OPEN-FILE REPORT 79-01

COLORADO COAL RESERVES DEPLETION DATA AND COAL MINE SUMMARIES

by

D. L. Boreck and D. Keith Murray

DOI: https://doi.org/10.58783/cgs.of7901.mpgn9779

Prepared for the
United States Department of Energy
Energy Information Administration
Cooperative Agreement No. EI-78-F-01-6229

Colorado Geological Survey
Department of Natural Resources
Denver, Colorado

1979

REPORT DOCUMENTATION PAGE

Title: Colorado Coal Reserves Depletion Data and Coal Mine Summaries

Authors: D. L. Boreck and D. Keith Murray

Performing Organization: Colorado Geological Survey, Rm. 715, 1313 Sherman St., Denver, CO 80203

Sponsoring Organization: Same

Report Date: January 1979

Report Number: Final

Grant Numbers: U.S. Department of Energy Cooperative Agreement No., EI-78-F-01-6229

Originators Key Words: coal, production, depletion, mines, coal stratigraphy, correlation, coking coal, coal analyses, methane

No. of pages: 65

ABSTRACT

The United States contains a demonstrated coal reserve base, remaining as of January 1, 1976, of approximately 438 billion tons. Revised figures show Colorado's demonstrated reserve base to be approximately 17.4 billion tons; these figures were calculated as original in-place reserves. In 1976, the Colorado Geological Survey was awarded a two-year grant from the U.S. Bureau of Mines (the second grant year has been funded by the U.S. Department of Energy) to conduct a detailed study of coal production and depletion by county and township.

There are eight coal-bearing regions in Colorado. Each one is unique in its geologic and mining history and coal bed nomenclature. For this reason, each region was evaluated separately.

The work plan was broken down into ten basic steps: (1) collection of mine data, (2) analysis of mine maps, (3) literature search, (4) general stratigraphic analysis, (5) coal bed correlations, (6) tabulation of production and depletion data, (7) map preparation, (8) field checking, (9) correction and revision, and (10) mine data entry. The recovery factors by mining method were assumed to be auger-45%; underground, room and pillar-50%; underground, longwall-80%; and surface, strip-80%. Mine production and depletion figures are listed under coal region, county, township, coal-bearing rock unit, coal zone, coal bed, and bed thickness. Production and depletion tables for each region and coal mine information sheets for each mine are included in the appendix of this report.

The accuracy of the coal reserves depletion study has been limited by (1) lack of published information on coal in Colorado, (2) incomplete records on coal production, and (3) insufficient time to conduct detailed research.

Mining in Colorado began in the 1860's. Since that time, some 1,667 mines located in the eight coal regions have produced a total of 598,824,876 short tons of coal as of January 1, 1977. This activity has depleted the reserve base by 1,160,752,484 short tons. Most of the coal produced to date has been mined in beds ranging from 4 to 10 feet in thickness in rock units ranging in age from Upper Cretaceous to early Eocene. Using original reserve base estimates calculated by the U.S. Department of Energy, 6.67 percent of the State's demonstrated coal reserve base has been mined or lost in the process of mining. This leaves 93.33 percent of the original reserve base intact. A summary report covering each of the eight coal regions is included.

CONTENTS

APPENDIX

ILLUSTRATIONS

ILLUSTRATIONS (Cont.)

TABLES

APPENDIX: Coal Reserve Depletion tables (separate from report)

INTRODUCTION

The United States contains a demonstrated coal reserve base, remaining as of January 1, 1976, 438.3 billion tons (U.S. Bureau of Mines, 1977).

Colorado, one of the major coal producers in the West, contains an original demonstrated coal reserve base of 17.40 billion tons (Matson, 1979, personal commun.). The State has a wide diversity in rank and grade of coal, ranging from anthracite to lignite, and from metallurgical to steam coal.

In the 1950's, the U.S. Geological Survey conducted a project to estimate the original in-place resources for the State of Colorado. The resultant report, "Coal Resources of Colorado", by E. R. Landis (1959), gave resource estimates by coal bed and by township. These data were used by the U.S. Bureau of Mines to establish their reserve base, which was updated as newer site-specific resource data became available. All estimates were made of original in-place resources and did not include the quantity that had been depleted from the base as a result of coal development.

In 1976, the Colorado Geological Survey was awarded a grant from the U.S. Bureau of Mines to estimate the depletion of coal reserves by coal bed and by county. The contract, now under the U.S. Department of Energy (Cooperative Agreement No. EI-78-F-01-6229), was to be a detailed study of coal production and depletion in each township, breaking down production by bed thickness and into correlatable coal beds or coal "zones".

The coal bed correlations and zonal designations contained in this report should be considered as being only preliminary in nature. It is beyond the scope of this project to resolve the many problems of coal bed correlations. This study is but a first step in the clarification of the coal resource picture in Colorado.

ACKNOWLEDGMENTS

The authors acknowledge the guidance given by William C. Henkes and Thomas K. Matson of the Energy Information Administration, U.S. Department of Energy, Denver; and E. R. Landis, of the Branch of Coal Resources, U.S. Geological Survey, Denver, during the planning and execution of the project. We also wish to recognize Andrew Deborski, Assistant Director, Coal Mining, and the rest of the staff of the Colorado Division of Mines; Carl Schlaphoff, computer program consultant, Schlaphoff and Associates, Denver; and Judith Primon, Ann Bowers, and members of the Colorado Geological Survey secretarial and drafting staff for their assistance in the preparation of this report.

Finally, we wish to thank the following institutions and individuals who aided in gathering and checking data for the coal regions listed:

Canon City Region

County Clerk's office, Fremont County, Canon City
Imogene and Robert Hastings, Hastings Strip Mine, Florence

Denver Region

R. M. Kirkham, Colorado Geological Survey, Denver

Green River Region

County Clerk's office, Routt County, Steamboat Springs
Paul and Ellen Bonnifield, Yampa
Modesto J. Compestine, Milner
Eunice Dorr, Steamboat Springs
Robert N. Robertson, Hayden
Robert Swinehart, Steamboat Springs
Ernest and Dorothy Todd, Steamboat Springs

North Park region

Dawn Hill Madden, Conservation Division,
U.S. Geological Survey, Denver

Raton Mesa region

Walter Danilchik, Branch of Coal Resources,
U.S. Geological Survey, Denver

San Juan River region

County Clerk's office, La Plata County, Durango
Barbara Coe, Colorado Geological Survey, Denver
Fidel Lobato, Blue Flame Mine, Hesperus
Frank Zellitti, Morningstar Mine, Durango
Jerry Zink, Golden
Rose Zink, Durango

PEOPLE AND INSTITUTIONS CONTACTED

During the course of the study, the following Federal agencies were contacted: U.S. Department of Energy, Bureau of Mines, and Geological Survey. Officials from the Colorado Division of Mines, Colorado Geological Survey, Colorado Division of Mined Land Reclamation, and Colorado Board of Land Commissioners also were contacted. In addition, contacts were made with county officials, private industry, and with individuals from several of the coal-producing areas in Colorado.

DEFINITION OF THE RESERVE BASE

The figures in this report were calculated using the parameters established in the coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey (U.S. Bureau of Mines and U.S. Geological Survey, 1976). Figure 1 shows the different modes of classification of the coal resource base. Reserve base is defined as that portion of the identified coal resources from which reserves are calculated. Reserves are defined as that portion of the identified coal resources that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the reserve base. Demonstrated has been defined as a collective term for the sum of coal in both measured and indicated resources and reserves. Demonstrated reserve base was calculated by determining the amount of coal under less than 1,000 ft of overburden and greater than 28 in. (78 cm) in thickness for anthracite and bituminous coal, and greater than 60 in. (150 cm) in thickness for subbituminous coal and lignite. The reserve base may also include some beds that are thinner and/or deeper than stipulated by the general criteria, but that are nevertheless presently being mined or judged to be commercially minable at this time.

Demonstrated coal reserve base figures used in this report came from several sources. Figures for the United States were taken from U.S. Bureau of Mines publication, Demonstrated coal reserve base of the United States on January 1, 1976, prepared in August 1977. Data for the State of Colorado was obtained from Thomas K. Matson, Office of Energy Data, Energy Information Administration, U.S. Department of Energy, Denver. These figures are newly revised and have not been formally published by the Energy Information Administration.

Both sets of figures were calculated and revised by the U.S. Bureau of Mines using reports and maps published by the U.S. Geological Survey from 1949 to 1972. These references are listed on Table 1.

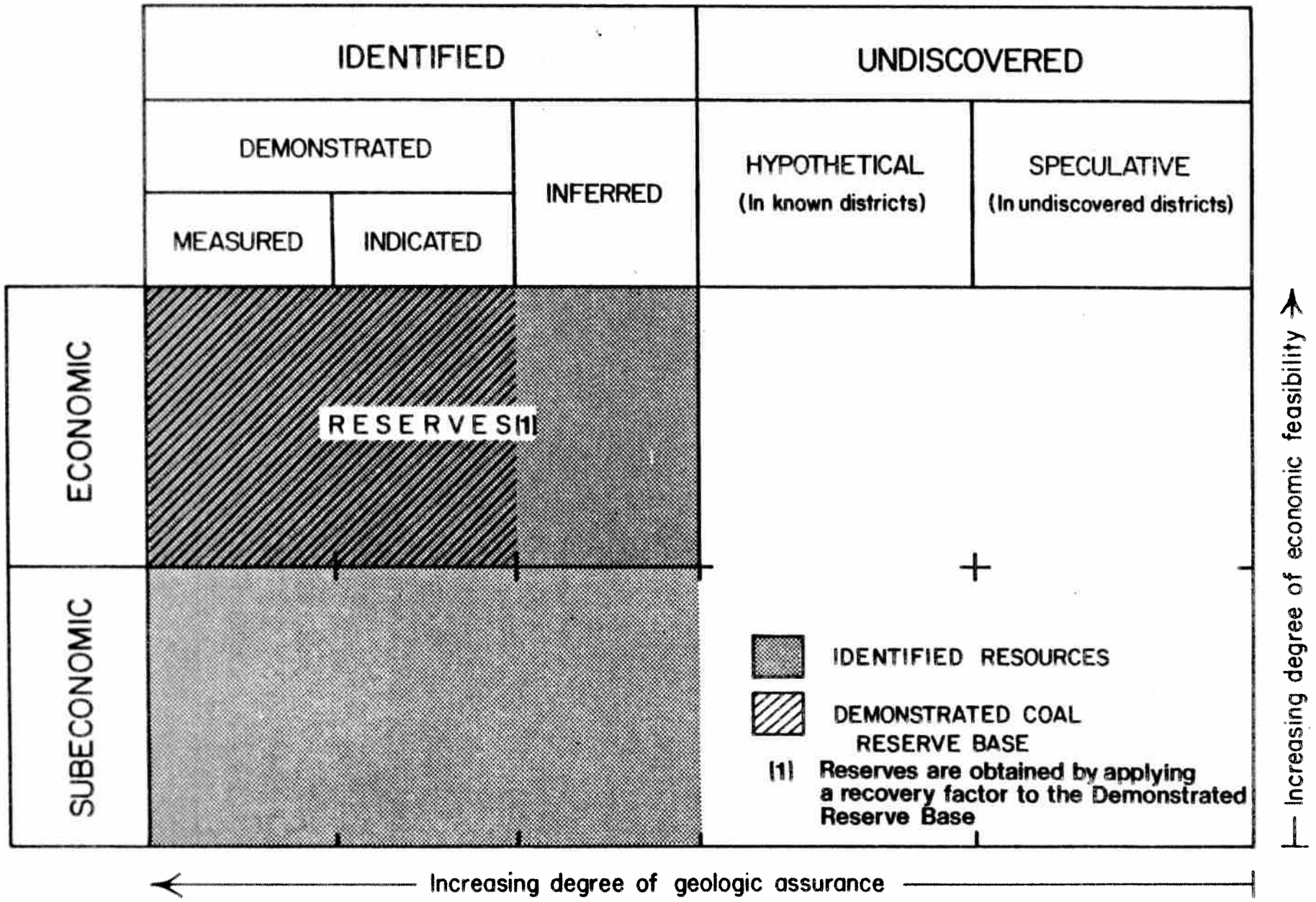


Figure 1. -- Coal resource classification system of the U.S. Bureau of Mines and the U.S. Geological Survey.

Table 1. References used in determining the demonstrated coal reserve base for the State of Colorado.

Author	Date	Publication
Barnes, H., Baltz, E.P., Jr., and Hayes, P.T.	1954	U.S.G.S. Map OM-149
Barnes, H.	1953	U.S.G.S. Map OM-138
Harbor, R.L., and Dickson, G.H.	1959	U.S.G.S. Bull. 1072G
Johnson, R.B.	1958	U.S.G.S. Bull. 1042-O
Johnson, R.B.	1961b	U.S.G.S. Bull. 1112-E
Johnson, R.B., and Stephens, J.G.	1954b	U.S.G.S. Map C-20
Landis, E.R.	1959	U.S.G.S. Bull. 1072-C
Landis, E.R., and Cone, G.C.	1972	U.S.G.S. Open-file Report
Wood, G.H., Jr., Johnson, R.B., Eargle, D.H., Duffner, R.T., and Major, H.	1951	U.S.G.S. Map C-4
Wood, G.H., Johnson, R.B., and Dixon, G.H.	1956	U.S.G.S. Map C-26
Wood, G.H., Johnson, R.B., and Dixon, G.H.	1957	U.S.G.S. Bull. 1051
Zapp, A.D.	1949	U.S.G.S. Map 109

WORK PROCEDURES

There are eight coal-bearing regions in Colorado (Fig. 2): the Canon City, Denver, Green River, North Park, Raton Mesa, South Park, San Juan River, and Uinta regions. The coals from these regions are mined from coal-bearing rock units ranging in age from Late Cretaceous to early Eocene. Although there are some geologic similarities between the different "basins", each coal-bearing area is unique in its geologic and mining history and coal bed nomenclature. For ease in data-processing, each region was treated as a separate entity and is presented as such in this report.

The work plan for each coal region was divided into ten basic steps: 1) collection of mine data, 2) analysis of mine maps, 3) literature search, 4) general stratigraphic analysis, 5) coal bed correlations, 6) tabulations of production and depletion data, 7) map preparation, 8) field checking, 9) correction and revision, and 10) mine data entry.

1) Collection of Mine Data

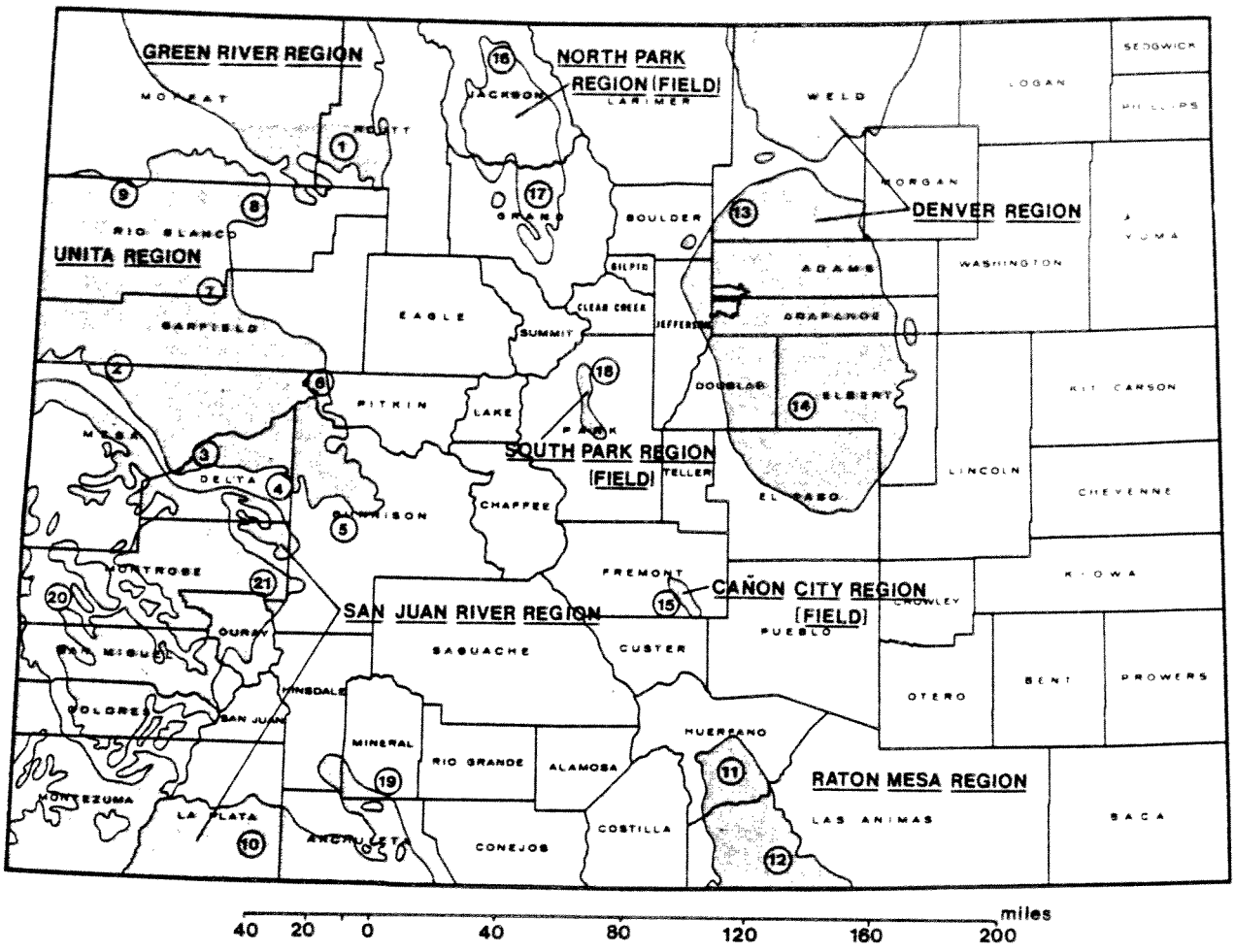
The beginning phase of the study was to tabulate mine names, their locations, production, and other pertinent data. All information was transferred to 5" x 8" cards, with each mine or group of related mines listed on one card. The mine data were primarily obtained from two sources: (a) Colorado Division of Mines coal history books, listing all licensed mines worked since the early 1880's; and (b) Holt, Richard D., unpublished data on the coal fields of Colorado compiled for the Colorado Geological Survey.

2) Analysis of Mine Maps

The Colorado Division of Mines houses a file of maps on most of the mines licensed by the State of Colorado since 1883. All pertinent maps were studied for exact mine entry locations, coal bed names, production proration by township and/or coal bed in the cases where the workings covered more than one township or mined more than one coal bed bedding attitudes, stratigraphic columns, overburden estimates, and any other useful data. The mine maps proved to be one of the major tools used in compiling this report because they helped to clear up any discrepancies in mine locations; and they gave a two- to three-dimensional picture of the mines, the stratigraphy of the coal bed(s), and a particular mine's relationship to other mines in the area.

3) Literature Search

The next step was to search all material published on the study area. Each reference was scanned for information on the history, general and detailed stratigraphy, and structure of the region. When the report contained specific sections on a coal mine or a stratigraphic description of the coal in a particular township, the information was copied and stapled either to the back of the mine data card or to a new card to be included with the rest of the data file on that township. When properly referenced, the data aided in speeding up correlations and checking.



COAL REGIONS AND FIELDS IN COLORADO
[ROCKY MOUNTAIN COAL PROVINCE]

COAL FIELDS

1. Yampa
2. Book Cliffs
3. Grand Mesa
4. Somerset
5. Crested Butte
6. Carbondale
7. Grand Hogback
8. Danforth Hills
9. Lower White River
10. Durango
11. Walsenburg
12. Trinidad
13. Boulder-Weld
14. Colorado Springs
15. Canon City
16. North Park
17. Middle Park
18. South Park
19. Pagosa Springs
20. Nucla-Naturita
21. Tongue Mesa

Figure 2. -- Coal-bearing regions in Colorado.

Another source of information that was not found until near the end of the project was the U.S. Bureau of Mines' microfilm file for the State of Colorado. In the one region in which it was used--the Canon City field--reports and maps included in the file proved helpful in finding "lost" mines or in locating new mines not listed in the other references.

Publications used in this report date from the 1860's to 1978. The majority of the data used were taken from sections measured at the outcrop or from maps showing the geology and coal outcrops in the study area. No drillhole data were used in this report, and no attempts at subsurface correlations were made.

4) General Stratigraphic Analysis

The stratigraphy of the coal-bearing rock units in the region was then studied as a whole to determine if there were any regional depositional patterns to aid in the more specific "zonal" correlations.

5) Correlation Work

The specific mine-to-mine "zonal" correlation work was done by (a) plotting all mine locations on a 7.5- or 15-minute topographic quadrangle sheet (scales 1:24,000 or 1:62,500); and (b) using all available information--including published reports and maps, structure maps on key sandstone beds where available, coal bed data, and mine data--to ascertain what coal beds or zones had been or were being mined in the area and which mine worked in which bed or zone.

6) Tabulation of Production and Depletion Figures

Production and depletion figures were tabulated on forms (Fig. 3) similar to those used by Landis and Cone (1971). Each sheet reports production and depletion as of January 1, 1977, by county, township, coal zone, coal bed name (when given), and coal bed thickness.

These forms provided a simple format for presenting large amounts of complex data and aided in detecting errors made during the various calculations.

