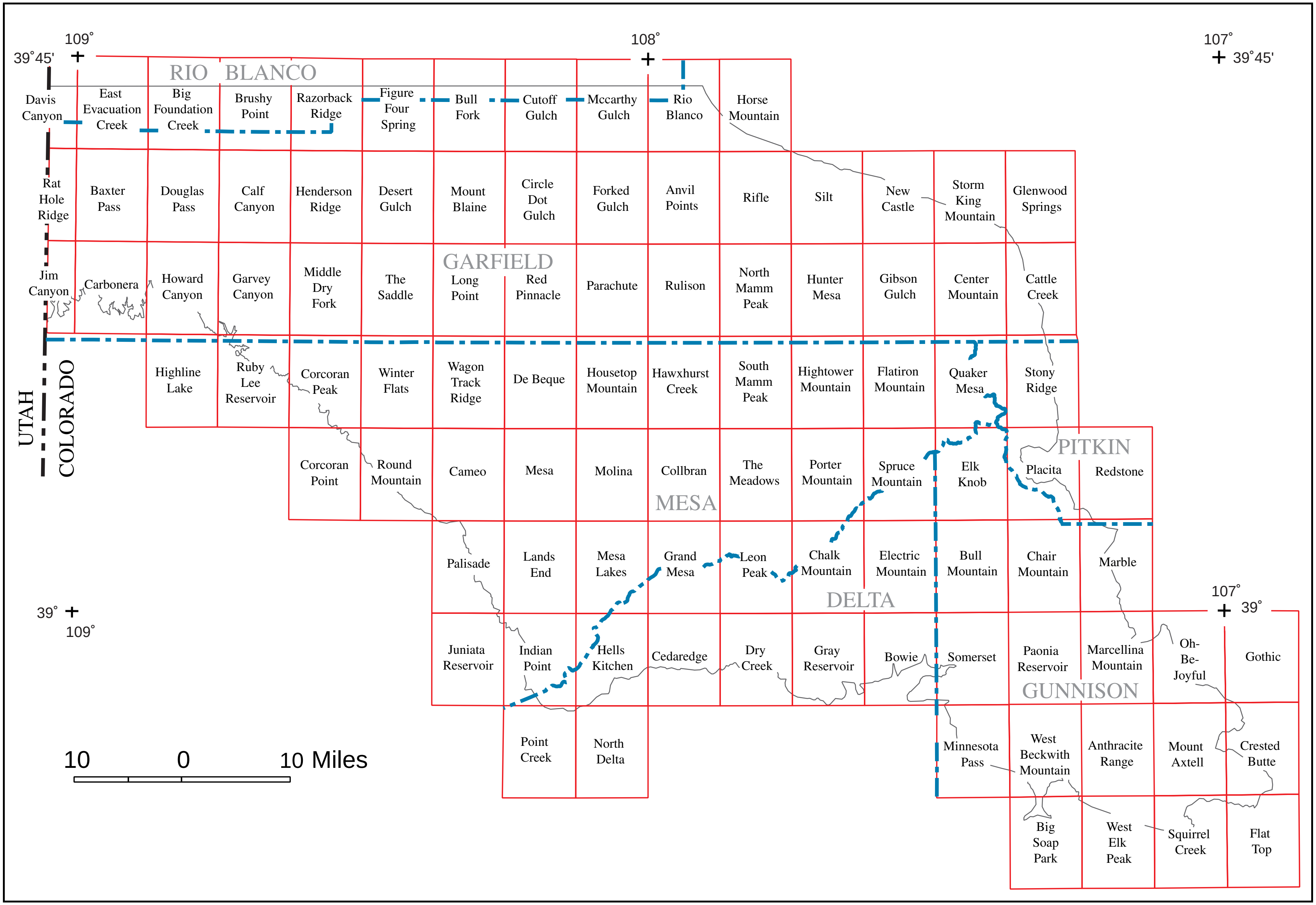
Surface owner	Grand total
Federal	860
Non-Federal	450
Grand total	1,300

Appendix 4—Maps of Counties, Townships, 7.5′ Quadrangles, and Coal Ownership in the Southern Part of the Piceance Basin, Colorado

