**DISSERTATION**

**Donald Rader Chesnut, Jr.**

**The Graduate School**

**University of Kentucky**

**1988**

# STRATIGRAPHIC ANALYSIS OF THE CARBONIFEROUS ROCKS OF THE CENTRAL APPALACHIAN BASIN

---

DISSERTATION

---

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Kentucky


BY

Donald Rader Chesnut, Jr.

Lexington, Kentucky

Co-Director: Dr. Nicholas Rast, Professor of Geology

Co-Director: Dr. Francis R. Ettensohn, Professor of Geology

Lexington, Kentucky


1988

ABSTRACT OF DISSERTATION

# STRATIGRAPHIC ANALYSIS OF THE CARBONIFEROUS ROCKS OF THE CENTRAL APPALACHIAN BASIN

A series of seven cross sections was constructed across part of the Central Appalachian Basin in Kentucky, Tennessee, Virginia, West Virginia, and Ohio. Information used to make these sections included well logs, coal-company core descriptions, measured sections, and mapped surface geology. The cross sections were used to establish a stratigraphic and structural framework for the Central Appalachian Basin. Newly discovered surface and subsurface structural features such as faults, folds, and flexures, are described. A new, unofficial lithostratigraphic nomenclature was introduced to illustrate the stratigraphic framework, and a regional unconformity was interpreted to occur between the Pennsylvanian Pocahontas Formation and the Pennsylvanian New River Formation. The cross sections reveal that sequential truncation of formations below the unconformity occurs to the northwest in the basin. A

regional unconformity and biostratigraphic evidence indicate that the Carboniferous rocks were deposited in a series of several small-scale environmental continua.

Pennsylvanian rocks overlying the regional unconformity sequentially overlap the underlying rocks to the northwest in the basin. Belts of quartzose sandstones (Lee Formation) within the overlying rocks, are oriented northeast-southwest. Succeeding sandstone belts onlap the unconformity to the northwest within the basin. A fluvial origin is suggested for the quartzose, conglomeratic sands of the Lee Formation. The source for these sands may have been reworked sediments derived from the Old Red Sandstone "continent" to the northeast in Canada. The remaining Pennsylvanian coal-bearing clastic rocks (Breathitt Group) were deposited as clastic wedges derived from the east and southeast on coastal lowlands.

_____
(Author's Name)

_____
(Date)

**STRATIGRAPHIC ANALYSIS OF THE CARBONIFEROUS ROCKS OF THE CENTRAL APPALACHIAN BASIN**

**by**

**Donald Rader Chesnut, Jr.**

_____
**(Co-Director of Dissertation)**

_____
**(Co-Director of Dissertation)**

_____
**(Director of Graduate Studies)**

_____
**(Date)**

RULES FOR THE USE OF THESES

Unpublished theses submitted for the Master's and Doctor's degrees and deposited in the University of Kentucky Library are as a rule open for inspection, but are to be used only with due regard to the rights of the authors. Bibliographical references may be noted, but quotations or summaries of parts may be published only with the permission of the author, and with the usual scholarly acknowledgments.

Extensive copying or publication of the thesis in whole or in part requires also the consent of the Dean of the Graduate School of the University of Kentucky.

A library which borrows this thesis for use by its patrons is expected to secure the signature of each user.

| Name and Address | Date |
| --- | --- |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

**DISSERTATION**

**Donald Rader Chesnut, Jr.**

**The Graduate School**

**University of Kentucky**

**1988**

# STRATIGRAPHIC ANALYSIS OF THE CARBONIFEROUS ROCKS OF THE CENTRAL APPALACHIAN BASIN

---

DISSERTATION

---

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Kentucky


BY

Donald Rader Chesnut, Jr.

Lexington, Kentucky

Co-Director: Dr. Nicholas Rast, Professor of Geology

Co-Director: Dr. Francis R. Ettensohn, Professor of Geology

Lexington, Kentucky


1988

ACKNOWLEDGMENTS

Geologists from the local state geological surveys furnished supplies, unpublished information, time, expertise, and enthusiastic support. I thank the following state agencies:

The Ohio Geological Survey

The Tennessee Division of Geology

The Virginia Division of Mineral Resources

West Virginia Geological and Economic Survey

This cooperation does not mean that these state surveys endorse the results of this study; these agencies have not reviewed this text at the time of writing.

Individuals from the following companies went to great effort to supply information for this study. I have great appreciation for these individuals and to the companies. I am happy to acknowledge the following companies for their progressive attitude in supporting the sciences. I am sorry that I cannot list the individuals from each company (there were commonly several from each company) because of the

large number who helped. The only individuals listed are those who supplied information from their private files.

ANR Coal Co.

ARMM Coal Co.

Appollo Fuels

Belfry Coal

Benham Coal, Inc.