7) Map Preparation

The locations of all mines in each region were plotted on mylar overlays registered to U.S. Bureau of Land Management Surface Mineral Management Quadrangle maps, scale 1 inch = 0.5 mi, or 1:126,720. The maps were chosen for their convenient size and scale, and for the fact that they portray ownership of surface and mineral rights (Federal, State, and private or fee), as of 1976.

8) Field-Checking

When it was considered feasible, the coal region being studied was visited to (a) attempt to find the locations of any "lost" mines, i.e., locations not recorded with the Coal Mine Inspector's Office

County_____ Twp/Rge_____

Coal Region_____ Coal-Bearing

Coal Field_____ Rock Unit_____

S=underground, shaft
Sl= " " , slope
D= " " , drift
T= " " , tunnel

O=surface, open pit
P=prospect

Sec.	Coal"zone"/ bed/ bed thickness	Mine index no.	Mine name/type/ overburden	Cumulative production to 1/1/77 (in short tons)	%* rec.	Total reserve depletion to 1/1/77 (in short tons)	Depletion in Short Tons by Bed Thickness (feet)									Sub-total
							un-known	1.1-2.3	2.3-3.5	3.5-4.0	4-5	5-10	10-15	15-25	25	

*% recovery (rec): % of reserve base produced.

Figure 3. -- Production and depletion tabulation sheet

(most of the work was aimed at finding mines with cumulative production of more than 1,000 tons); (b) field check any stratigraphic discrepancies and gather information on areas about which little or no information had been published; and (c) obtain a general geologic and historical overview of the area. Due to the lack of time, the authors were able to visit only the Canon City, Green River, and San Juan River regions.

9) Checking and Revision

The next step was to make any revisions necessary on the tables, incorporating new information from the field or other sources, and to make final corrections on the production and depletion totals.

10) Mine Data Entry

The data on each region were transferred from the work cards to data entry forms. They then were entered by region into the Colorado Geological Survey's WANG word-processing unit for correction, revision, and storage. The final product, Coal Mine Information Sheets (Fig. 4), were printed out for all known mines (approximately 1,600) in the eight coal regions. (See the Appendix for these information sheets.)

REPORTING PROCEDURES

As the work progressed, it became necessary to define (or redefine) several parameters used in the compilation. The first of these was the recovery percentage. The percent recovery, or recovery factor as it is also called, is the ratio between the amount of coal produced and the total amount of coal originally in-place within the mined area (i.e., the reserve base). The amount of coal depleted from the reserve base includes the quantity produced plus coal left as pillars or beneath roads or permanent structures that cannot be economically or legally mined, and is otherwise wasted. The recovery factor varies according to mining methods and conditions.

For this report, the recovery factors by mining method were assumed to be the following:

Auger, 45%
Underground--room and pillar, 50%
Underground--longwall, 80%
Surface--strip, 80%

In reality, the recovery factor for underground-longwall mining may be 60% or lower and for surface-strip operations may be as high as 95%.

The second parameter that, in this case, was redefined was the coal bed thickness category. Most of the work done on Western coal by Federal agencies follows the same thickness breakdown that has been used for Eastern coal: i.e., 14-28 in., 28-42 in., and greater than 42 in. In a State where the average thickness of coal beds is approximately 8 ft, and where beds occasionally attain a thickness of more than 50 ft. the previously used thickness divisions proved to be inadequate.

COLORADO COAL MINE INFORMATION

PRIMARY MINE NAME: Hezron
OPERATOR, PERIOD WORKED: Caddell and Son, 1901-1925

SECONDARY MINE NAME (1):
OPERATOR, PERIOD WORKED:
SECONDARY MINE NAME (2):
OPERATOR, PERIOD WORKED:

GEOGRAPHY

COAL REGION: Raton Mesa
AREA:
COAL FIELD: Walsenburg
COUNTY: Huerfano
SEC., TWP., RGE.: SW SW NE Sec 13 T29S R66W
MINE INDEX NUMBER: 252
MAP INDEX NUMBER: SE-16
MINE TYPE: Underground-drift
PORTAL ELEVATION (ft): 5007

GEOLOGIC INFORMATION

COAL-BEARING ROCK UNIT: Vermejo Fm
GEOLOGIC AGE: Upper Cretaceous
COAL 'ZONE': Robinson
COAL BED NAME: Hezron
COAL THICKNESS (ft): 4.0-4.6
STRATIGRAPHIC POSITION:
BEDDING ATTITUDE (degrees): N35W 8SW
OVERBURDEN THICKNESS (ft):

ANALYSIS

APPARENT COAL RANK: Bituminous
HEAT VALUE, AS-RECEIVED (Btu/lb):

PROXIMATE ANALYSIS (Coal Analysis-Dry. Moist. and Btu-As Recv'd):
Ash (%):
Volatile Matter (%):
Fixed Carbon (%):
Moisture (%):
Sulfur (%):

COKING COAL DATA: Coking coal reported
FREE SWELLING INDEX (FSI):
METHANE DATA: Gas explosion (1918)

PRODUCTION AND DEPLETION

PRODUCTION (short tons):
Differentiated: 899,683
Total: 899,683
RECOVERY FACTOR (%): 50
DEPLETION, TOTAL (short tons): 1,799,366

GENERAL INFORMATION

REFERENCES: Fender and Murray (1978); Richardson (1910)

REMARKS:

Figure 4. -- Coal Mine Information Sheets

For the present study, the following coal bed thickness categories have been employed:

1.1 (14") - 2.3 ft (28")
2.3 (28") - 3.5 ft (42")
3.5 (42") - 4.0 ft
4.0 - 5.0 ft
5.0 - 10.0 ft
10.0 - 15.0 ft
15.0 - 25.0 ft
25.0 ft or greater
Unknown

"Unknown" is used when a mine did not report the thickness of the mined coal bed(s).

COAL BED CORRELATIONS

In any coal resource study, one of the main problems encountered is that of coal bed correlations. In Colorado, due to deposition in highly transitional and laterally changing environments, the coal beds tend to be lenticular. It is not uncommon to find it difficult to correlate two coal beds that are less than 0.25 mi apart and, presumably, the same stratigraphic distance above a marker bed. Colorado coal beds can thicken, thin, split, or entirely disappear within a distance of less than a mile. Furthermore, more than one mine may assign the same coal bed two different names, or coal beds several hundred feet apart stratigraphically may have been given the same name.

Considerable confusion has resulted from problems in coal bed terminology and usage. In order to handle the data with some flexibility, mine production and depletion are listed in this report under coal region, county, township, coal-bearing rock unit, coal "zone," and coal bed.

The term "coal-bearing rock unit" is self-explanatory and may represent a geologic member (e.g., Bowie Shale Member), formation (e.g., Vermejo Formation), or group (e.g., Mesaverde Group). The term "group" also has been used informally as a sub-division of a coal-bearing rock unit (e.g., Black Diamond Coal group of the Iles Formation, Danforth Hills field). The informal term "group" has been used extensively in the Yampa field, Green River region; in the Durango field, San Juan River region; and in the Danforth Hills and Lower White River fields, Uinta region.

The Glossary of Geology (American Geological Institute, 1974) defines "zone" as "A general, informal working term for a stratigraphic unit of any kind...Characterized by some unifying property, attribute or content." In the present report, "zone" is used for a coal-bearing unit identified either at a certain vertical distance above a generally accepted marker bed (i.e., Trout Creek or Rollins Sandstones), where applicable, or for a coal-bearing unit reported by reliable sources to be correlatable from one mining area to another despite variations in vertical distance above a marker bed. A "zone" usually contains several coal beds that either are independent of the main bed mined or that split from that bed.

In this report, a coal "bed" is simply identified either by the name given to it by the miners, or by the name given to the same bed in an adjacent mine.

On the Coal Mine Information sheet for each mine, the coal field, county, and township give the general geographic location; the coal-bearing rock unit heading identifies the group, formation, or member containing the coal; and the coal "zone" gives possible correlations and relationships to other beds mined in the same area. Wherever possible, an estimate of the vertical position of the coal bed in the stratigraphic sequence was made. Finally, the heading entitled "bed" simply tells the name of the mined bed.

LIMITATIONS OF THE STUDY

The accuracy of the data in the coal reserves depletion study has been limited by the following factors: (1) paucity of published information on coal in Colorado, (2) incomplete records on coal mining, and (3) the availability of time to conduct detailed research in certain areas.

Published material on coal in Colorado is limited both in quantity and in its coverage of the coal regions. Reports were published on areas in most of the coal regions beginning in the early 1900's. These reports, most of which were done by the geologists of the U.S. Geological Survey, present a thorough overview of the general stratigraphy, mining history, and presence of mineral fuels in the areas covered. These publications proved invaluable to our study because preliminary coal-bed correlations often were done by the early workers. Studies pertaining to Colorado coal progressed at a slow pace until the 1970's, when warnings of an energy crisis and environmental concerns sparked a renewed interest in Western coal. However, the resultant reports, except for drill-hole information, essentially reiterated what already had been said in the earlier, more generalized reports.

Another limitation to the project was the incomplete nature of the records kept on coal mining in Colorado. This is due to the fact that production records were not kept by State agencies until 1883. Most production prior to 1883, and a great deal of production after 1883, was never recorded. For example, a mine reported production for the years of 1910 to 1915 only. Yet in a U.S.G.S. report published in 1910, it was noted that the same mine had been producing an estimated 250 tons per year for 20 years. This results in a discrepancy of 5,000 tons.

The last and most important limitation was that of time. To do a thorough, in-depth study of coal in Colorado, it probably would take from one to several years per coal region. The objective of the reserves depletion study was to cover all eight regions in Colorado. Thus, depletion figures do not reflect the amount of coal estimated to have been lost due to in-situ burning, nor do they show reserves for areas where the overburden thickness is greater than 1,000 ft. Extensive field work also was beyond the scope of this project, making coal bed correlations only as exact as the quality, amount, and availability of outcrop and mine data would allow.

Despite the above-mentioned limitations, the authors nevertheless believe that the data presented herein are the most complete available and that the goals of the subject grant have been met.

COAL REGION SUMMARIES

Due to the large amount of data collected on each region, a summary report is included covering each of the eight coal regions in Colorado. The reports include comments on the geography, general geology, coal bed stratigraphy, zonal correlations, and name variations of the correlated beds. Short citations of key references are listed at the end of each coal region summary. The reports also include stratigraphic columns, and an index map of the available BLM Surface Mineral Management Quadrangle overlays.

SUMMARY AND CONCLUSIONS

Coal mining began in Colorado in the early 1860's. Since then, the 1,667 mines located by the authors have produced a total of 598,824,876 short tons of coal to January 1, 1977. This activity has depleted the reserve base of Colorado by 1,160,752,484 short tons (Table 2). Most of the coal produced to date has been mined from beds ranging from 4-10 ft in thickness.

Using original reserve base estimates calculated by the U.S. Department of Energy (Matson, 1979), 6.67 percent of the State's demonstrated coal reserve base has been produced or lost in the process of mining. This leaves 93.33 percent of the original reserve base intact. Estimates of the remaining demonstrated coal reserve base for each coal-bearing region are given on Table 3.

Of the eight coal-bearing regions, the Raton Mesa region has the highest recorded cumulative production--250,124,216 short tons, or 41.77 percent of Colorado's total production to date. The Denver region is second, with 130,196,330 short tons, or 21.74 percent of the total. Of the remaining regions, the Uinta region produced 14.65 percent of the total; Green River, 12.45 percent; Canon City, 6.84 percent; San Juan River, 1.97 percent; North Park region, 0.46 percent; and South Park, 0.12 percent.

Table 4 gives production figures for 1977 and 1978. All data in the body of the report are based on production to January 1, 1977. This table updates coal production by region to January 1, 1979 and clearly shows the upward trend in mining today. During the two-year period, 1977-1978, the main producing region, the Green River, produced 15,405,488 short tons, or 58.62 percent of total two-year Statewide production of 26,279,491 tons. This high figure is the result of large surface mining operations in the area. The Uinta region was second, reporting 7,533,563 short tons, or 28.67 percent of the total. South Park region has not produced coal commercially since 1935.

In conclusion, coal has been produced from all of the coal-bearing regions in Colorado. This report is an attempt to determine how much coal has been mined or otherwise rendered unavailable to mining and from what coal "zones" this production has been obtained.

The data presented are preliminary in nature; however, this report does represent a concise summary of certain aspects of the coal mining history of Colorado. The authors hope that this project will result in more efficient future development and production of coal in this State.

Table 2. - Cumulative production, total reserve base depletion, depletion by coal bed thickness given by coal region and county.

County	Cumulative Production to 1/1/77 (in short tons)	Total Reserve Base Depletion to 1/1/77 (in short tons)	Depletion in Short Tons by Bed Thickness (feet)								
			unknown	1.1-2.3	2.3-3.5	3.5-4.0	4-5	5-10	10-15	15-25	≥ 25
COAL REGION											
CANON CITY REGION											
Fremont	40,940,262	73,331,716	107,676	7,672	19,913,779	5,373,044	22,927,287	23,952,586	1,049,672		
Total:	40,940,262	73,331,716	107,676	7,672	19,913,779	5,373,044	22,927,287	23,952,586	1,049,672		
DENVER REGION											
Adams	37,112	74,224				1,804		72,420			
Arapahoe	470	940	940								
Boulder	41,327,996	82,655,992	210,418		300		5,193,398	71,413,610	5,838,266		
Douglas	25,667	51,334						51,334			
Elbert	108,948	196,155	1,892				1,050	46,127	147,086		
El Paso	16,164,310	32,270,340	618		65,944	21,248	1,502,160	25,062,296	5,618,074		
Jefferson	6,622,552	13,244,104	24,912		1,780	36,054	33,446	12,216,156	894,056	37,700	
Larimer	54,611	109,222	4,270				22,490	82,462			
Weld	65,854,664	131,614,406	162,114		138,314	138,592	512,074	130,649,440	13,872		
Total:	130,196,330	260,216,717	405,164		206,338	197,698	7,264,618	239,593,845	12,511,354	37,700	
GREEN RIVER REGION											
Moffat	2,928,408	5,608,634	200				19,026	52,734	2,986,055	2,545,377	5,242
Routt	71,656,829	112,045,290	32,105		8,009	5,908	4,079,795	96,245,666	11,021,113	495,106	157,588
Total:	74,585,237	117,653,924	32,305		8,009	5,908	4,098,821	96,298,400	14,007,168	3,040,483	162,830
NORTH PARK REGION											
Jackson	2,737,704	10,029,822	1,964				500		391,825	1,332	9,634,201
Total:	2,737,704	10,029,822	1,964				500		391,825	1,332	9,634,201
RATON MESA REGION											
Huerfano	74,054,871	148,043,253	2,620	330	11,623,724	10,529,724	53,370,440	65,813,485	6,702,930		
Las Animas	176,069,345	352,167,773	202,280	74,476	8,754,656	15,466,365	124,242,478	203,427,518			
Total:	250,124,216	500,211,026	204,900	74,806	20,378,380	25,996,089	177,612,918	269,241,003	6,702,930		

Table 2. - Cumulative production, total reserve base depletion, depletion by coal bed thickness given by coal region and county - Continued.

County	Cumulative Production to 1/1/77 (in short tons)	Total Reserve Base Depletion to 1/1/77 (in short tons)	Depletion in Short Tons by Bed Thickness (feet)								
			un-known	1.1-2.3	2.3-3.5	3.5-4.0	4-5	5-10	10-15	15-25	≥25
COAL REGION											
SAN JUAN RIVER											
Archuleta	38,330	76,328	683	2,078	7,392	5,372	15,672	11,741	33,390		
Dolores	74,481	148,962	2,000		65,780			81,182			
La Plata	9,620,810	19,241,620	27,096	679,324	1,965,850	308,788	4,311,556	11,904,548	41,608	2,850	
Montezuma	139,018	278,036	1,972		126,556	19,080	69,080	58,526	2,822		
Montrose	1,874,817	2,682,756	180		11,446	610	83,686	2,586,834			
Ouray	17,623	35,246	922	2,886	7,088			6,118		3,942	14,290
San Miguel	26,300	52,600			46,766	644	5,190				
Total:	11,791,379	22,515,548	30,853	686,288	2,230,878	334,494	4,485,184	14,648,949	77,820	6,792	14,290
SOUTH PARK REGION											
Park	724,658	1,449,316	1,000					1,448,316			
Total:	724,658	1,449,316	1,000					1,448,316			
UINTA REGION											
Delta	11,456,027	22,894,836	1,428			8,422	440,226	3,100,617	725,475	18,618,668	
Garfield	7,059,428	14,118,856	204,910	119,746	2,424	5,454	137,992	5,426,142	2,435,912	2,984,840	2,801,436
Gunnison	39,975,950	79,951,900	447,070		1,956,506	1,777,250	2,659,164	23,408,588	24,134,188	25,569,134	
Mesa	7,329,143	14,569,739	800	2,050	864,451	1,384,596	2,192,828	10,125,014			
Moffat	3,521,205	7,042,410						82,856		6,950,720	8,834
Pitkin	17,762,181	35,524,362	226		487,492		268	28,966,226	6,070,150		
Rio Blanco	621,156	1,242,312	315,454			1,842	518	516,712	146,642	62,632	298,512
Total:	87,725,090	175,344,415	969,888	121,796	3,310,873	3,177,564	5,430,996	71,626,155	33,412,367	54,185,994	3,108,782
COLORADO TOTAL:	598,824,876	1,160,752,484	1,753,750	890,562	46,048,257	35,084,797	221,820,324	716,809,254	68,153,136	57,272,301	12,920,103

Table 3. - Production, depletion, and reserve base data for the State of Colorado given by coal region.

Coal Region	No. of Mines	Cumulative Production to 1/1/77 (short tons)	Total Reserve Base Depletion to 1/1/77 (short tons)	Original Demonstrated Reserve Base (estimated, million short tons)	% Reserve Base Depleted	Remaining Demonstrated Reserve Base (estimated, million short tons)	% Reserve Base Remaining
Canon City	177	40,940,262	73,331,716	180.32	40.7	106.99	59.3
Denver	387	130,196,330	260,216,717	4006.07	6.50	3745.85	93.50
Green River	192	74,585,237	117,653,924	6683.14	1.76	6565.49	98.24
North Park	35	2,737,704	10,029,822	823.51	1.22	813.48	98.78
Raton Mesa	371	250,124,216	500,211,026	1171.68	42.69	671.47	57.31
San Juan River	194	11,791,379	22,515,548	1346.19	1.67	1323.67	98.33
South Park	14	724,658	1,449,316	25.31	5.7	23.86	94.3
Uinta	297	87,725,090	175,344,415	3161.71	5.55	2986.37	94.45
TOTAL	1,667	598,824,876	1,160,752,484	17,397.93	6.67	16,237.18	93.33

Table 4. - Production data for 1977 and 1978, and cumulative production to 1/1/79 (preliminary).

Coal Region	Number of Licensed Mines 1977	Number of Licensed Mines 1978	Production for 1977 (short tons)	Production for 1978 (preliminary) (short tons)	Approximate Total Production 1977-78	Cumulative Production to 1/1/77 (short tons)	Approximate Cumulative Production to 1/1/79 (short tons)
Canon City	7	6	90,669	124,599	215,268	40,940,262	41,155,530
Denver	2	1	105,103	72,909	178,012	130,196,330	130,374,342
Green River	14	14	7,131,657	8,273,831	15,405,488	74,585,237	89,990,725
North Park	2	2	495,956	707,657	1,203,613	2,737,704	3,941,317
South Park	No activity	-	-			724,658	724,658
Raton Mesa	5	9	742,315	656,145	1,398,460	250,124,216	251,522,676
San Juan River	8	7	124,120	220,967	345,087	11,791,379	12,136,466
Uinta	30	27	3,281,323	4,252,240	7,533,563	87,725,090	95,258,653
TOTAL	68	66	11,971,143	14,308,348	26,279,491	598,824,876	625,104,367

REFERENCES

Adams, Diana, 1976, Geology of North Park, Jackson County, Colorado, with special references to coal resources: prepared for Jackson County Department of Administration and Planning, Walden, Colorado, July 1976, (open-file copies may be obtained from the Jackson County Administrator).

Allen, E.G., Lutz, G.A., and DeCiccio, D.A., 1976, Leasable mineral and waterpower land classification map of the Pueblo quadrangle, Colorado: U.S. Geol. Survey Open-File Rept. 76-656, scale 1:250,000.

American Geological Institute, 1976, Bibliography and index of Colorado geology, 1875-1975: Colorado Geol. Survey Bull. 37, 488 p.

Amuedo and Ivey, 1975, Ground subsidence and land-use considerations over coal mines in the Boulder-Weld coal field, Colorado: Colorado Geol. Survey Envir. Geol. 9, var. paged text, figs., pls.

___1975, Coal resources and preliminary geologic hazards study, Archuleta County, Colorado: prepared for the Upper San Juan Regional Planning Commission, Pagosa Springs, Colorado, November 28, var. paged text, figs., tables, maps.

Amuedo, C.L., and Bryson, R.S., 1977, Trinidad-Raton basins, [Colorado-New Mexico]: a model coal resource evaluation program, in Geology of Rocky Mountain coal, Proceedings of the 1976 Rocky Mountain Coal Symposium, D.K. Murray, ed.: Colorado Geol. Survey Resource Ser. 1, p. 45-60.

Anonymous, 1903, Barella Mesa coal field, Colorado: Mines and Minerals, v. 24, p. 139.

Apples, E.C., 1940, Coal metamorphism in the Anthracite-Crested Butte quadrangles, Colorado: Econ. Geology, v. 35, no. 1, p. 109.