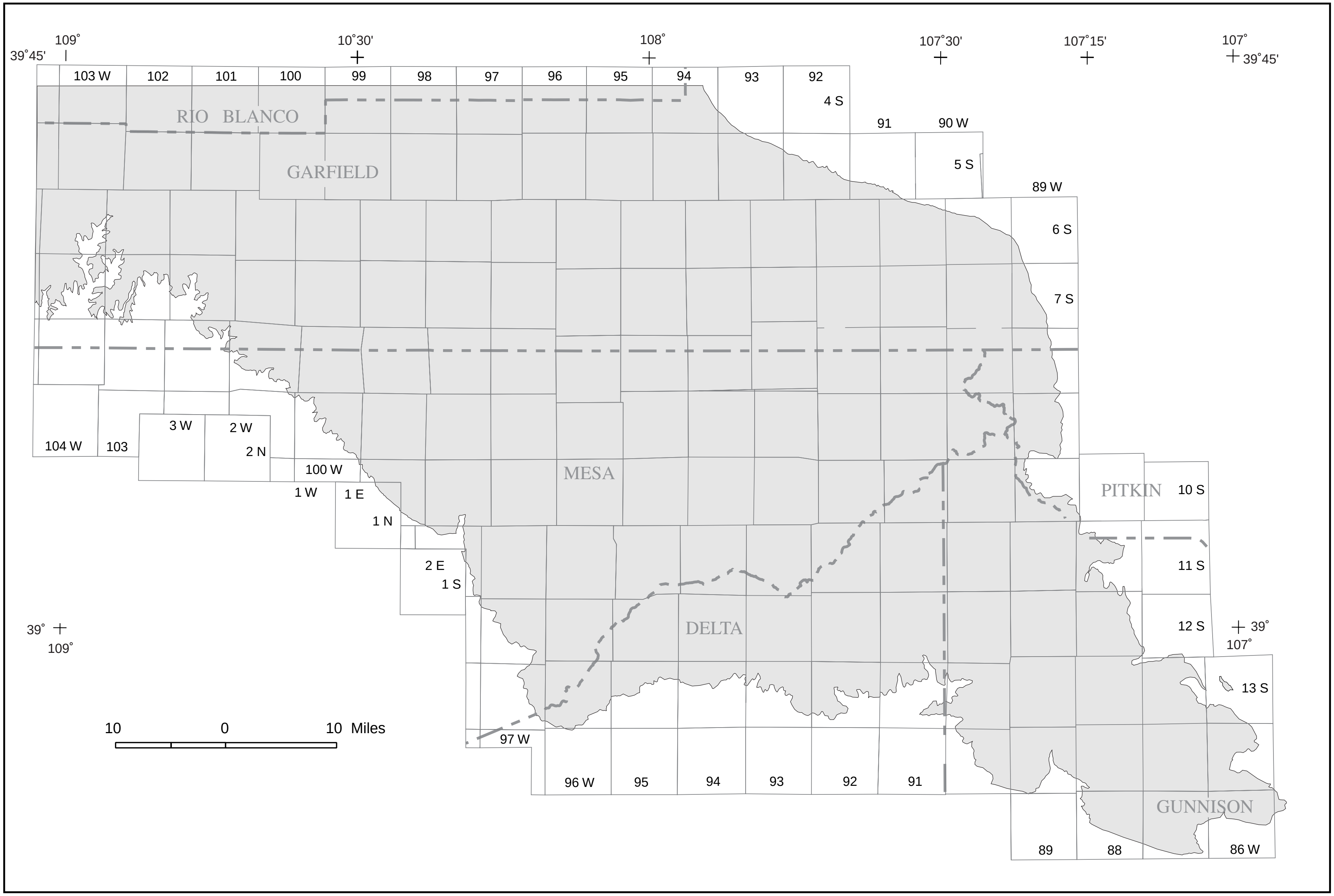
Appendix 4 contains figures showing the location of counties, townships, 7.5′ quadrangles, and areas of coal ownership in the southern part of the Piceance Basin, Colorado.



Coal ownership for areas that are underlain by the Cameo-Fairfield coal group in the Mesaverde Formation and Mesaverde Group in the southern part of the Piceance Basin, Colorado.



Names and locations of 7.5′ quadrangles in the southern part of the Piceance Basin, Colorado.



Map of counties, townships, and region underlain by the Cameo-Fairfield coal group (gray shaded area) in the southern part of the Piceance Basin, Colorado. The coal group includes the Cameo-Wheeler, South Canyon, and Coal Ridge coal zones, and coeval coal-bearing strata east of long 107˚15′W.

Appendix 5—Database Used for the Southern Piceance Basin Assessment Unit, Colorado

Appendix 5 contains the database used to asses coal resources in the Southern Piceance Basin assessment unit. The location, lithologic, and stratigraphic data are available in ASCII format, DBF, and Excel spreadsheet files on disc 2 of this CD-ROM. Drill-hole locations are shown on plate 1 and described in Appendix 1.

Appendix 6—ArcView Project for the Southern Piceance Basin Assessment Unit, Colorado

The digital files used for the coal resource assessment of the Southern Piceance assessment unit are presented as views in the ArcView project.