Dr. Richard Bergenback

Blackwood Land Co., Inc.

Blue Diamond Coal Co.

Mr. Eugene Boston

CSX Mineral Development, Inc.

Cardinal Resources, Inc.

Cargill-Johnson Coal Co.*

Citation Coal Co.

Clinchfield Coal Co.

Consolidation Coal Co.

Cumberland Mountain Coal Co.

Diamond Coal Co.*

Diamond Shamrock Coal Co.

The Elkhorn Coal Corp.

Enterprise Coal Co.*

Mr. Wayne Frankie

Gatliff Coal Co.

Glamorgan Coal Corp.

Greenwood Land and Mining Co.*

Ikerd-Bandy Co., Inc.

Ingram Coal

Interstate Coal Co., Inc.

Island Creek Coal Co.

Kentland Elkorn

Kentucky Berwind Land Co.

Kentucky Carbon Corp.

Kentucky Prince Coal Corp.

Kentucky River Coal Corp.

King Coal Co.

Koppers Co., Inc.

Manalapan Mining Co.

Mapco Coals, Inc.

Middle States Coal Co.

Mr. Robert Miser

Mountain Coals, Inc.

National Mines Corp.

Penn-Virginia Resources Corp.

Pickands-Mathers Co.

Pikeville Coal Co.

Plastics Universal*

Powell Mountain Coal Co.

R. B. Coal Co.

R. J. F. Coal co.

Richland Coal Co.

River Processing, Inc.*

Royal Land Company (Old Ben Coal Co.)

Ruby Coal Co.

Sandy Fork Mining Co.

Sierra Coal Co.

Southeast Coal Co.

The Stearns Co.

Straight Creek Resources

Taywood Mining, Inc.

Triple Elkhorn Mining Co., Inc.

United Coal Co.

United States Steel Mining Co.

Utah International, Inc.

VICC Land Company

WesCo Engineering

Mr. Gerald Yahne

*Acquired during a previous study.

I hope I have not inadvertently forgotten to include any companies on this list, though this is a possibility. If I have, I offer my apologies.

I wish to acknowledge the hospitality of Dr. Richard Bergenback and Dr. Habte G. Churnet at the University of Tennessee at Chattanooga, who not only supplied information for this study, but also spent a full day in the rain showing me important localities. I wish to thank Mr. Bryan Bunch, who helped with contacts with mining companies in south-central Kentucky.

My dissertation co-advisors, Dr. Nicholas Rast and Dr. Frank R. Ettensohn, critiqued my awkward manuscripts and offered many helpful suggestions for many years; this could not have been a pleasant experience. I owe them a great deal for any success of this dissertation. I also wish to thank my committee members, Drs. Bruce Moore, Denny Harris, John Ferm, and outside reviewer Dr. Lee Saperstein. I especially want to thank Dr. Sue Rimmer who replaced, on very short notice, Dr. John Ferm who would not attend the dissertation defense.

Dr. James Cobb, head of the Coal Section of the Kentucky Geological Survey, offered moral and scientific support throughout the duration of this study. Dr. John Ferm and Dr. Gerald Weisenfluh, University of Kentucky Department of Geological Sciences, offered useful suggestions concerning construction of the cross sections.

Dr. Donald C. Haney, State Geologist, and the Kentucky Geological Survey deserve much acknowledgment. This

dissertation could not have been started without the logistical and financial support provided by the Survey. In addition, much of the final drafting was done by Kentucky Geological Survey personnel, including Mr. Roger Potts, Chief Cartographic Illustrator, and Mr. Robert Holladay, who spent many hours redrafting the cross sections. Typing and correction of early drafts of the manuscript was done by the Survey staff including: Ms. Shirley Dawson, Ms. Donna Ramseur, Ms. Rebecca Wingate, and Ms. Marilyn Wooten. Chief Editor, Mr. Donald Hutcheson, and Editor, Ms. Meg Smath, edited the manuscripts and figures: Ms. Smath was especially helpful with editorial suggestions and help with the word processor. My son, Donald Chesnut, III, also entered corrections into the word processor.

I finally wish to thank my family and friends for my time away from home and for their support. I dedicate this study to my wife, Anne, my son, Donald, and to my mother, Madge Chesnut, and father, Don Chesnut, Sr.