Ashley, G.H., and Fisher, C.A., 1910, The value of coal land, in The valuation of public coal lands: U.S. Geol. Survey Bull. 424, 75 p., tables.

Averitt, Paul, 1975, Coal resources of the United States, January 1, 1974: U.S. Geol. Survey Bull. 1412, 131 p., illus., tables.

Barnes, Harley, 1953, Geology of the Ignacio and Pagosa Springs quadrangles, La Plata and Archuleta Counties, Colorado: U.S. Geol. Survey Oil and Gas Inv. Map OM-138, geol. map, scale 1:63,360, sections and text.

REFERENCES

Barnes, Harley, Baltz, E.H., Jr., and Hayes, P.T., 1954, Geology and fuel resources of the Red Mesa area, La Plata and Montezuma Counties, Colorado: U.S. Geol. Survey Oil and Gas Inv. Map OM-149, geol. map, scale 1:62,500, sections and text.

Bass, N.W., and Northrop, S.A., 1963, Geology of the Glenwood Springs quadrangle and vicinity, northwestern Colorado: U.S. Geol. Survey Bull. 1142-J, p. J1-J74, illus., tables, geol. map.

Bass, N.W., Eby, J.B., and Campbell, M.R., 1955(56), Geology and mineral fuels of parts of Routt and Moffat Counties, Colorado: U.S. Geol. Survey Bull. 1027-D, p. 143-250, illus., sections.

Beekly, A.L., 1915, Geology and coal resources of North Park, Colorado: U.S. Geol. Survey Bull. 596, 121 p., illus., sections, geol. map.

Boreck, D.L., Jones, D.C., Murray, D.K., Schultz, J.E., and Suek, D.C., 1977, Colorado coal analyses, 1975 (Analyses of 64 samples collected in 1975): Colorado Geol. Survey Inf. Ser. 7, 112 p., illus., tables.

Boyer, W.W., and Lee, W.T., 1925, Coal in the Dakota Formation in southwestern Colorado and eastern Utah: U.S. Geol. Survey unpub. manuscript.

Campbell, G.S., 1958, Geology of the Book Cliffs region, Utah and Colorado, in Geological Record [8th Ann. Mtg., Rocky Mtn. Sec., A.A.P.G., Casper, Wyo., April 27-30, 1958]: Denver, Petroleum Information, p. 63-69.

Campbell, M.R., 1912, Contributions to Economic Geology. Miscellaneous analysis of coal samples from various fields in the United States: U.S. Geol. Survey Bull. 471, p. 629-655.

___1923, The Twentymile Park district of Yampa coal field, Routt County, Colorado: U.S. Geol. Survey Bull. 748, 82 p., illus., sections, geol. map.

Carter, D.A., 1956, Coal deposits of the Raton basin, Colorado and New Mexico, in Guidebook to the geology of the Raton basin, Colorado: Rocky Mtn. Assoc. Geologists, p. 89-92, sections, maps.

Clement, J.H., and Dolton, G.L., 1970, A chronicle of exploration in South Park basin, Park County, Colorado: Mtn. Geologist, v. 7, no. 3, p. 205-216.

Collier, A.J., 1919, Coal south of Mancos, Montezuma County, Colorado: U.S. Geol. Survey Bull. 691-K, p. 293-310, illus., tables, sections, geol. map.

REFERENCES

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

Colorado Division of Mines, 1975, A summary of mineral industry activities in Colorado--Part 1, Coal: Colo. Div. Mines, Dept. Natural Resources, Denver, 30 p.

___1976, A summary of mineral industry activities in Colorado--Part 1, Coal: Colo. Div. Mines, Dept. of Natural Resources, Denver, 40 p.

___1977, A summary of mineral industry activities in Colorado--Part 1, Coal:: Colo. Div. Mines, Dept. Natural Resources, Denver, 45 p.

Colorado Springs Planning Department, 1967, Mining report, Colorado Springs coal field, a guide for future land use: Colorado Springs Planning Dept., Geol. Sec., 10 p, figs., tables.

Cullins, H.L., and Bowers, W.E., 1965, East Cortez coal area, Montezuma County, Colorado: U.S. Geol. Survey Open-File Rept. 801, 21 p., illus., tables, geol. map.

Cummings, K.F., and Pott, R.L., 1962, South Craig area, Townships 1 to 6 North, Ranges 86 to 94 West, Routt, Moffat, Garfield, and Rio Blanco Counties, Colorado, in Exploration for oil and gas in northwestern Colorado: Rocky Mtn. Assoc. Geol. Field Conf. Guidebook, p. 84-86, illus.

Danilchik, Walter, 1979, Geologic and coal outcrop map of the Madrid quadrangle, Las Animas County, Colorado: U.S. Geol. Survey Open-File Rept. 79-377, scale 1:24,000.

Dawson, L.C., and Murray, D.K., 1978, Colorado coal directory and source book: Colorado Geol. Survey Resource Ser. 3, 222 p., tables, figs.

Dickinson, R.G., 1965, (1966), Geologic map of the Cerro Summit quadrangle, Montrose County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-486, scale 1:24,000, sections.

___1966, Geology of the Cerro Summit quadrangle, Montrose County, Colorado: U.S. Geol. Survey Open-File Rept., 117 pp., illus., tables, sections, geol. map.

Donnell, J.R., 1959, Mesaverde stratigraphy in the Carbondale area, northwestern Colorado, in Symposium on Cretaceous Rocks of Colorado and adjacent areas, 11th Field Conf. Guidebook: Rocky Mtn. Assoc. Geol., p. 76-77, illus.

___1962, Geology and coal resources of the Carbondale area, Garfield, Pitkin, and Gunnison Counties, Colorado: U.S. Geol. Survey Open-File Rept., table, geol. map.

Dyni, J.R., 1966, Measured sections of the Mesaverde Group and list of fossils collected from the Mancos Shale and Mesaverde Group, Moffat and Rio Blanco Counties, Colorado: U.S. Geol. Survey Open-File Rept., 22 pp., illus.

Erdmann, C.E., 1934, The Book Cliffs coal field in Garfield and Mesa Counties, Colorado: U.S. Geol. Survey Bull. 851, 150 pp., illus., geol. map.

___1941, Preliminary report on geology of the Coalmont district, Jackson County, Colorado: U.S. Geol. Survey Open-File Rept., 207 pp., illus., tables, sections, geol. map.

Ettinger, Morris, 1964, Geology of the Hartsel area, South Park , Park County, Colorado: Mtn. Geologist, v. 1, no. 3, p. 127-132.

Fassett, J.E., and Hinds, J.S., 1971, Geology and fuel resources of the Fruitland Formation and Kirtland Shale of the San Juan basin, New Mexico and Colorado: U.S. Geol. Survey Prof. Paper 676, 76 p., plates.

Fender, H.B., and Murray, D.K., 1978, Data accumulation on the methane potential of the coal beds of Colorado, final report: Colorado Geol. Survey Open-File Rept. 78-2, 25 p., fig., tables, plates, map.

Fender, H.B., Jones, D.C., and Murray, D.K., 1978, Bibliography and index of publications related to coal in Colorado, 1972-77: Colorado Geol. Survey Bull. 41, figs., key word index.

Fenneman, N.M., and Gale, H.S., 1906a, The Yampa coal field, Routt County, Colorado: U.S. Geol. Survey Bull. 285-F, p. 226-239, illus., sections, geol. map.

___1906b, The Yampa coal field, Routt County, Colorado, with a chapter on the character and use of Yampa coals, by M.R. Campbell: U.S. Geol. Survey Bull. 297, 96 pp., illus., sections, geol. map.

Fisher, C.A., 1910, Depth and minimum thickness of coal beds as limiting factors in valuation, in The valuation of public coal lands: U.S. Geol. Survey Bull. 424, p. 48-75, tables.

Fisher, D.J., and others, 1960, Cretaceous and Tertiary formations of the Book Cliffs, Carbon, Emery and Grand Counties, Utah, and Garfield and Mesa Counties, Colorado: U.S. Geol. Survey Prof. Paper 332, 80 pp., illus., geol. map.

REFERENCES

Gale, H.S., 1907, Coal fields of the Danforth Hills and Grand Hogback in northwestern Colorado: U.S. Geol. Survey Bull. 316-E, p. 264-301, illus., sections, maps.

___1909, Coal fields of northwestern Colorado and northeastern Utah: U.S. Geol. Survey Bull. 341, p. 283-315, illus., sections, geol. maps.

___1910, Coal fields of northwestern Colorado and northeastern Utah: U.S. Geol. Survey Bull. 415, 265 p., illus., tables, sections, geol. map.

Gardner, J.H., 1909, The coal field between Durango, Colorado, and Monero, New Mexico: U.S. Geol. Survey Bull. 341, p. 352-363, illus., geol. map.

Gaskill, D.L., and Horn, G.H., 1961, Northeast Rangely coal area, Rio Blanco and Moffat Counties, Colorado: U.S. Geol. Survey Open-File Rept., Series 627, 49 p.

Goldman, M.I., 1910, The Colorado Springs coal field, Colorado: U.S. Geol. Survey Bull. 381-C, p. 317-340, illus., sections, geol. map.

Goolsby, S.M., and Reade, N.B.S., 1978, Map of licensed coal mines in Colorado, as of June 1, 1978: Colorado Geol. Survey Map Ser. 12, scale 1:1,000,000.

Grace, W.P., 1962, Danforth Hills area, Townships 2 to 5 North, Ranges 93 to 96 West, Moffat and Rio Blanco Counties, Colorado, in Exploration for oil and gas in northwestern Colorado: Rocky Mtn. Assoc. Geologists Field Conf. Guidebook, p. 92-95, illus.

Gregory, H.E., 1938, The San Juan Country. A geographic reconnaissance of southeastern Utah: U.S. Geol. Survey Prof. Paper 188, p. 61-62.

Hail, W.J., Jr., 1965, Geology of northwest North Park, Colorado: U.S. Geol. Survey Bull. 1188, 133 pp., illus., tables, sections, geol. map.

___1968, Geology of southwestern North Park and vicinity, Colorado: U.S. Geol. Survey Bull. 1257, 119 p., illus., tables, sections, geol. map.

Haines, D.V., 1978, Core-hole drilling and coal analysis report for nine holes drilled during 1977 in the Nucla coal field, Montrose County, Colorado: U.S. Geol. Survey Open-File Rept. 78-899, 37 p., figs., table.

REFERENCES

Hamilton, P.A., White, D.H., Jr., and Matson, T.K., 1975, The reserve base of U.S. coals by sulfur content (in two parts). 2. The Western States: U.S. Bur. Mines Inf. Circ. 8693, 332 p.

Hancock, E.T., 1925, Geology and coal resources of the Axial and Monument Butte quadrangles, Moffat County, Colorado: U.S. Geol. Survey Bull. 757, 134 p, illus., sections, geol. map.

Hancock, E.T., and Eby, J.B., 1930, Geology and coal resources of the Meeker quadrangle, Moffat and Rio Blanco Counties, Colorado: U.S. Geol. Survey Bull. 812, p. 191-242, illus., geol. map.

Hanks, T.L., 1962, Geology and coal deposits, Ragged-Chair Mountain area, Pitkin and Gunnison Counties, Colorado: Brigham Young Univ. Geology Studies, v. 9, pt. 2, p. 137-160, illus., tables, geol. maps.

Harbour, R.L., and Dixon, G.H., 1959, Coal resources of Trinidad-Aguilar area, Las Animas and Huerfano Counties, Colorado: U.S. Geol. Survey Bull. 1072-G, p. 445-489, illus., tables, sections, geol. map.

Hills, R.C., 1899, Description of the Walsenburg quadrangle, Colorado: U.S. Geol. Survey Atlas Folio 58, 6 p.

___1900, Description of the Walsenburg quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 68, 6 p.

___1901, Description of the Spanish Peaks quadrangle, Colorado: U.S. Geol. Survey Atlas Folio 71, 7 p.

Hodgson, H.E., ed., 1977, Proceedings of the Second Symposium on the Geology of Rocky Mountain Coal: Colorado Geol. Survey Resource Ser. 4, 219 p., illus., tables, sections.

Holmes, W.H., 1877, Report on the San Juan district, Colorado: U.S. Geol. and Geographic Survey of the Territories, 9th Ann. Rept. for 1875, p. 237-276.

Holt, R.D., 1972, Bibliography, Coal resources in Colorado: Colorado Geol. Survey Bull. 34-A, 32 p.

Horn, G.H., and Adair, J.S., 1959, Geologic map of Ragged Mountain coal area, Gunnison County, Colorado: U.S. Geol. Survey Open-File Map, scale 1:24,000.

Hornbaker, A.L., Holt, R.D., and Murray, D.K., 1976, 1975 Summary of coal resources in Colorado: Colorado Geol. Survey Special Pub. 9, 17 p., 3 figs., table.

REFERENCES

Johnson, R.B., 1958, Geology and coal resources of the Walsenburg area, Huerfano County, Colorado: U.S. Geol. Survey Bull. 1042-0, p. 557-583, illus., tables, sections, geol. map.

___1961b, Coal resources of the Trinidad coal field in Huerfano and Las Animas Counties, Colorado: U.S. Geol. Survey Bull. 1112-E, p. 129-180, illus., tables, sections, geol. map.

___1969, Geologic map of the Trinidad quadrangle, southcentral Colorado: U.S. Geol. Survey Misc. Geol. Inv. Map C-558, scale 1:250,000.

Johnson, R.B., and Stephens, J.G., 1954b, Coal resources of the La Veta area, Huerfano County, Colorado: U.S. Geol. Survey Coal Inv. Map C-20, scale 1:31,680.

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

Jones, D.C., 1977, Licensed coal mines in Colorado: Colorado Geol. Survey Map Ser. 8, scale 1:1,000,000.

Jones, D.C., and Murray, D.K., 1978, First annual report, evaluation of coking coal deposits in Colorado: Colorado Geol. Survey Open-File Rept. 78-1, 18 p., 1 fig., 5 plates, 10 tables.

Jones, D.C., Murray, D.K., and Schultz, J.E., 1977, Coal resources and development map of Colorado: Colorado Geol. Survey Map Ser. 9, scale 1:500,000.

Keenan, A.M., and Carpenter, R.H., 1961, Faults in pitching coal seams, their effect on mining: Am. Inst. Mining, Metallurgical and Petroleum Engineers Trans. 1960, v. 217, p. 230-236, illus.

Kilgore, L.W., 1955, Geology of the Durango area, La Plata County, Colorado, in Guidebook of parts of the Paradox, Black Mesa, and San Juan basins, 1st Field Conference: Four Corners Geol. Soc., p. 118-124.

Kinney, D.M., 1970a, Preliminary geologic map of the Gould quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey Open-File Rept., scale 1:48,000.

___1970b, Preliminary geologic map of the Rand quadrangle, North Park, Jackson and Grand Counties, Colorado: U.S. Geol. Survey Open-File Rept., scale 1:48,000.

Kinney, D.M., and Hail, W.J., Jr., 1970a, Preliminary geologic map of the Walden quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey Open-File Map, scale 1:48,000.

___1970b, Preliminary geologic map of Hyannis Peak quadrangle, North and Middle Parks, Jackson and Grand Counties, Colorado: U.S. Geol. Survey Open-File Rept., scale 1:48,000.

Kinney, D.M., Hail, W.J., Jr., Steven, T.A., and others, 1970, Preliminary geologic map of the Cowdrey quadrangle, North Park, Jackson County, Colorado: U.S. Geol. Survey Prelim. Map, open file, scale 1:48,000.

Kirkham, R.M., 1978a, Location map of drill holes used for coal evaluation in the Denver and Cheyenne Basins, Colorado: Colorado Geol. Survey Open-File Rept. 78-8.

___1978b, Coal mines and coal analyses of the Denver and Cheyenne Basins, Colorado: Colorado Geol. Survey Open-File Rept. 78-9.

___1978c, General coal geology in the Denver Basin [abst.]: Rocky Mtn. Assoc. Geol., Energy Resources of the Denver Basin, symposium program and abstracts, p. 5.

Kirkham, R.M., and Ladwig, L.R., 1977, Preliminary investigation and feasibility study of environmental impact of energy resource development in the Denver Basin: Colorado Geol. Survey Open-File Rept. 77-1, 30 p.

Knowlton, F.H., 1917b, Flora of the Fruitland and Kirtland Formations: U.S. Geol. Survey Prof. Paper 98-S, p. 327-353.

Landis, E.R., 1959, Coal resources of Colorado: U.S. Geol. Survey Bull. 1072-C, p. 131-232, illus., tables, map.

Landis, E.R., and Cone, G.C., 1972, Coal resources of Colorado; tabulated by bed: U.S. Geol. Survey Open-File Rept., 515 p., tables, explanation.

Lee, W.T., 1909, The Grand Mesa coal field, Colorado: U.S. Geol. Survey Bull. 341-C, p. 316-334, illus., sections, geol. map.

___1912, Coal fields of Grand Mesa and the West Elk Mountains, Colorado: U.S. Geol. Survey Bull. 510, 237 pp., illus., sections, geol. map.

___1922, Raton - Brilliant - Koehler Folio, New Mexico and Colorado: U.S. Geol. Survey Atlas Folio 214, 17 pp.

Lee, W.T., and Knowlton, F.H., 1917, Geology and paleontology of the Raton Mesa and other regions in Colorado and New Mexico: U.S. Geol. Survey Prof. Paper 101, 450 pp.

Lowrie, R.L., 1966, Analysis of the coal industry in Boulder-Weld coal field, Colorado: U.S. Bur. Mines Rept. Inv. 6726, 79 pp., illus., graphs, tables, sections, maps.

REFERENCES

Marr, J.D., 1931, Geology of the Pole Hill - Buffaloe Creek anticline, Jackson County, Colorado: M.S. thesis, Colorado Sch. Mines.

Martin, G.C., 1910, Coal in the Denver basin, Colorado: U.S. Geol. Survey Bull. 381, p. 297-306.

Marvine, A.R., 1874, The sedimentary rocks east of the Front Range: U.S. Geol. Survey Terr., 7th Ann. Rept., p. 93-163, illus.

Miller, A.E., 1975, Geologic, energy and mineral resources maps of Routt County, Colorado: Colorado Geol. Survey Map Ser. 1, 2 pls., scale 1:126,720.

___1977, Geology of Moffat County, Colorado: Colorado Geol. Survey Map Ser. 3, scale 1:126,720.

Miller, J.C., 1934, Geology of North and South McCallum anticline, Jackson County, Colorado: U.S. Geol. Survey Circ. 5, 27 p., mimeo.

Mull, C.G., 1960, Geology of the Grand Hogback monocline near Rifle, Garfield County, Colorado: M.S. thesis, Univ. of Colorado.

Murray, D.K., ed., 1977, Geology of Rocky Mountain coal--A symposium, 1976: Colorado Geol. Survey Resource Ser. 1, 175 p., illus., tables, sections.

Myers, A.R., and others, 1978, Coal and clay mine hazard study and estimated unmined coal resources, Jefferson County, Colorado: Amuedo and Ivey, Consulting Geologists, Denver.

Newman, K.R., 1964, Palynologic correlations of Late Cretaceous and Paleocene formations, northwestern Colorado, in Palynology in oil exploration - A symposium, San Francisco, Calif., 1962: Soc. Econ. Paleontologists and Mineralogists Spec. Pub. 11, p. 169-180, illus.

Newman, Karl R., 1965, Mancos to Wasatch measured section in Meeker-Rio Blanco area, northwestern Colorado: Mtn. Geologist, v. 2, no. 3, p. 135-139.

Pearl, R.H., and Murray, D.K., 1974, Colorado stratigraphic correlation chart: Colorado Geol. Survey, 1 plate.

Phipps, J.B., 1961, Geology of the area north of New Castle, Colorado: M.S. Thesis, Univ. of Colorado.

Poole, F.G., 1954, Geology of the southern Grand Hogback area, Garfield and Pitkin Counties, Colorado: M.S. thesis, Univ. Colorado.

REFERENCES

Reeside, J.B., and Knowlton, F.H., 1924, Upper Cretaceous and Tertiary formations of the western part of the San Juan basin, Colorado and New Mexico, and flora of the Animas Formation: U.S. Geol. Survey Prof. Paper 134, 117 pp., illus., tables, sections, index map, geol. map.

Richardson, G.B., 1909, Reconnaissance of the Book Cliffs coal field between Grand River, Colorado and Sunnyside, Utah: U.S. Geol. Survey Bull. 371, 54 p., illus., geol. map.

___1910, The Trinidad coal field, Colorado: U.S. Geol. Survey Bull. 381-C, p. 379-446, illus., sections, geol. map.

Robinson, C.S., and Associates, 1975, Mineral Resources maps of Moffat County, Colorado: Colorado Geol. Survey Open-File Rept. 75-3, 3 sheets, scale 1:126,720.

Rocky Mountain Association of Geologists, 1972, Geologic atlas of the Rocky Mountain Region, United States of America: Denver, Colorado, Rocky Mtn. Assoc. Geologists.

Roehler, H.W., 1973a, Geologic map of Henderson Ridge quadrangle, Garfield County, Colorado: U.S. Geol. Survey Quad. Map GQ-1113, scale 1:24,000.

___1973b, Geologic map of Calf Canyon quadrangle, Garfield County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-1086, scale 1:24,000.

Schrader, F.C., 1906, The Durango-Gallup coal field of Colorado and New Mexico: U.S. Geol. Survey Bull. 285-F, p. 241-258, illus., sections, geol. map.

Schwochow, S.D., 1978, Mineral resources survey of Mesa County--A model study: Colorado Geol. Survey Resource Ser. 2, 110 p., illus, maps.