The ArcView project and the digital files are stored on both discs of this CD-ROM set—Appendix 6 of chapter O resides on both discs. Persons who do not have ArcView 3.1 may query the data by means of the ArcView Data Publisher on disc 1. Persons who do have ArcView 3.1 may utilize the full functionality of the software by accessing the data that reside on disc 2. An explanation of the ArcView project and data library—and how to get started using the software—is given by Biewick and Mercier (chap. D, this CD-ROM). Metadata for all digital files are also accessible through the ArcView project.

Click on image below to bring up high-resolution image of plate 1.

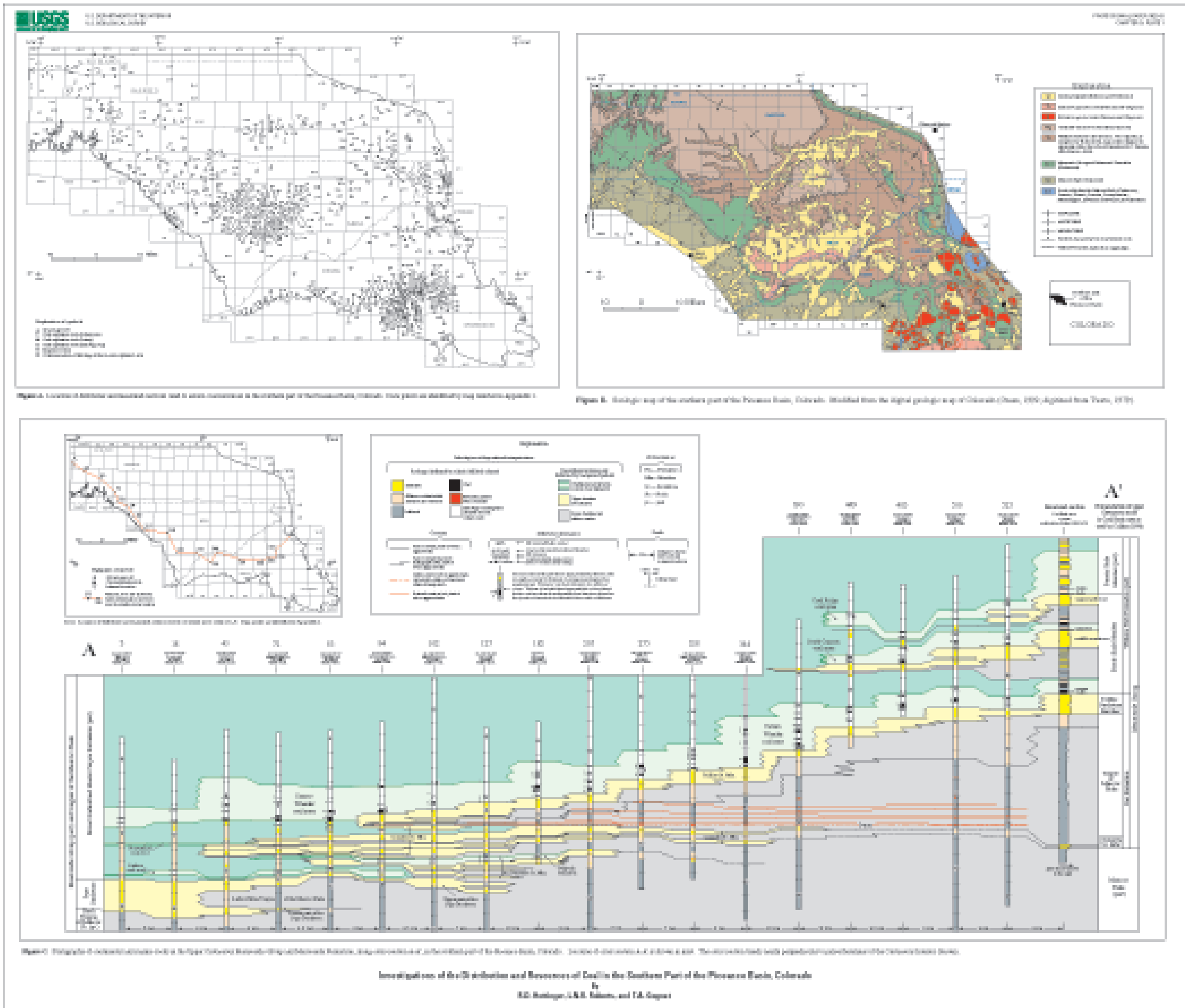
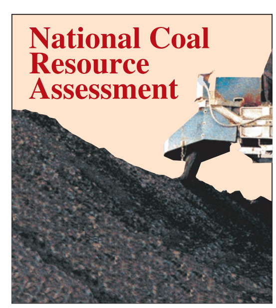


Plate 1. Investigations of the distribution and resources of coal in the southern part of the Piceance Basin, Colorado.



Click here to return to Disc 1 Volume Table of Contents