TABLE OF CONTENTS

LIST OF FIGURES

## LIST OF TABLES

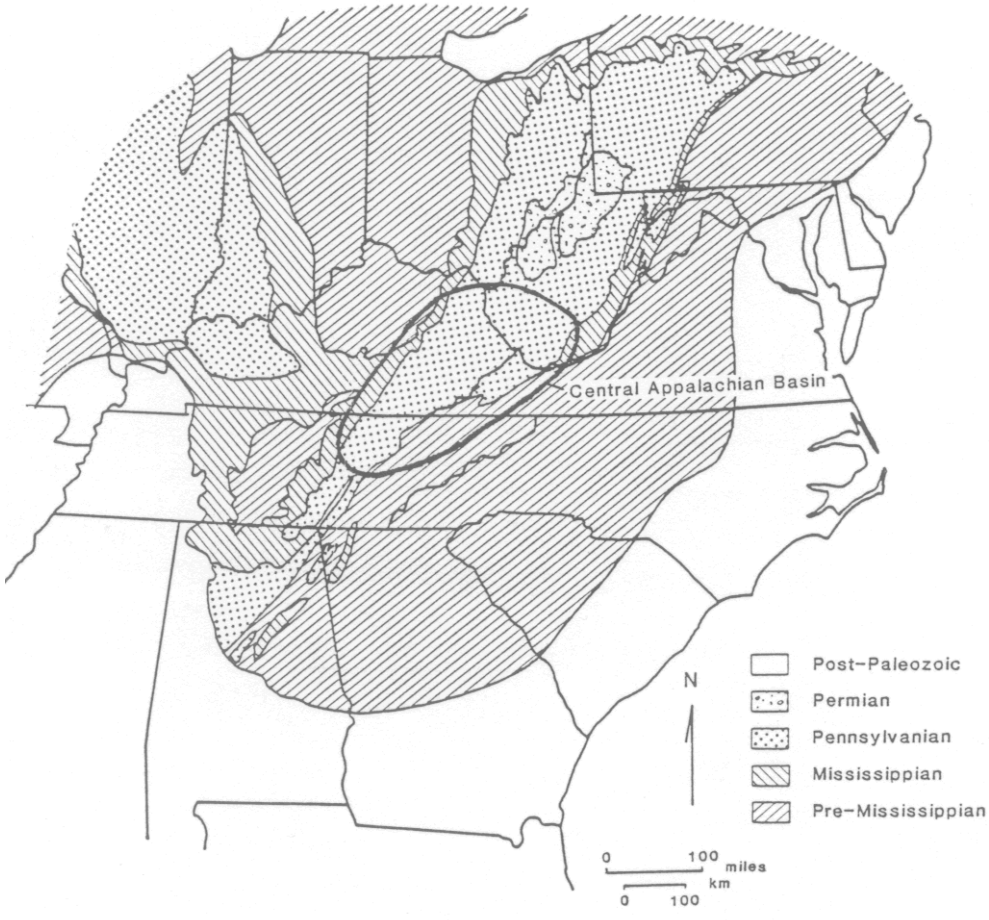
Table

# INTRODUCTION

The most important economic base for most of the Central Appalachian basin (Fig. 1) is its mineral resources. All of the coal and a large part of the oil and gas in this basin are found in Carboniferous rocks. As important as these rocks are, however, little is known about some aspects of their geology. The overall model for the deposition of Carboniferous rocks in the basin is a highly debated topic among the adherents of two major views: the followers of one view suggest that most of the Carboniferous rocks were deposited within a single uninterrupted depositional continuum, whereas those holding the other view propose that the rocks were deposited in separate, smaller scale depositional basins, one after the other, with at least one major break in deposition. The implications of these hypotheses have a potentially great impact on the stratigraphy, biostratigraphy, and depositional environments of individual units and on the extent and availability of coal resources, coal quality, and mine-roof conditions.

This study attempts to provide a descriptive stratigraphic and structural framework for Carboniferous rocks of eastern Kentucky and immediately adjacent areas, and tests the applications of the two hypotheses on a regional basis against the established framework. This

**Figure 1. Location of the Central Appalachian basin in the eastern United States.**


Central Appalachian Basin
N
Post-Paleozoic
Permian
Pennsylvanian
Mississippian
Pre-Mississippian
0 100 miles
0 100 km