Scott, G.R., 1977, Reconnaissance geologic map of the Canon City quadrangle, Fremont County, Colorado: U.S. Geol. Survey Misc. Field Studies Map MF-892.

_____, and Cobban, W.A., 1975, Geologic and biostratigraphic map of the Pierre Shale in the Canon City - Florence basin and the Twelve Mile Park area, south-central Colorado: U.S. Geol. Survey Misc. Inv. Ser. Map I-937.

_____, and Taylor, R.B., 1974, Reconnaissance geologic map of the Rockvale quadrangle, Custer and Fremont Counties, Colorado: U.S. Geol. Survey Misc. Field Studies Map MF-562.

Serviss, F.L.F., 1922, The Trinidad coal field of Colorado: M.S. thesis, Colorado Sch. Mines, 80 p., diagrams.

REFERENCES

Shaler, M.K., 1907, A reconnaissance survey of the western part of the Durango-Gallup coal field of Colorado and New Mexico: U.S. Geol. Survey Bull. 316-F, p. 376-426, illus., tables, sections, geol. map.

Speltz, C.N., 1976, Strippable coal resources of Colorado - location, tonnage, and characteristics of coal and overburden: U.S. Bur. Mines Inf. Circ. 8713, 70 p.

Stark, J.T., Johnson, J.H., Behre, C.J., Jr., and others, 1949, Geology and origin of South Park, Colorado: Geol. Soc. America Memoir 33, 188 p.

Taff, J.A., 1907, The Durango coal district, Colorado: U.S. Geol. Survey Bull. 316, p. 321-337, illus., sections, geol. map.

Toenges, A.L., Turnbull, L.A., Davis, J.D., Reynolds, D.A., Cooper, H.M., and Abernethy, R.F., 1952, Coal deposits, Coal Creek district, Gunnison County, Colorado: U.S. Bur. Mines Bull. 501, 83 pp.

Tweto, Ogden, 1975, Preliminary geologic map of the Craig 1° x 2° Quadrangle, northwestern Colorado: U.S. Geol. Survey Misc. Field Studies Map MF-666.

___1976, Preliminary geologic map of Colorado: U.S. Geol. Survey Misc. Field Studies Map MF-788, scale 1:500,000, 2 sheets.

U.S. Bureau of Mines, (undated), Microfilm data file for the State of Colorado: U.S. Bur. Mines Intermountain Field Operations Center, Denver, Colorado.

___1973, Bureau of Mines coal analyses data for the State of Colorado: U.S. Bur. Mines Data Bank, computer printout.

___1975, Demonstrated coal reserve base of the United States by sulfur category, on January 1, 1974: U.S. Bur. Mines Mineral Industry Surveys, Washington, D.C., May, 7 p.

___1976, Bureau of Mines coal analyses data for the State of Colorado: U.S. Bur. Mines Mineral Industry Surveys, Washington, D.C., 8 p.

___1977, Demonstrated coal reserve base of the United States on January 1, 1976: Mineral Industry Survey, 1977, August 1977, 8 p., 5 tables.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geol. Survey Bull. 1450-B,, 7 p., table, fig.

REFERENCES

U.S. Geological Survey and Colorado Geological Survey, 1977, Energy resources map of Colorado: U.S. Geol. Survey Misc. Geol. Inv. Map I-1039, scale 1:500,000.

U.S. Geological Survey and U.S. Bureau of Mines, 1977, Mineral resources of the Chama-Southern San Juan Mountains Wilderness Study Area, Mineral, Rio Grande, Archuleta, and Conejos Counties, Colorado: U.S. Geol. Survey Open-File Rept. 77-309.

Wanek, A.A., 1954, Geologic map of the Mesa Verde area, Montezuma County, Colorado: U.S. Geol. Survey Oil and Gas Inv. Map OM-152, scale 1:63,360.

___1959, Geology and fuel resources of the Mesa Verde area, Montezuma and La Plata Counties, Colorado: U.S. Geol. Survey Bull. 1072-M, p. 667-721, illus., tables, sections, geol. map.

Warner, D.L., 1961, Stratigraphy of the Mancos - Mesaverde intertonguing, southeast Piceance basin, Colorado, and geology of a portion of the Grand Hogback, Garfield County, Colorado: M.S. thesis, Colorado Sch. Mines.

Washburne, C.W., 1910, The South Park coal field, Colorado: U.S. Geol. Survey Bull. 381-C, p. 307-316, table, section, geol. map.

___1910, The Canon City coal field, Colorado: U.S. Geol. Survey Bull. 381-C, p. 341-378, illus., sections, table, geol. map.

White, C.A., 1889, On the geology of and physiography of a portion of northwestern Colorado and adjacent parts of Utah and Wyoming: U.S. Geol. Survey Annual Rept. No. 9, p. 677-712, illus., map.

Williams, P.L., 1964, Geology, structure, and uranium deposits of the Moab quadrangle and Nucla-Naturita area, Colorado and Utah: U.S. Geol. Survey Misc. Geol. Inv. Map I-360, scale 1:250,000.

Wood, G.H., Johnson, R.B., and Dixon, G.H., 1956, Geology and coal resources of the Gulnare-Cuchara Pass, and Stonewall area, Huerfano and Las Animas Counties, Colorado: U.S. Geol. Survey Coal Inv. Map C-26, scale 1:31,680.

___1957, Geology and coal resources of the Starkville - Weston area, Las Animas County, Colorado: U.S. Geol. Survey Bull. 1051, 68 pp., illus, tables, sections, geol. map.

Wood, G.H., Jr., Johnson, R.B., Eargle, D.H., Duffner, R.T., and Major, Harold, 1951, Geology and coal resources of the Stonewall - Tercio area, Las Animas County, Colorado: U.S. Geol. Survey Coal Inv. Map C-4, 2 sheets, scale 1:31,680.

REFERENCES

Wood, G.H., Kelly, V.C., and MacAlpin, A.J., 1948, Geology of the southern part of Archuleta County, Colorado: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 81, scale 1:63,360.

Woodruff, E.G., 1912, Coal resources of Gunnison Valley, Mesa and Delta Counties, Colorado: U.S. Geol. Survey Bull. 471, p. 565-593, illus., map.

Zapp, A.D., 1949, Geology and coal resources of the Durango area, La Plata and Montezum Counties, Colorado: U.S. Geol. Survy Oil and Gas Inv. Prelim. Map 109, scale 1:31,680.

_____, and Cobban, W.A., 1960, Some Late Cretaceous strand lines in northwestern Colorado and northeastern Utah, in Geological Survey Research, 1960--Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper No. 400-B, p. 246-249.

APPENDIX

Coal Region: Canon City

Coal Field: Canon City

County(ies): Fremont

Geographic Setting: Located in south-central Colorado (Fig. 2). Main population centers are Canon City and Florence. Lies about 45 mi southwest of Colorado Springs.

Geologic Setting: Part of Canon City - Florence basin, a Laramide-age structural basin with Precambrian rocks to the south and west and Cretaceous rocks to the north and east. The basin is believed to be a northward extension of the Raton Mesa region (Hornbaker and others, 1976). Main structures are the Wet Mountains thrust fault system and Chandler syncline.

Stratigraphy of the coal-bearing rock unit(s)

Vermejo Formation (Upper Cretaceous): The Vermejo Formation here is reported by Washburne (1910) to be approximately 1,200 ft thick. It consists mainly of sandstone with lesser amounts of shale and coal. It most likely was deposited in a marginal-marine environment.

No other formations in the Canon City field are reported to be coal-bearing.

Stratigraphy of the Coal Zones and Minable Beds

The coal is concentrated in the lower 600-700 ft of the Vermejo Formation. Hornbaker and others (1976) reported 16 coal beds in the field, 7 of which appear to be minable. These are grouped into 6 coal "zones" in the present report (Fig. 5). The coal beds mined range from 2 ft to over 10 ft thick.

Production and Depletion History

Number of mines on record: 177

Cumulative production to 1/1/77 (short tons): 40,940,262

Cumulative Production to 1/1/79, preliminary (short tons): 41,155,560

Total reserve base depletion to 1/1/77 (short tons): 73,331,716

Original demonstrated reserve base (estimated, million short tons): 180.32
(per T.K. Matson, U.S. DOE, Denver)

Percentage of reserve base depleted: 40.7 (59.3% remaining)

Remaining reserve base to 1/1/77 (estimated, million short tons): 106.99

Selected References

Hornbaker and others (1976); Lee and Knowlton (1917); Scott (1977); Scott and Taylor (1974); Washburne (1910).

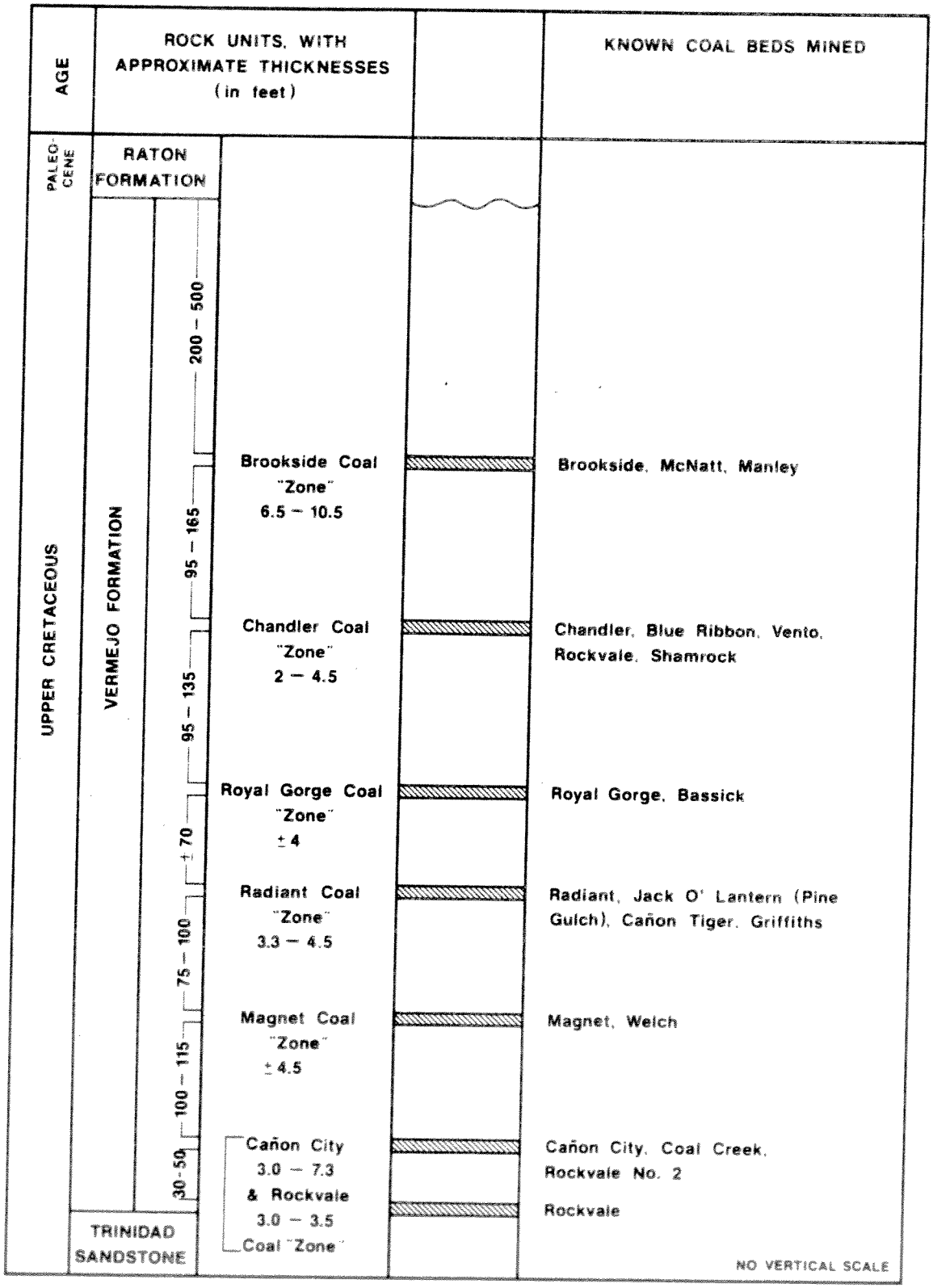


Figure 5. --Generalized columnar section of coal-bearing rocks in the Canon City field, Colorado (after Hornbaker and others, 1976; Lee and Knowlton, 1917; Tweto, 1976; and Washburne, 1910).

Coal Region — Denver

Coal Field(s) — Boulder-Weld, Briggsdale (area), Buick-Matheson (area), Colorado Springs, Eaton (area), Foothills (district), Ramah-Fondis (area), Scranton (district), and Wellington (area)

County(ies) — Adams, Arapahoe, Boulder, Douglas, Elbert, El Paso, Jefferson, Larimer, and Weld

Geographic Setting — Located in eastern Colorado, the Denver region covers approximately 7,500 sq mi (Fig. 2). It is bordered by the Front and Rampart Ranges on the west, and the Colorado-Wyoming border on the north. The region extends onto the Colorado high plains to the south and east.

Geologic Setting — The Denver region is composed of two structural basins: Denver basin and Cheyenne basin, separated by a structural high termed the Greeley arch (Kirkham and Ladwig, 1979). Other main controlling structural features are the Laramide-age Front Range uplift to the west and the Las Animas arch to the southeast.

Stratigraphy of the Coal-Bearing Rock Unit(s)

Laramie Formation (Upper Cretaceous): This unit consists of approximately 300-700 ft of sandstone with interbedded shale and coal. The sequence was deposited in a marginal-marine environment. Mined coal beds ranged from 1 to over 14 ft thick.

Denver Formation (Upper Cretaceous-Paleocene): This unit consists of [approximately] 600-1580 ft of claystone, siltstone, fine-grained sandstone, and andesitic conglomerate. It was deposited in a continental environment.

Stratigraphy of the Coal Zones and Minable Beds

Due to structural complexity and general lack of data, columnar sections were constructed only for the Laramie Formation in the Boulder-Weld and Colorado Springs fields (Figs. 6 and 7). Kirkham and Ladwig (1979) have completed an extensive study of the Denver Formation; however, time did not allow correlation of these data with the mine data collected for the subject project.

Production and Depletion History

Number of mines of record: 387

Cumulative production to 1/1/77 (short tons): 130,196,330

Cumulative production to 1/1/79, preliminary (short tons): 130,374,342

Total reserve base depletion to 1/1/77 (short tons): 260,216,717

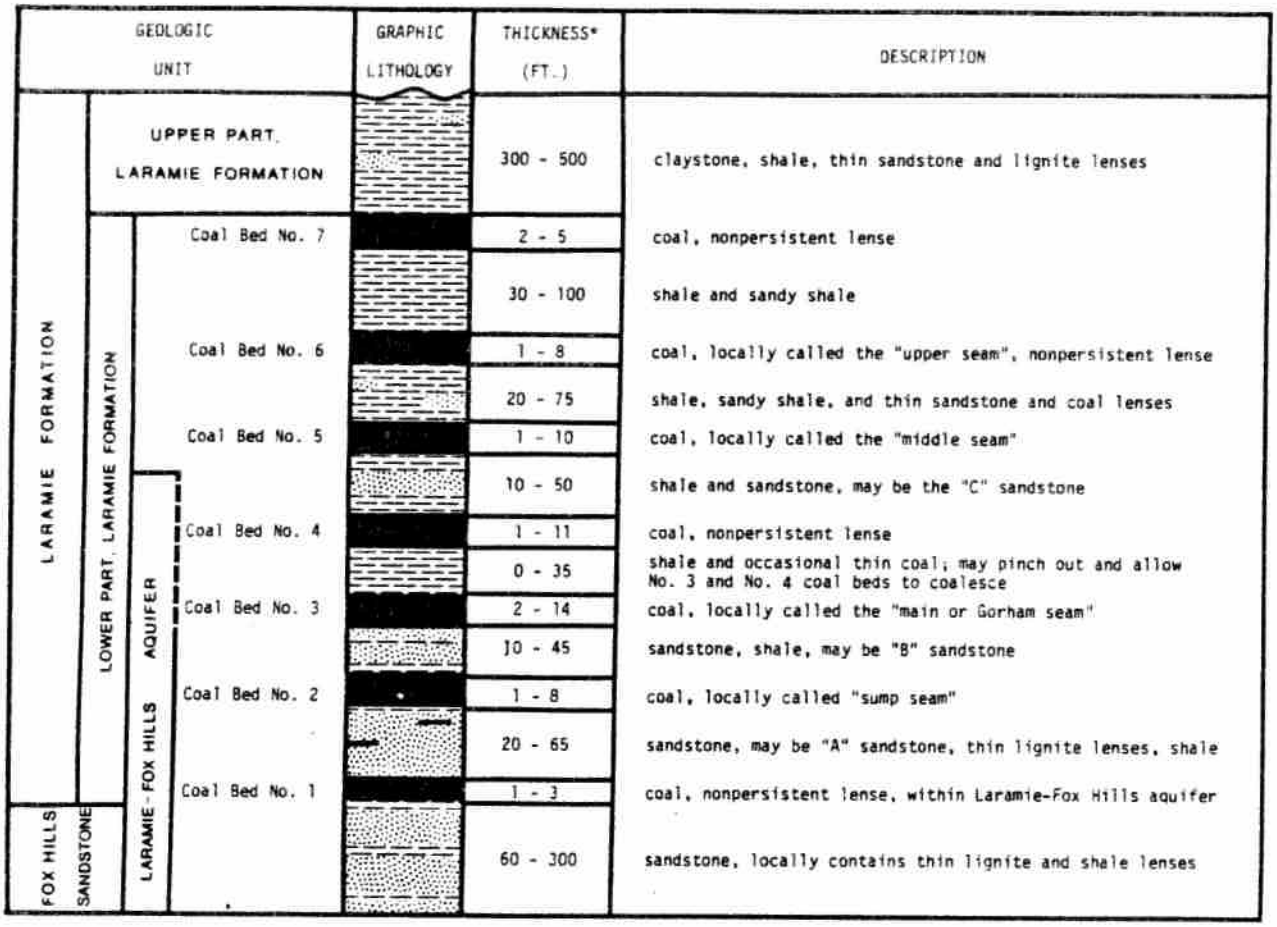
Original demonstrated reserve base (estimated, million short tons): 4,006.07 (per T.K. Matson, U.S. DOE, Denver)

Percentage of reserve base depleted: 6.5 (93.5% remaining)

Remaining reserve base to 1/1/77 (estimated, million short tons): 3,745.85

Selected References

Amuedo and Ivey (1975); Colorado Springs Planning Department (1967); Goldman (1908); Kirkham (1978); Kirkham and Ladwig (1979); Lowrie (1966); Martin (1910); Marvine (1874); Myers and others (1978).



*thickness not to scale

modified from Lowrie (1966), Amuedo and Ivey (1975), and Zawistowski, pers. comm. (1978)

Figure 6. --Generalized columnar section of coal-bearing rocks in the Boulder-Weld field, Denver region, Colorado (from Kirkham, 1978).

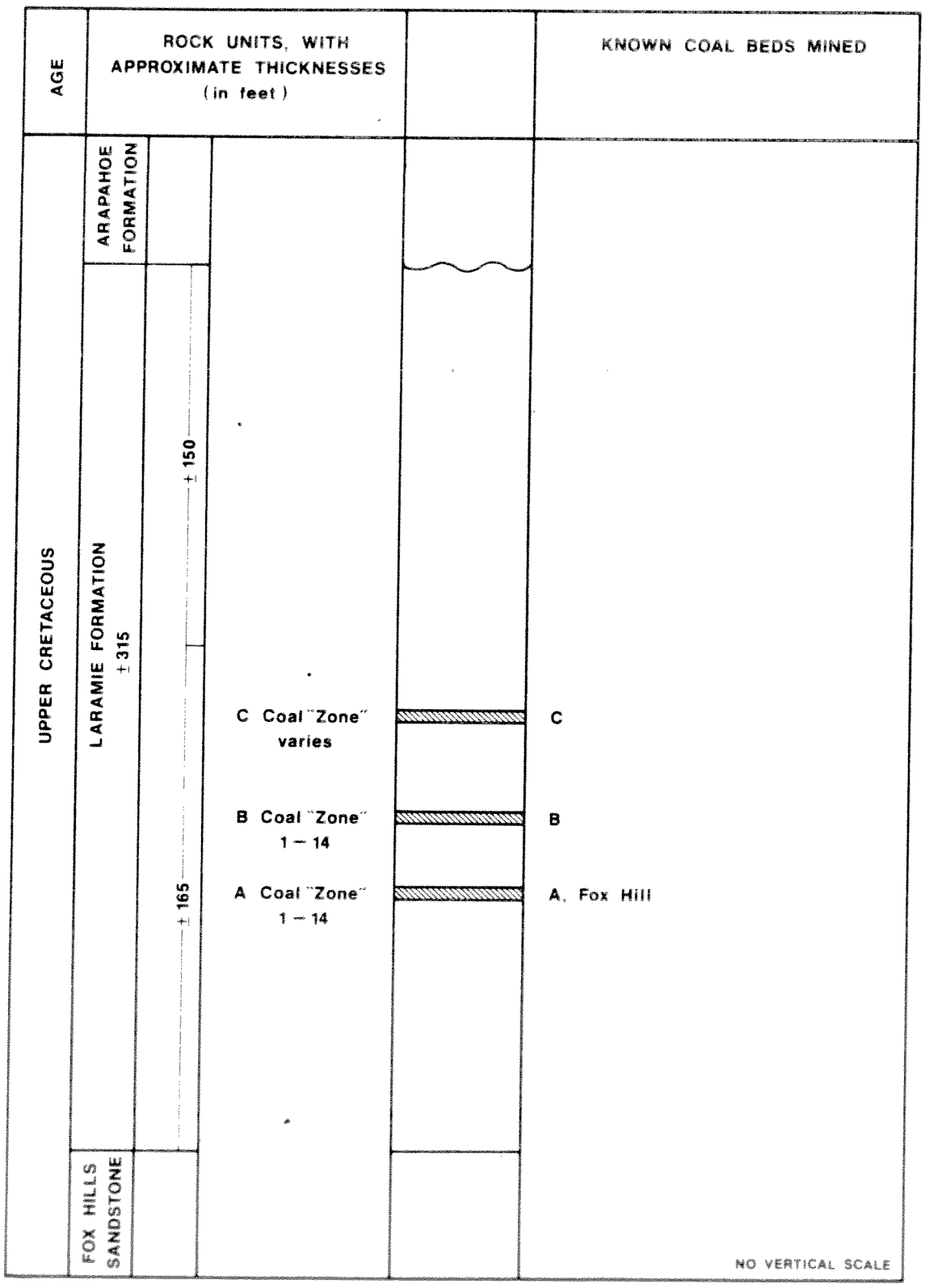


Figure 7. --Generalized columnar section of coal-bearing rocks in the Colorado Springs field, Denver region, Colorado (after Goldman, 1908).

Coal Region — Green River

Coal Field — Yampa

County(ies) — Moffat and Routt

Geographic Setting — Located in northwestern Colorado (Fig. 2). Bounded on the north by the Colorado-Wyoming State line, on the east by the Park Range, on the west by the Colorado-Utah State line, and on the south by the Axial Basin uplift.

Geologic Setting — The Green River region covers a large area in southwestern Wyoming and northwestern Colorado. The Colorado part of the region, the Sand Wash basin, is a structural basin of Laramide age. Local folding and faulting exist in parts of the area.

Stratigraphy of the Coal-Bearing Rock Unit(s)

Iles Formation, Mesaverde Group (Upper Cretaceous): The oldest of the coal-bearing rock units; consists of approximately 1,500 ft of sandstone, shale, and coal.

Williams Fork Formation, Mesaverde Group (Upper Cretaceous): Consists of from 1,100-2,000 ft of sandstone, shale, and coal.

Both the Iles and Williams Fork Formations were deposited in a predominantly marginal-marine environment.

Lance Formation (Upper Cretaceous): Consists of approximately 1,050-1,500 ft of shale, sandstone, and local coal beds.

Fort Union Formation (Paleocene): Consists of approximately 1,400 ft of shale, sandstone, and local coal beds.

Wasatch Formation (Eocene): Consists of 1,000-plus ft of claystone, shale, sandstone, and some coal beds.

The Lance was deposited in a marginal marine environment, while the Fort Union and Wasatch are predominantly of freshwater origin.

Stratigraphy of the Coal Zones and Minable Beds

Iles Formation: The lower coal "group" of the Iles Formation is concentrated in the upper 1,000-1,100 ft of the formation (Fig. 8). The "group" contains six known major coal zones: No. 1, A, B, C, D, and E. Coal beds up to 12 ft in thickness have been mined.

Williams Fork Formation: Contains two major coal "groups": The Middle coal "group" with the F, G, H or Wolf Creek, I or Wadge, J or Lennox coal zones; and the upper coal "group," with the K, L, M, N, O, P, Q, R, S coal zones (Fig. 9). Coal beds up to 16 ft thick have been worked in the area.

The Lance, Fort Union, and Wasatch Formations are coal-bearing in this region. Data on the Lance, Fort Union, and Wasatch were not available in sufficient detail to draft up columns for these formations. For more information, see Bass and Eby (1955).

Production and Depletion History

Number of mines of record: 192

Cumulative production to 1/1/77 (short tons): 74,585,237

Cumulative production to 1/1/79, preliminary (short tons): 89,990,725

Total reserve base depletion to 1/1/77 (short tons): 117,653,924

Original demonstrated reserve base (million short tons): 6,683.14
(per T.K. Matson, U.S. DOE, Denver)*

Percentage of reserve base depleted: 1.76 (98.24% remaining)

Remaining reserve base to 1/1/77 (million short tons): 6,565.49

Selected References

Bass and others (1955); Campbell (1923); Fenneman and Gale (1906a); Fenneman and Gale (1906b); Gale (1909); Gale (1910); Hancock (1925); Tweto (1975).

* Although part of Moffat County is in the Uinta region, its reserve estimates were included entirely in the Green River region.

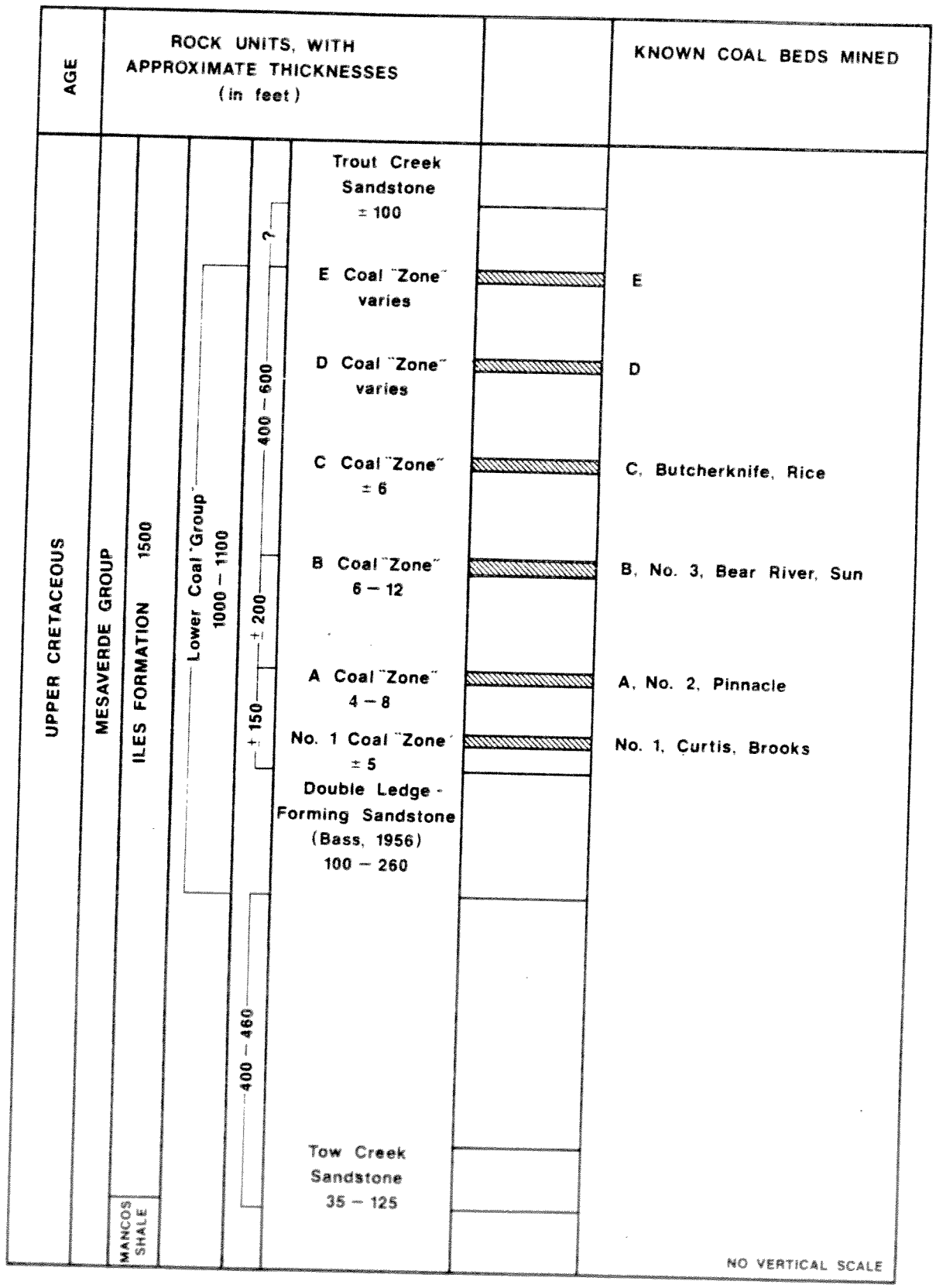


Figure 8. --Generalized columnar section of coal-bearing rocks in the Iles Formation, Yampa field, Green River region, Colorado (after Bass and Eby, 1955).

GREEN RIVER REGION - WILLIAMS FORK FORMATION

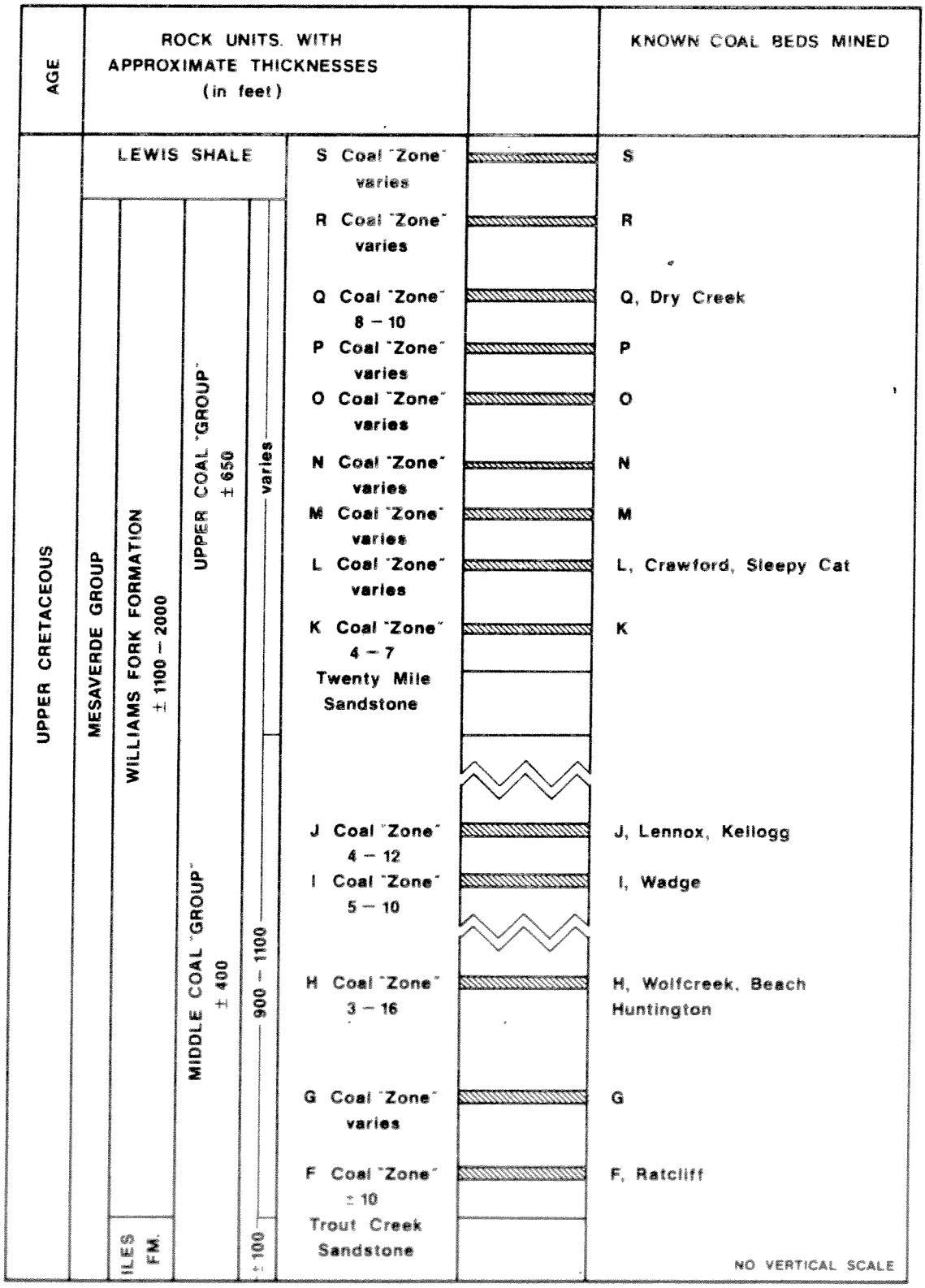


Figure 9. --Generalized columnar section of coal-bearing rocks in the Williams Fork Formation, Yampa field, Green River region, Colorado (after Bass and Eby, 1955).

Coal Region North Park

Coal Field North Park

County(ies) Jackson

Geographic Setting Located in north-central Colorado (Fig. 2), North Park is an intermontane basin bounded by the Colorado-Wyoming border on the north, the Park Range on the west, the Medicine Bow Range on the east, and the Rabbit Ears Range on the south. The main population center is Walden, Colorado.

Geologic Setting The North Park region is both a Laramide-age structural and depositional basin. Major structural controls include the Independence Mountain thrust fault on the north, the Park Range uplift on the west, the Medicine Bow uplift on the east, and the North Park syncline, which trends along the eastern side of the field. The area also contains a number of igneous intrusive and extrusive bodies related to middle to late Tertiary activity south of the field.

Stratigraphy of the Coal-Bearing Rock Unit(s)

Coalmont Formation (Paleocene-Eocene): The only coal bearing-unit in this region is the Coalmont Formation, which varies from 2,000 to 12,000(?) ft in thickness, and consists mainly of terrigenous clastics, carbonaceous shales, and coals.

Stratigraphy of the Coal Zones and Minable Beds

Coal beds occur throughout the Coalmont sequence. Two areas that have been extensively mined in the North Park region are the Coalmont district and the McCallum Anticline district. Due to variations in the stratigraphy, columnar sections have been constructed for each district (Figs. 10 and 11). The bed most extensively mined in the Coalmont district is the Riach coal bed; and in the McCallum Anticline district, the Sudduth coal bed. Both beds reach maximum thicknesses of approximately 60-70 ft in North Park.

Production and Depletion History

Number of mines of record: 35

Cumulative production to 1/1/77 (short tons): 2,737,704

Cumulative production to 1/1/79 preliminary (short tons): 3,941,317

Total reserve base depletion (short tons): 10,029,822

Original demonstrated reserve base (estimated, million short tons): 823.51
(per T.K. Matson, U.S. DOE, Denver)

Percentage of reserve base depleted: 1.22 (98.78% remaining)

Remaining reserve base to 1/1/77 (estimated, million short tons): 813.48

Selected References

Beekly (1915); Erdmann (1941); Hail (1965); Hail (1968); Kinney and Hail (1970a); Kinney and Hail (1970b); Kinney (1970a); Kinney (1970b); Kinney and others (1970); Miller (1934); Marr (1931).

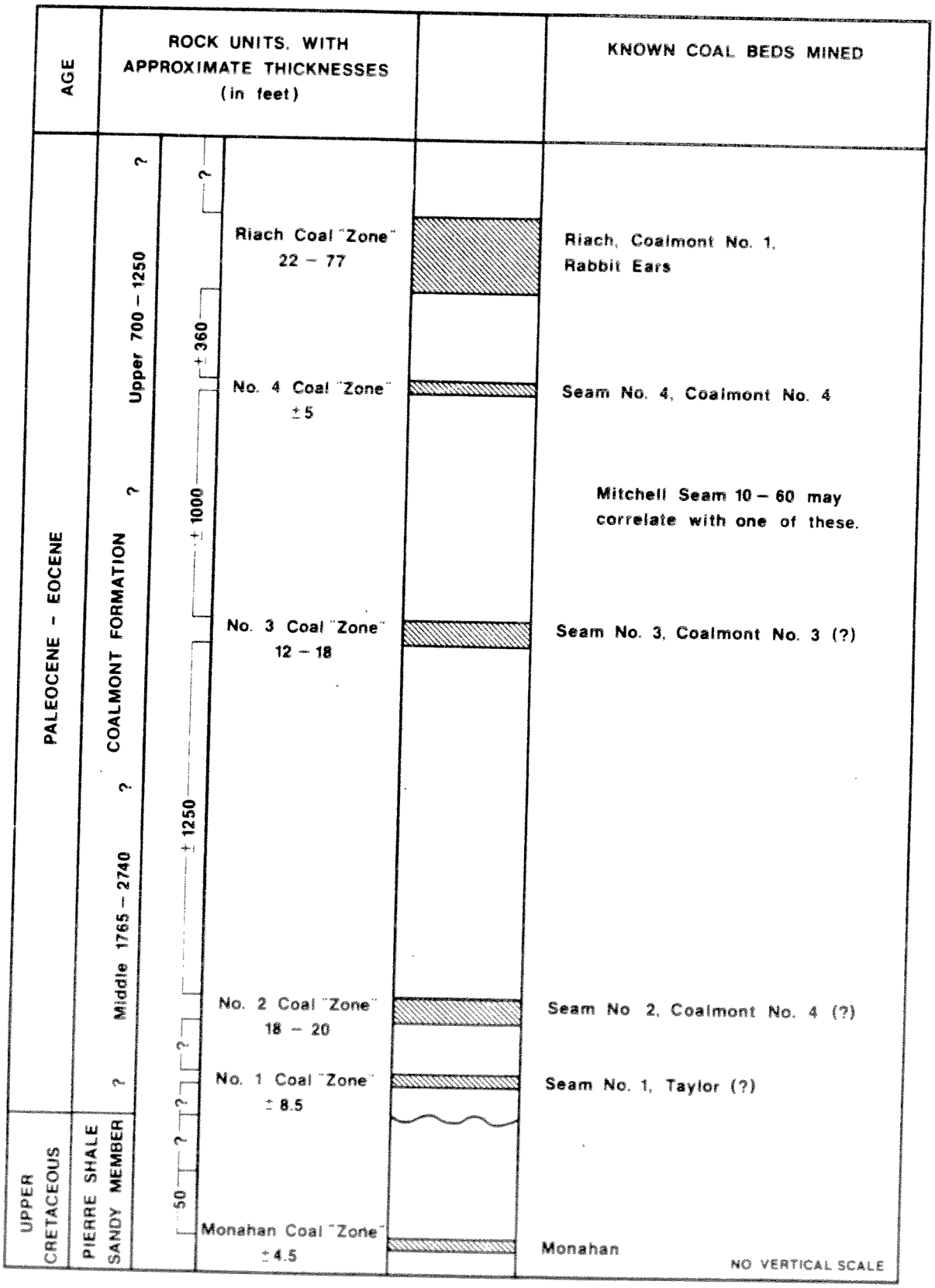


Figure 10. --Generalized columnar section of coal-bearing rocks in the Coalmont district, North Park field, Colorado (after Beekly, 1915; Erdmann, 1941; Hail, 1968; and Hornbaker and others, 1976).

NORTH PARK - McCALLUM ANTICLINE DISTRICT

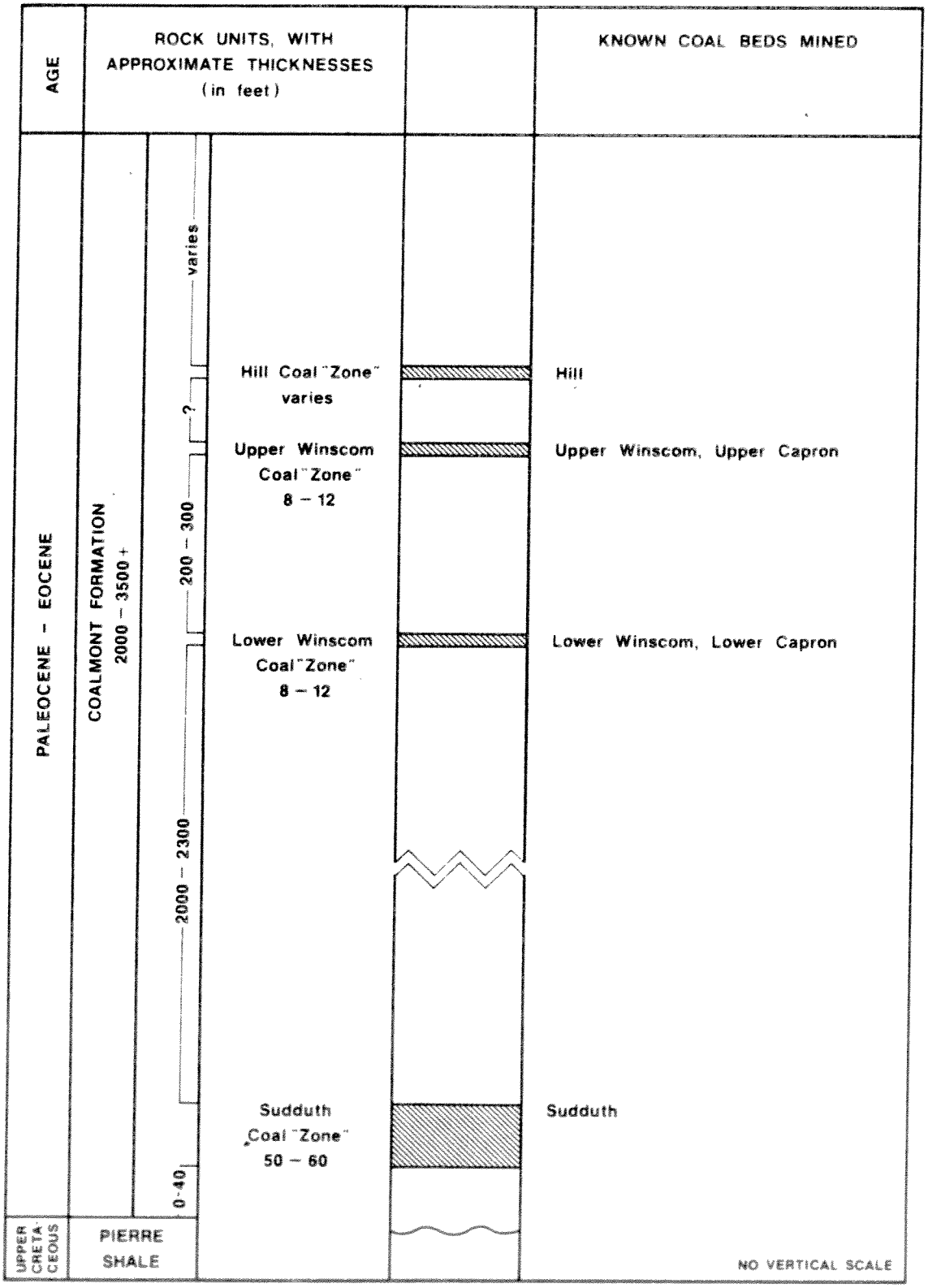


Figure 11. --Generalized columnar section of coal-bearing rocks in the McCallum Anticline district, North Park field, Colorado (after Beekly, 1915; Hail, 1965; and Hornbaker and others, 1976).

Coal Region — Raton Mesa

Coal Fields — Trinidad and Walsenburg

County(ies) — Huerfano and Las Animas

Geographic Setting — The Raton Mesa region covers a large area in southern Colorado and northern New Mexico (Fig. 1). The Colorado portion of the region is bordered by the Cucharas River on the north, the Culebras and Sangre de Cristo mountains on the west, the high plains on the east, and the Colorado-New Mexico border on the south. The main population centers are the towns of Trinidad and Walsenburg, Colorado.

Geologic Setting — The Colorado part of this region consists of the northern portion of the asymmetric Raton structural basin of Laramide age. The main structures in the area are the La Veta syncline, which trends southeast, following the western edge of the basin; the Sangre de Cristo uplift on the west; and the Del Carbon syncline and Greenhorn anticline, that strike southwest and are located in the northern part of the basin.

Stratigraphy of the Coal-Bearing Rock Unit(s)

Vermejo Formation (Upper Cretaceous): Varies from 79 to 552 ft in thickness; consists mainly of sandstone, shale, and coal.

Raton Formation (Upper Cretaceous-Paleocene): Consists of from zero to 2,075 ft of arkosic sandstone, siltstone, shale, and major coal beds.

The Vermejo Formation was deposited in a regressive marginal-marine environment, while the Raton Formation is predominantly of freshwater origin.

Stratigraphy of the Coal Zones and Minable Beds

Coal occurs throughout the Vermejo and Raton Formations (Figs. 12 and 13). Due to the complexity of the coal-bearing sequences in both formations, the shaded areas on Figures 12 and 13 designate the general stratigraphic location of the zones and the variations in vertical distance of each zone above the Trinidad sandstone. Mined coal bed thicknesses vary from 1 ft to greater than 14 ft.

Production and Depletion History

Number of mines of record: 371

Cumulative production to 1/1/77 (short tons): 250,124,216

Cumulative production to 1/1/79, preliminary (short tons): 251,522,676

Total reserve base depletion to 1/1/77 (short tons): 500,211,026

Original demonstrated reserve base (estimated million short tons):

1,171.68 (per T.K. Matson, U.S. DOE, Denver)

Percentage of reserve base depleted: 42.69 (57.31% remaining)

Remaining reserve base to 1/1/77 (estimated, million short tons): 671.47

Selected References

Anonymous (1903); Amuedo and Bryson (1977); Amuedo and Ivey (1977); Carter (1956); Danilchik (1978); Harbour and Dixon (1959); Hills (1899); Hills (1900); Hills (1901); Johnson and Stephens (1954b); Johnson and Stephens (1955); Johnson (1958); Johnson (1969); Lee (1922); Lee and Knowlton (1917); Richardson (1910); Serviss (1922); Wood and others (1951); Wood and others (1956); Wood and others(1957).

RATON MESA REGION - VERMEJO FORMATION

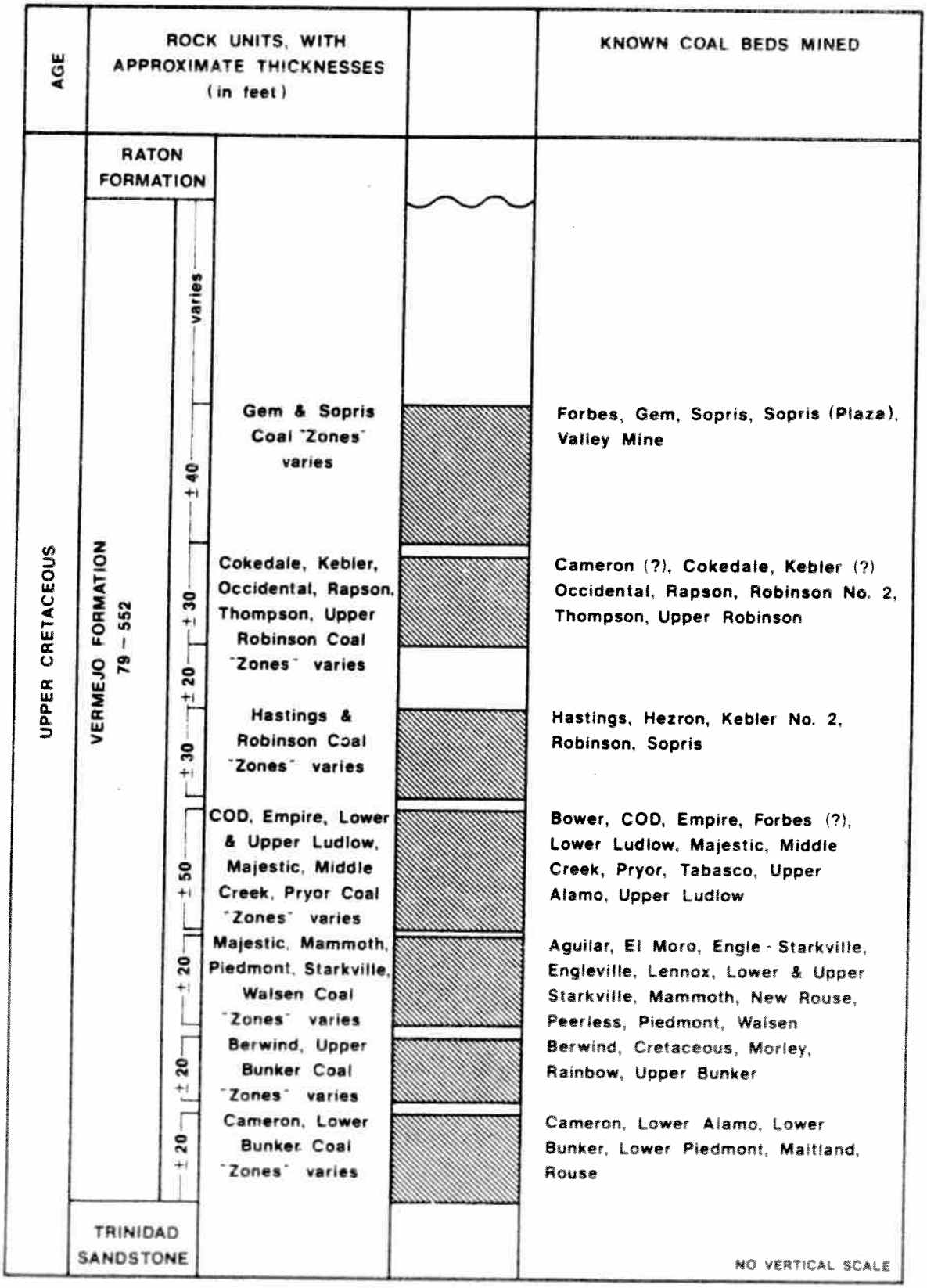


Figure 12. --Generalized columnar section of coal-bearing rocks in the Vermejo Formation, Raton Mesa region, Colorado (after Danilchik, personal communication; Harbour and Dixon, 1959; Johnson, 1958; Johnson and Stephens, 1954b; Richardson, 1910; Wood and others, 1956; and Wood and others, 1957). Shaded area designates the general stratigraphic location of the coal zones and their estimated lower and upper stratigraphic limits.

RATON MESA REGION - RATON FORMATION

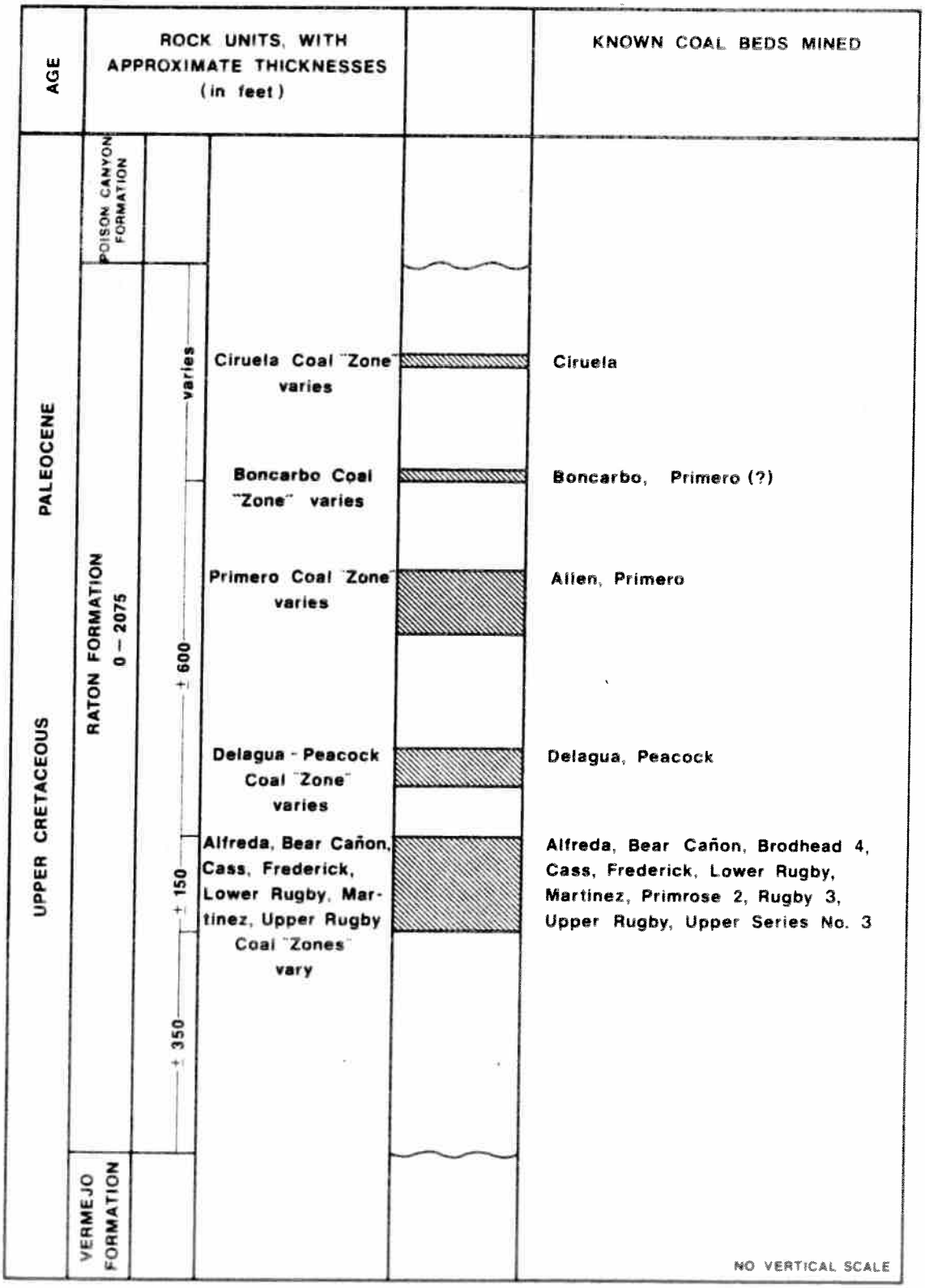


Figure 13. --Generalized columnar section of coal-bearing rocks in the Raton Formation, Raton Mesa region, Colorado (after Danilchik, personal communication; Danilchik (1978(9?); Harbour and Dixon, 1959).
Shaded area designates the general stratigraphic location of the coal zones and their estimated lower and upper stratigraphic limits.

Coal Region — San Juan River

Coal Fields — Durango, Nucla-Naturita, and Pagosa Springs

County(ies) — Archuleta, Dolores, La Plata, Montezuma, Montrose, Ouray, and San Miguel

Geographic Setting — Located in southwestern Colorado and northwestern New Mexico, the region covers approximately 7,500 sq mi (Fig. 2). The Colorado portion of the region is bordered on the north and east by the Gunnison River and the San Juan Mountains, and on the south and west by the Colorado-New Mexico and Colorado-Utah borders, respectively. Durango, Cortez, and Pagosa Springs, Colorado, are the main population centers.

Geologic Setting — The region is part of an asymmetric structural basin of Laramide age located in Colorado and New Mexico. The Colorado part of the basin is as much as 8,000 feet deep, using the base of the Dakota Formation as a datum. Main tectonic features of the area are the Uncompahgre and the San Juan uplifts on the north, Four Corners platform on the south, and Paradox basin on the west.

Stratigraphy of the Coal-Bearing Rock Unit(s)

Dakota Formation (Upper Cretaceous): Composed of 200 to 300+ ft of sandstone, shale, and coal. It is the oldest of the coal-bearing rock units in Colorado.

Menefee Formation (Upper Cretaceous): Ranges from 300-400 ft in thickness in the Colorado area and consists mainly of sandstone, shale, and coal.

Fruitland Formation (Upper Cretaceous): Consists of approximately 300 ft of sandstone, shale, and coal. It is the youngest of the three coal-bearing rock units in the region.

All three coal-bearing sequences were deposited in a marginal-marine transgressive-regressive environment.

Stratigraphy of the Coal Zones and Minable Beds

Dakota Formation: Dakota coals are mined in two main areas--the Cortez area and the Nucla-Naturita field. In the Cortez area, three to four coal zones have been reported. Only one of these has been mined (Fig. 14).

In the Nucla-Naturita field, three coal zones have been reported (Fig. 15). The middle, or Oberding, coal zone has been the most heavily mined. In many areas, the No. 3 coal zone is eroded.

Menefee Formation: Coals have been mined extensively from three coal groups in the Menefee formation (Fig. 16). The coal beds mined range in thickness from 3 to 10 ft.

Fruitland Formation: Most of the important coals in the Fruitland occur at the base of the formation (Fig. 17). The coals vary from 3 to 30 ft thick.

Production and Depletion History

Number of mines of record: 194

Cumulative production to 1/1/77 (short tons): 11,791,379

Cumulative production to 1/1/79, preliminary (short tons): 12,136,466

Total reserve base depletion (short tons): 22,515,548

Original demonstrated reserve base (estimated, million short tons): 1,346.19 (per T.K. Matson, U.S. DOE, Denver)*

Percentage of reserve base depleted: 1.67 (98.33% remaining)

Remaining reserve base (estimated, million short tons): 1,323.67

Selected References

Amuedo and Ivey (1975); Barnes (1953); Barnes and others (1954); Boyer and Lee (1925); Collier (1919); Cullins and Bowers (1965); Dickinson (1965); Dickinson (1966); Fassett and Hinds (1971); Gardner (1909); Haines (1978); Holmes (1877); Kilgore (1955); Knowlton (1917b); Reeside and Knowlton (1924); Shaler (1907); Schrader (1906); Taff (1907); Wanek (1954); Wanek (1959); Zapp (1949).

* No reserve figures are available for Dolores and San Miguel Counties, although some coal has been produced from the area.

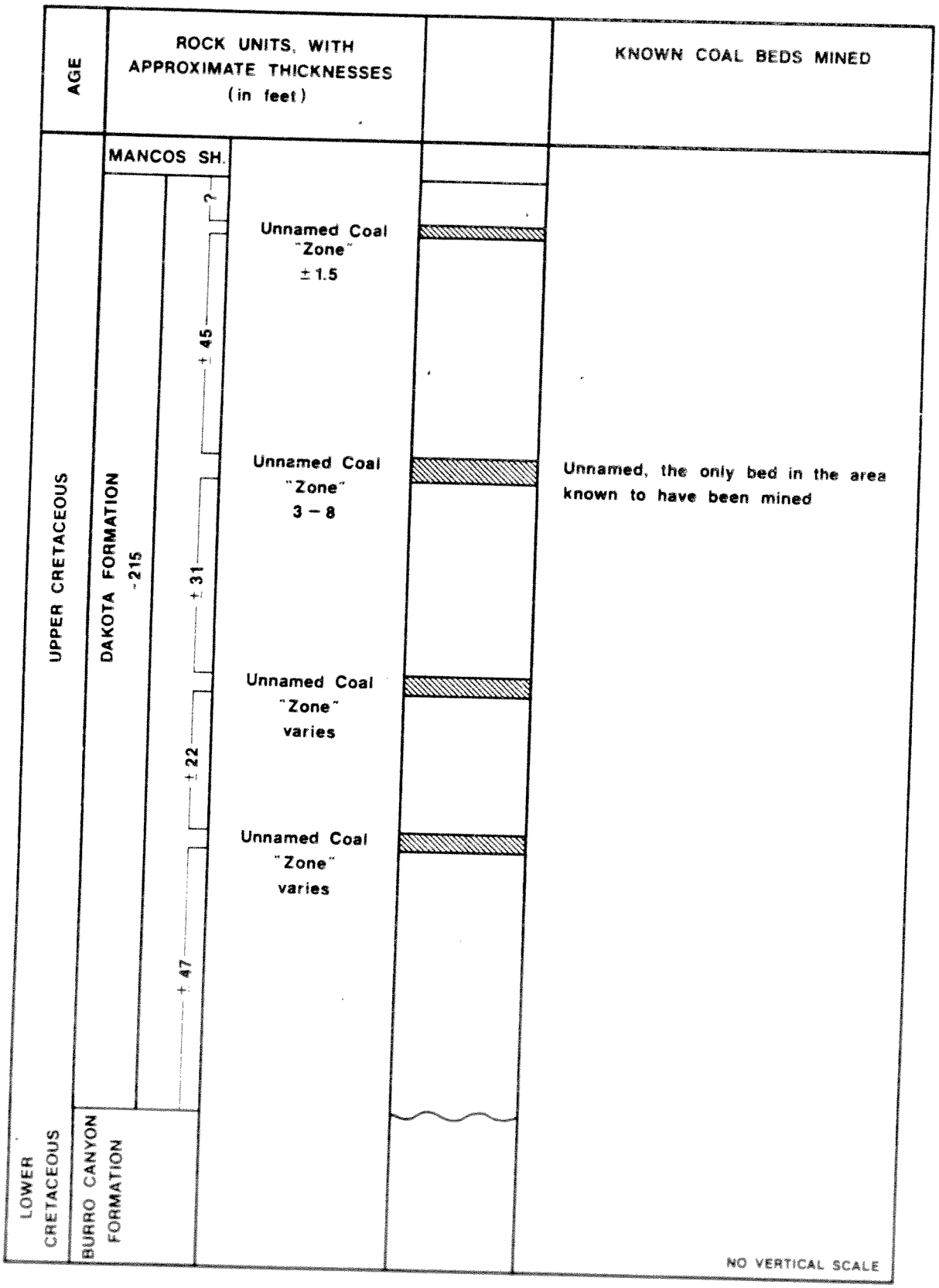


Figure 14. --Generalized columnar section of coal-bearing rocks in the Cortez area, San Juan River region, Colorado (after Cullins, 1965).

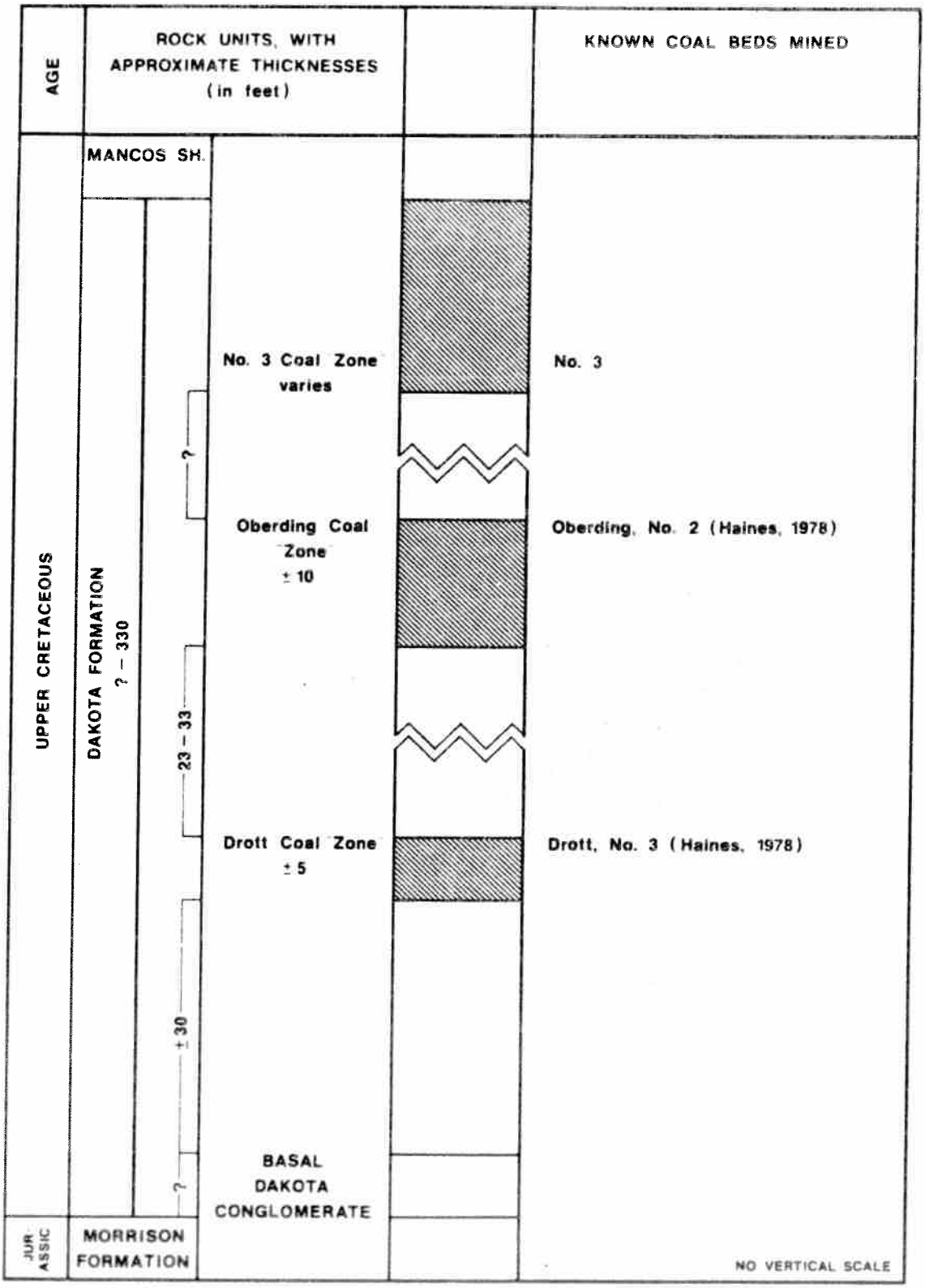


Figure 15. --Generalized columnar section of coal-bearing rocks in the Nucla-Naturita field, San Juan River region, Colorado (after Boyer and Lee, 1925; and Haines, 1978).

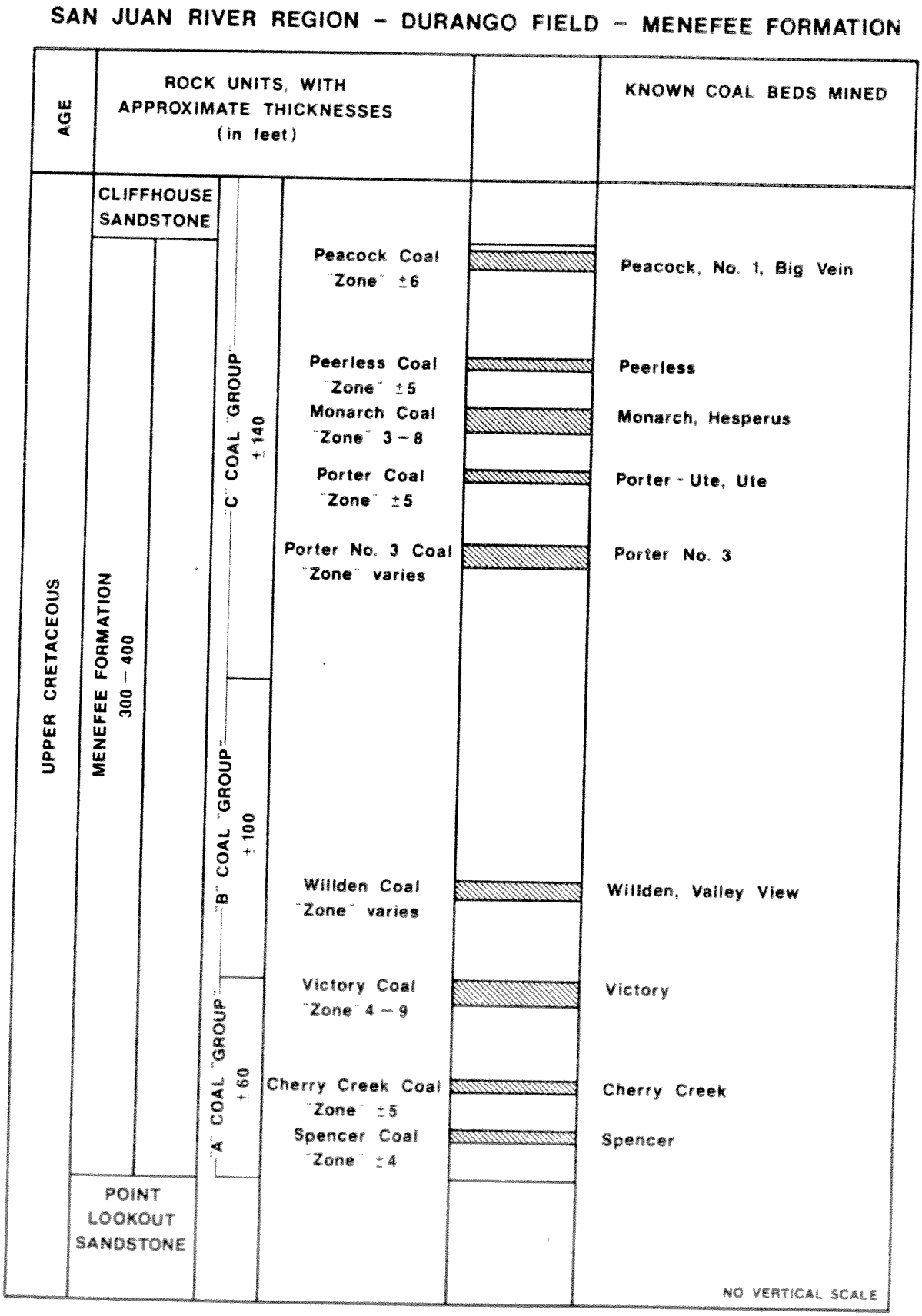


Figure 16. --Generalized columnar section of coal-bearing rocks in the Menefee Formation, Durango field, San Juan River region, Colorado (after Collier, 1919; and Zapp, 1949).

SAN JUAN RIVER REGION - DURANGO FIELD - FRUITLAND FM.

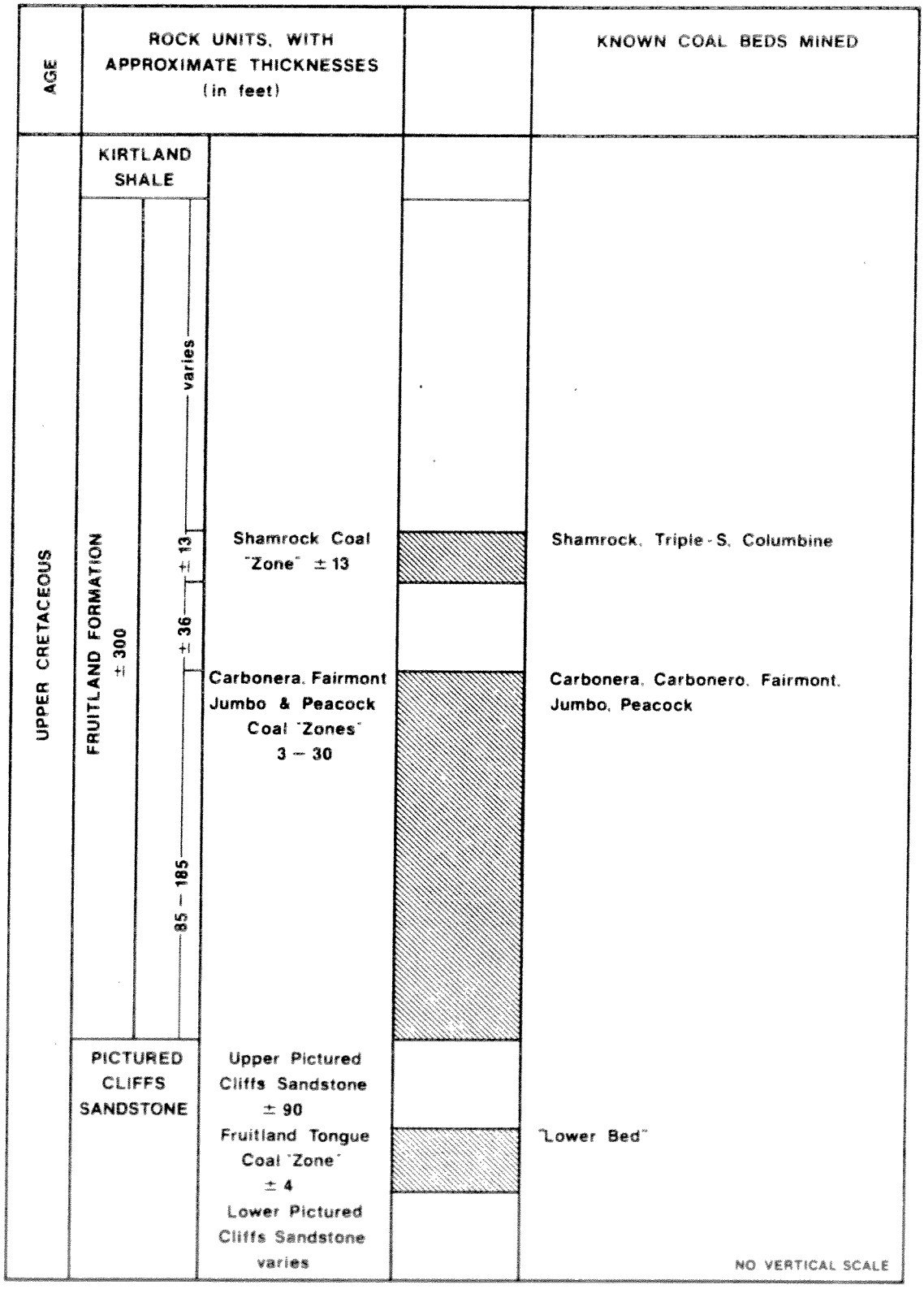


Figure 17. --Generalized columnar section of coal-bearing rocks in the Fruitland Formation, Durango field, San Juan River region, Colorado (after Barnes, 1953; Barnes, 1954; and Zapp, 1949).

Coal Region: South Park

Coal Field: South Park

County(ies): Park

Geographic Setting: South Park is an intermontane basin located in central Colorado (Fig. 2). It is bounded by the Front Range on the north, the Mosquito Range on the west, the Taryall Range on the northeast, and the Thirtynine Mile volcanic field on the south. The main population center is Fairplay.

Geologic Setting: South Park field is part of a Larimide-age structural basin. The chief structure in the area of interest is the Michigan syncline.

Stratigraphy of the Coal-Bearing Rock Unit(s)

Laramie Formation (Upper Cretaceous): Varies from 0-425 ft in thickness; composed of sandstone, with minor amounts of shale and coal. The sequence was deposited in a marginal-marine environment.

Stratigraphy of the Coal Zones and Minable Beds

Coal has been mined from three known coal zones within the Laramie Fm (Fig. 18). The "Upper" zone is eroded in many places. The Como and King mines reported working all three zones, with coal beds up to 40' thick mined.

Production and Depletion History

Number of mines of record: 14

Cumulative production to 1/1/77 (short tons): 724,658

Cumulative production to 1/1/79 (short tons): 724,658

Total reserve base depletion to 1/1/77 (short tons): 1,449,316

Original demonstrated reserve base (estimated, million short tons): 25.31 (Hamilton and others, 1975, pt. 2)

Percentage of reserve base depleted: 5.7 (94.3% remaining)

Remaining reserve base to 1/1/77 (estimated, million short tons): 23.86

Selected References

Clement and Dotton (1970); Ettinger (1964); Landis (1959); Washburne (1910).

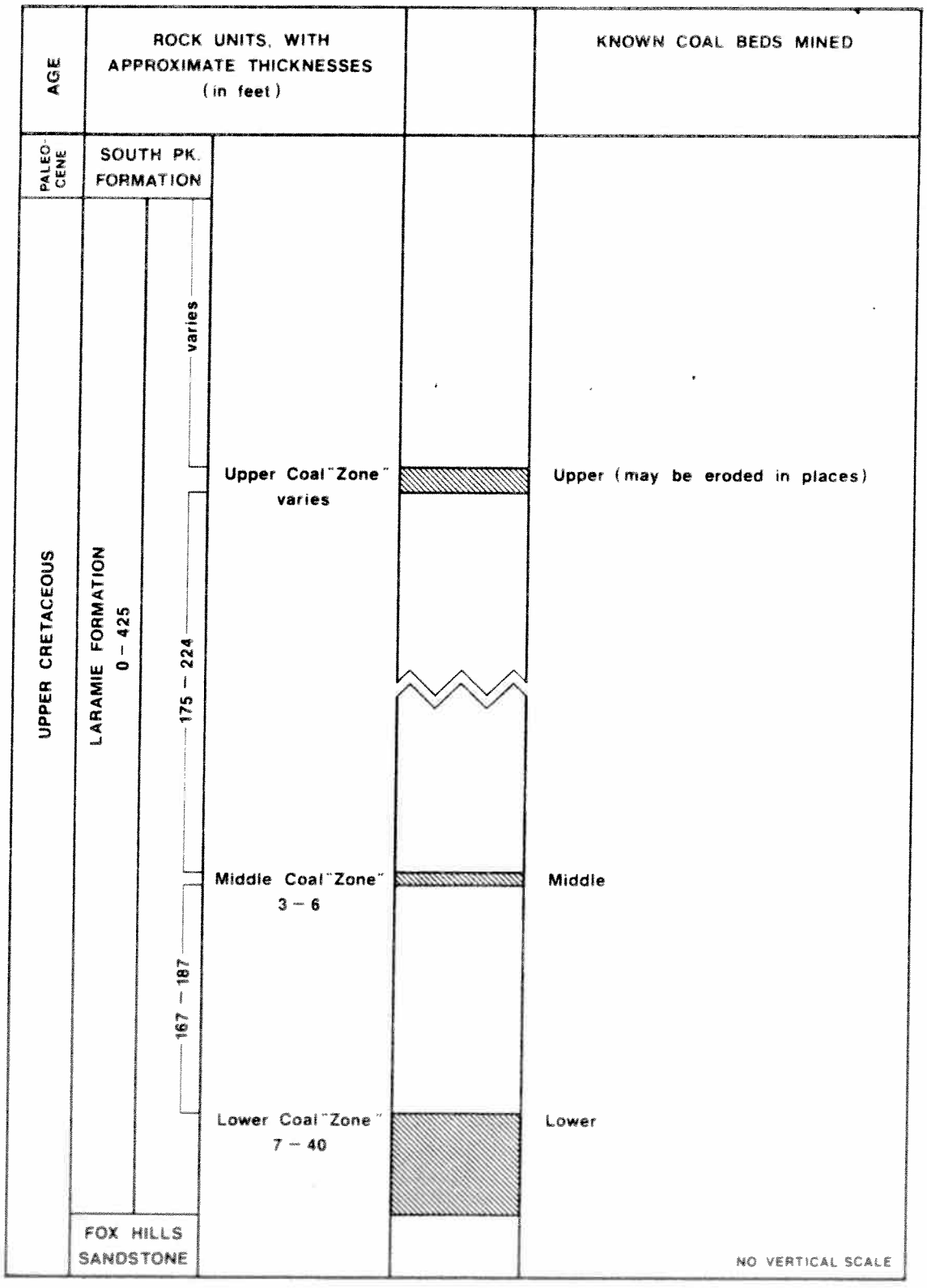


Figure 18. --Generalized columnar section of coal-bearing rocks in the Como area, South Park field, Colorado (after Washburne, 1910).

Coal Region: Uinta

Coal Fields: Book Cliffs, Carbondale, Crested Butte, Danforth Hills, Grand Hogback, Grand Mesa, Lower White River, and Somerset

County(ies) and: Delta, Garfield, Gunnison, Mesa, Moffat, Pitkin, Rio Blanco

Geographic Setting: Located in west-central Colorado (Fig. 2). The region is bordered by the Axial Basin uplift on the north, the White River uplift on the east, the Gunnison uplift on the south and southeast, the Colorado-Utah border on the west, and Grand Valley and the Colorado River on the southwest.

Geologic Setting: The Uinta coal region in Colorado consists of eight fields located along the periphery of the Piceance Creek basin, an asymmetric structural basin of Laramide age covering more than 7,200 sq mi. In Colorado, the basin is bounded by the Grand Hogback monocline on the northeast, the Axial Basin uplift on the north, the Gunnison uplift on the southeast, and the Douglas Creek arch on the west.

Stratigraphy of the Coal-Bearing Rock Unit(s)

The stratigraphy of the coal-bearing units is complicated. All coal-bearing sequences are in the Mesaverde Group. In the Book Cliffs field, the Mesaverde contains the coal-bearing Mount Garfield Formation and the barren Hunter Canyon Formation. From the Somerset field north to the Danforth Hills area, the Mesaverde Group contains the Iles Formation and the Williams Fork Formation (separated by the Rollins-Trout Creek Sandstone). All the sequences in the Mesaverde consist chiefly of interbedded sandstone, shale, and coal.

Stratigraphy of the Coal Zones and Minable Beds

Except for the Book Cliffs and Danforth Hills coal fields, most coals exploited in the past came from coal zones above the Rollins-Trout Creek Sandstone (Figs. 20, 21, 22, 23). In the Book Cliffs (Fig. 19) and the Danforth Hills fields (Fig. 21), considerable coal was mined from the Sego, Corcoran, and Cozzette coal zones and from the Black Diamond coal group. Coal beds varied from 3 to 30 ft thick.

Production and Depletion History

Number of mines of record: 297

Cumulative production to 1/1/77 (short tons): 87,725,090

Cumulative production to 1/1/79, preliminary (short tons): 95,258,653

Total reserve base depletion to 1/1/77 (short tons): 175,344,415

Original demonstrated reserve base (estimated, million short tons): 3,161.71 (per T.K. Matson, U.S. DOE, Denver)*

Percentage of reserve base depleted: 5.55 (94.45% remaining)

Remaining reserve base (million short tons): 2,986.37

Selected References

Campbell (1958); Collins (1975); Cummings and Pott (1962); Apples (1940); Donnell (1959); Donnell (1962); Erdmann (1934); Fisher (1960); Gale (1907); Gale (1910); Gaskill and Horn (1961); Hancock (1925); Hancock and Eby (1930); Hanks (1962); Johnson (1948); Lee (1909); Lee (1912); Mull (1960); Richardson (1909); Toenges (1952); Warner (1961); White (1889); Woodruff (1912).

* Excludes reserves from Moffat County.

UINTA REGION - BOOK CLIFFS FIELD

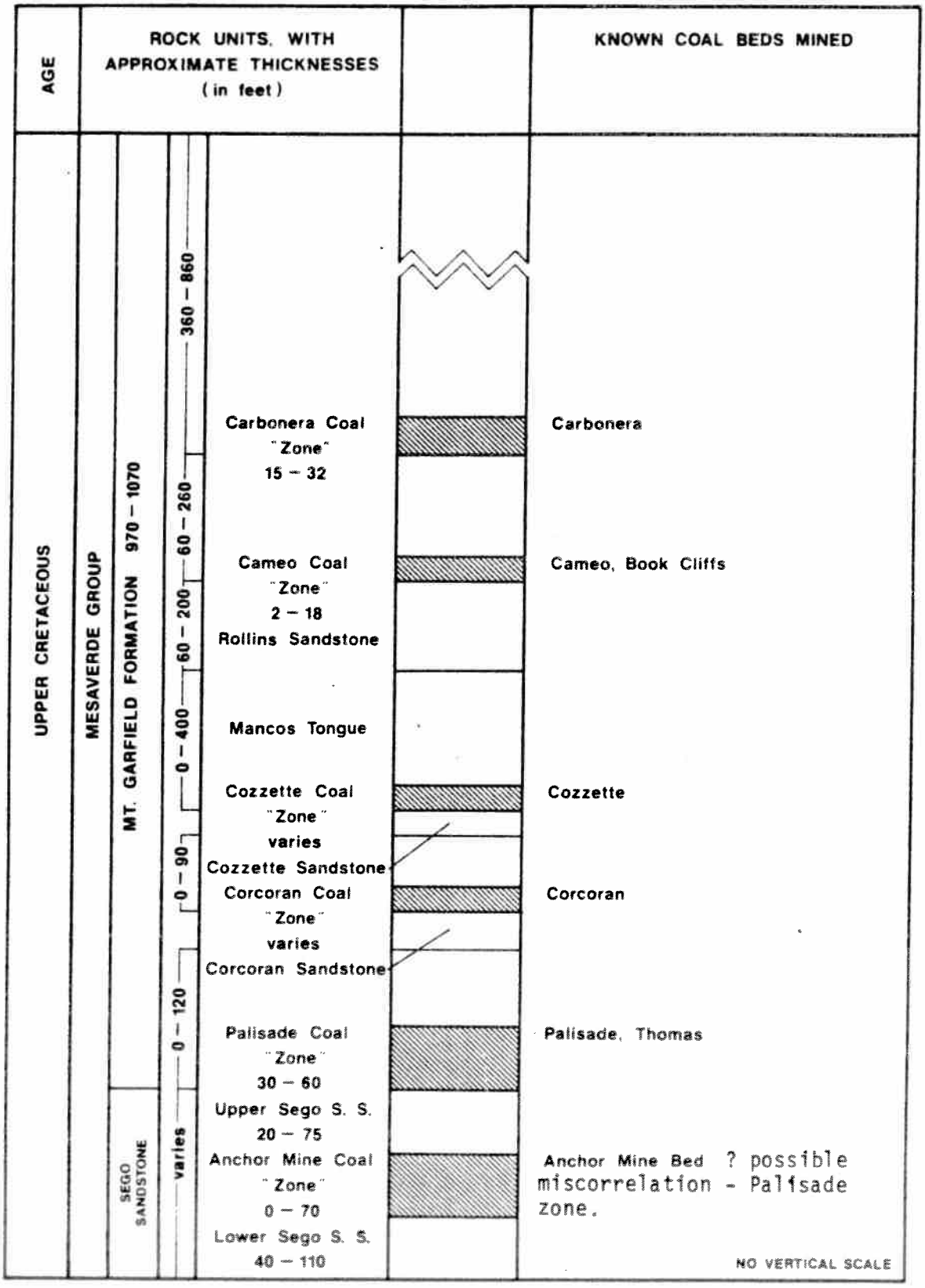


Figure 19. --Generalized columnar section of coal-bearing rocks in the Book Cliffs field, Uinta region, Colorado (after Fisher and others, 1960; and Richardson, 1909).

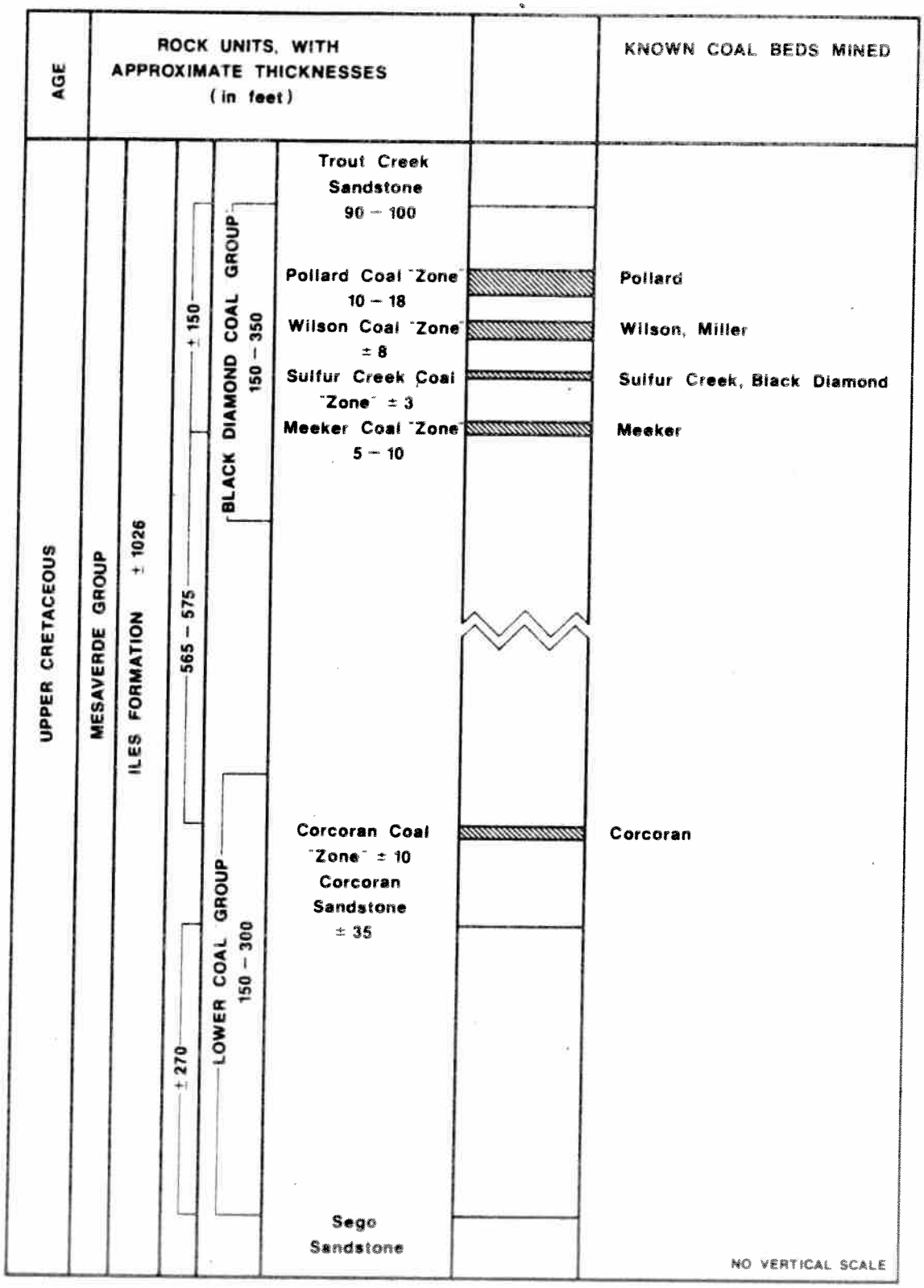


Figure 20. --Generalized columnar section of coal-bearing rocks in the Iles Formation, Danforth Hills field, Uinta region, Colorado (after Hancock and Eby, 1930; Landis, 1956; Warner, 1961).

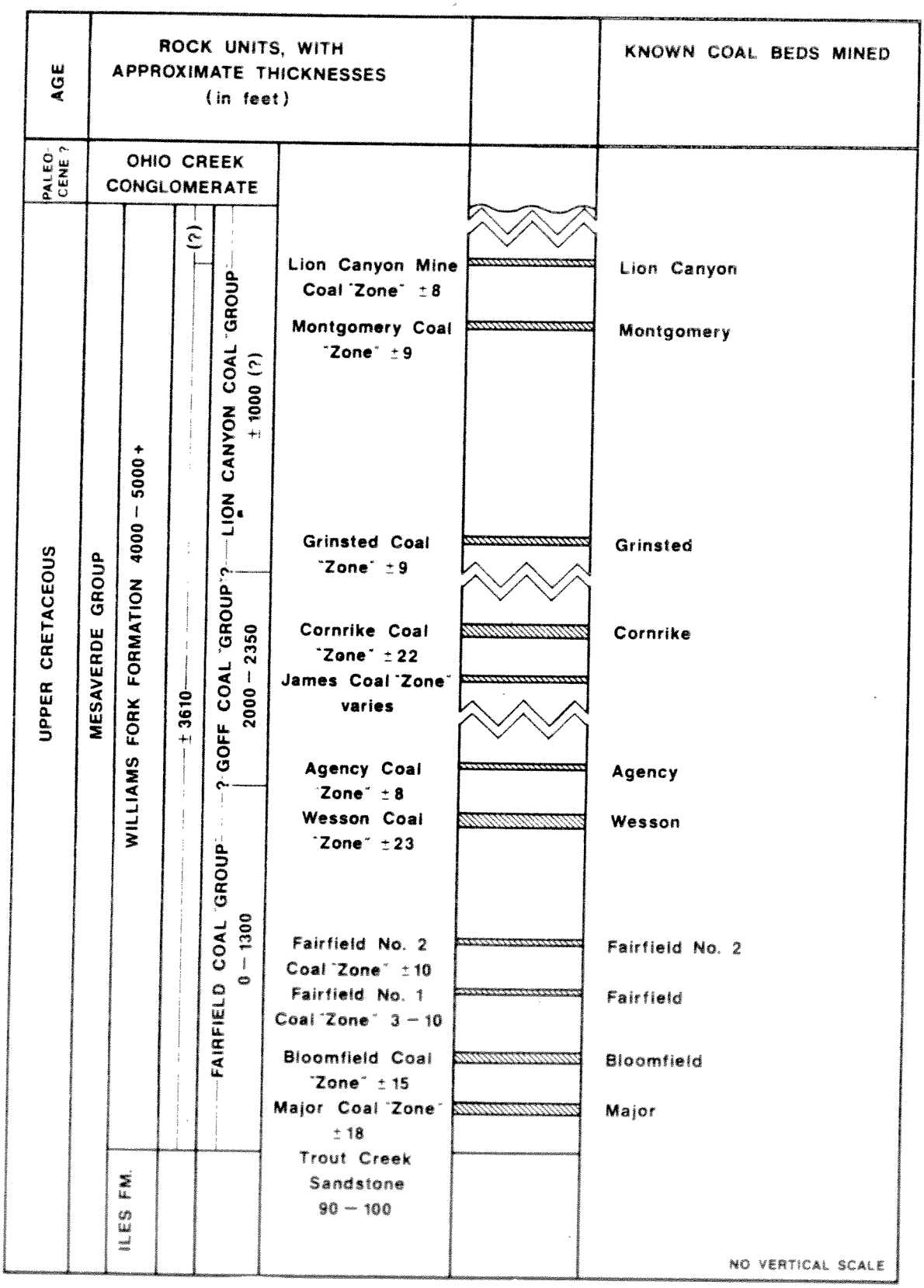


Figure 21. --Generalized columnar section of coal-bearing rocks in the Williams Fork Formation, Danforth Hills field, Uinta region, Colorado (after Hancock and Eby, 1930).

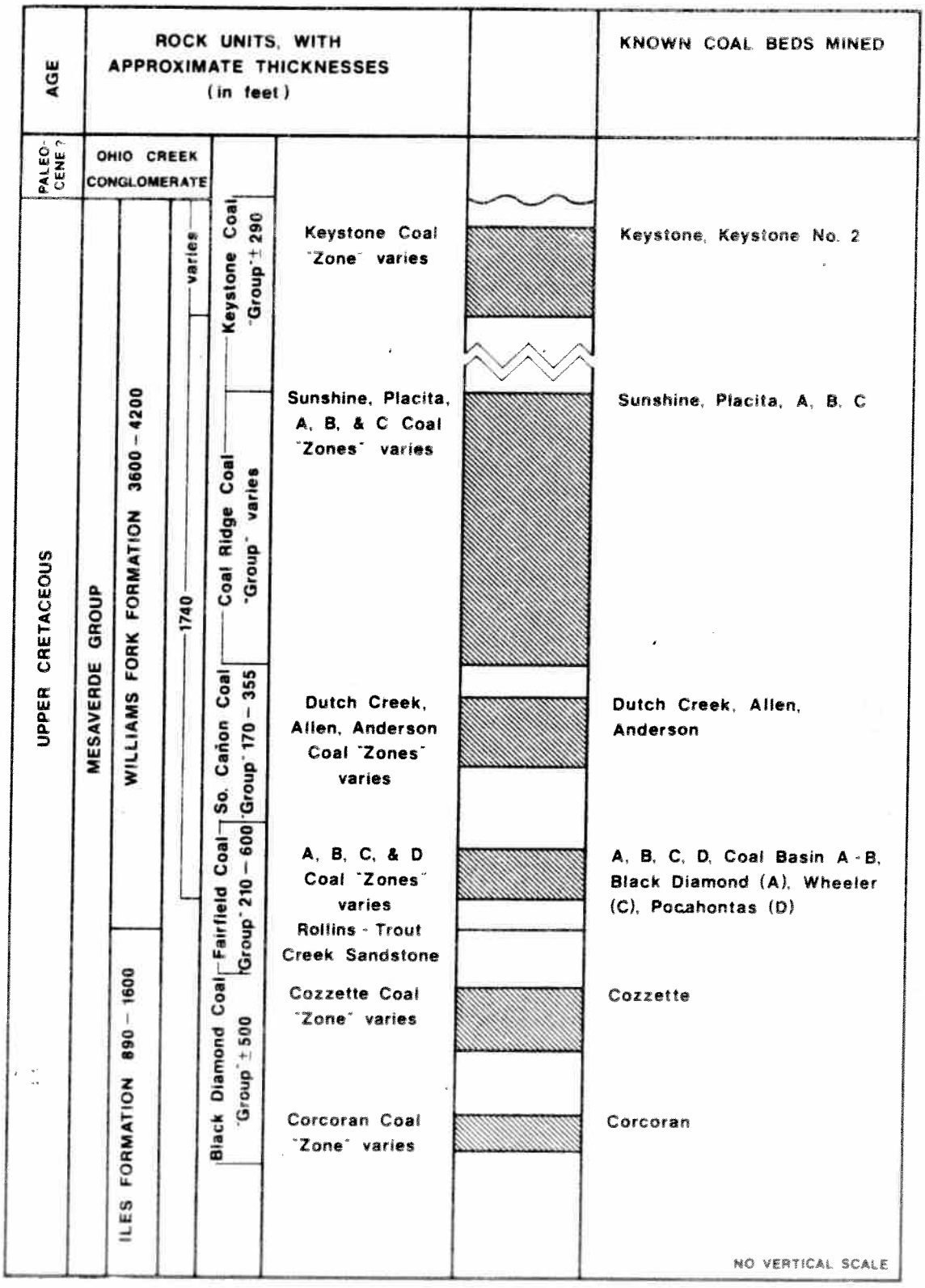


Figure 22. --Generalized columnar section of coal-bearing rocks in the Grand Hogback and Carbondale fields, Uinta region, Colorado (after Collins, 1976). Shaded area designates the general stratigraphic location of the coal zones and their estimated lower and upper stratigraphic limits.

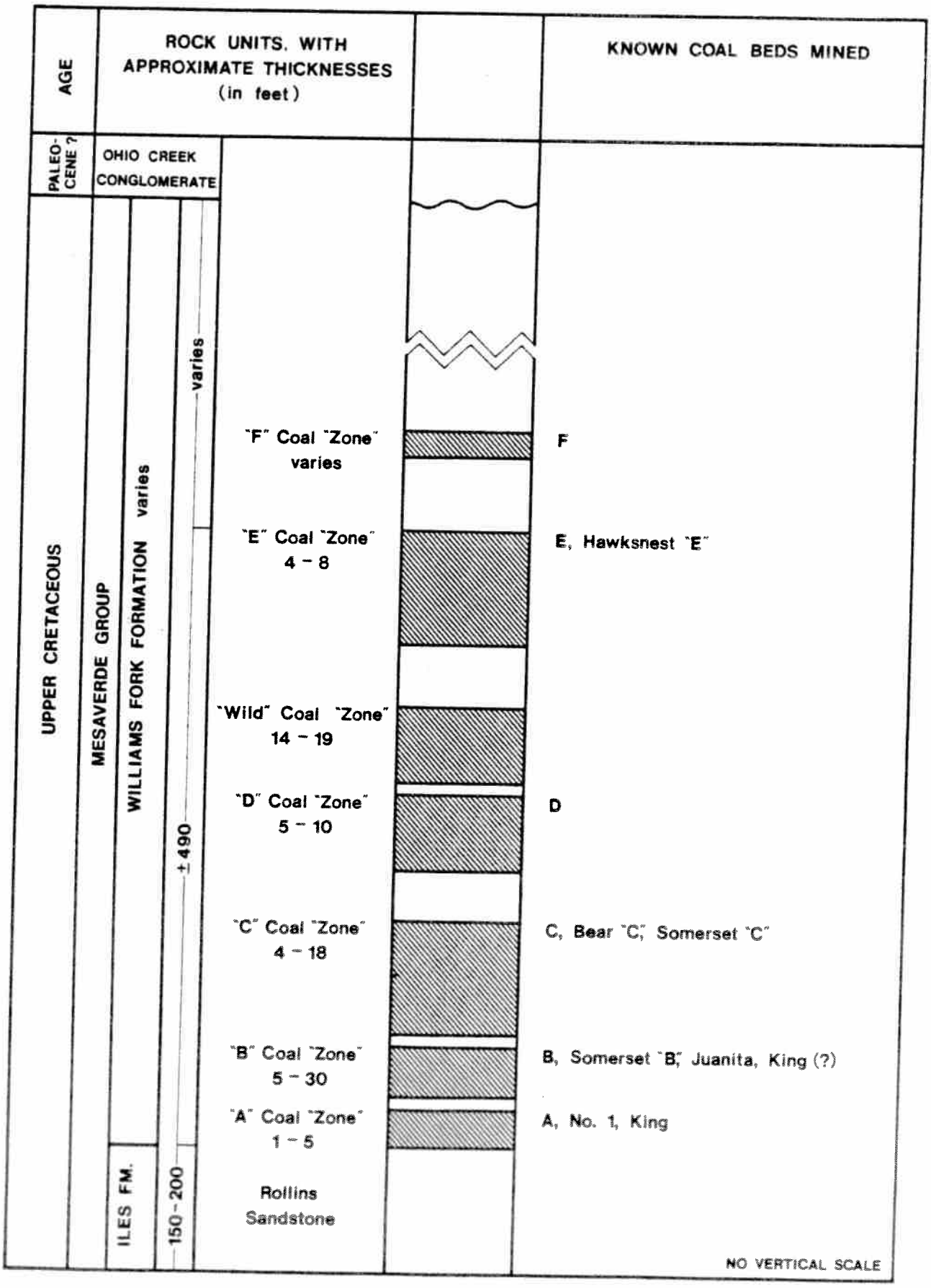


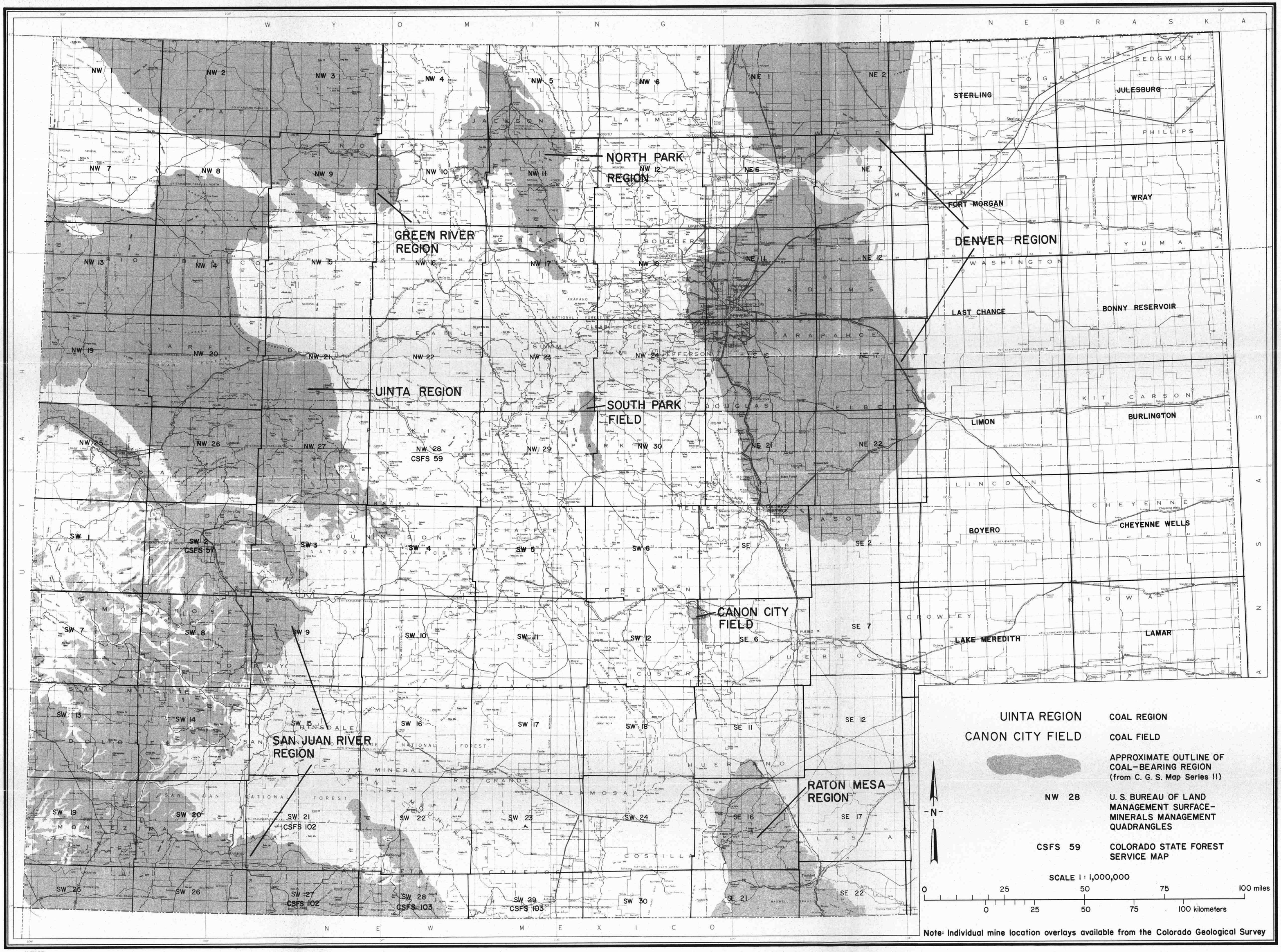
Figure 23. --Generalized columnar section of coal-bearing rocks in the Somerset field, Uinta region, Colorado (after Johnson, 1948).

Colorado Geological Survey
Dept. of Natural Resources
John W. Rold, Director

COLORADO COAL RESERVES DEPLETION DATA AND COAL MINE SUMMARIES

by D. L. Boreck and D. K. Murray

Colorado Geological Survey
Open-File Report 79 - 1



Note: Individual mine location overlays available from the Colorado Geological Survey

INDEX MAP OF THE U. S. BUREAU OF LAND MANAGEMENT SURFACE - MINERALS MANAGEMENT QUADRANGLES, COLORADO, 1979