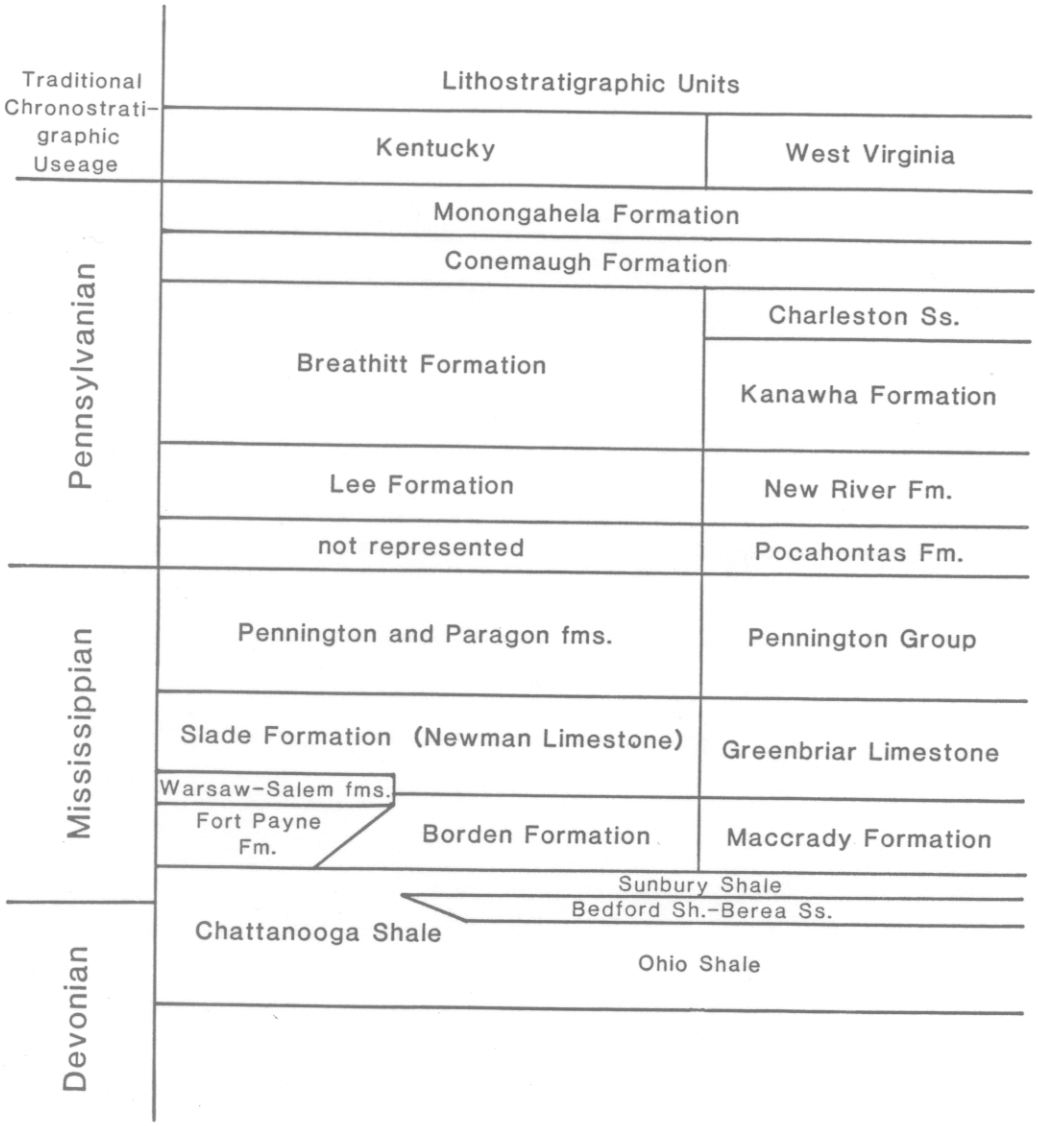
framework was developed through the use of very extensive stratigraphic data available from the mineral industry and geological surveys; the data were used to construct a series of cross sections both perpendicular and parallel to strike. The geological implications of the consequent stratigraphic and structural framework are then examined.

## Previous Work

Previous work resulted in a stratigraphic sequence for the Carboniferous rocks of the central Appalachians, which is shown in a highly generalized form on Figure 2. The Mississippian rocks of the region are mainly marine, whereas the Pennsylvanian rocks are dominantly terrestrial. Except for the Slade Formation, the Mississippian rocks are largely siliciclastic. The Lee Formation is composed of sandstones, most of which are quartz-rich, and some of which are quartz arenites. Coal-bearing rocks of economic significance are restricted to the Pennsylvanian system, especially in the Pocahontas, New River, Breathitt, and Monongahela formations.

No single locality in the Central Appalachian basin contains all the Carboniferous units. For instance, the Fort Payne Limestone is found only in the southwestern part of the basin, whereas the Pocahontas Formation is found only

**Figure 2. Carboniferous lithostratigraphic units of the Central Appalachian basin.**


Traditional Chronostrati-graphic Useage
Lithostratigraphic Units
Kentucky
West Virginia
Pennsylvanian
Monongahela Formation
Conemaugh Formation
Breathitt Formation
Charleston Ss.
Kanawha Formation
Lee Formation
New River Fm.
not represented
Pocahontas Fm.
Mississippian
Pennington and Paragon fms.
Pennington Group
Slade Formation (Newman Limestone)
Greenbriar Limestone
Warsaw-Salem fms.
Fort Payne Fm.
Borden Formation
Maccrady Formation
Sunbury Shale
Bedford Sh.-Berea Ss.
Chattanooga Shale
Ohio Shale
Devonian

in the southeastern-most part. The terminology used in the different states is shown in Table 1.

The terms "Mississippian" and "Pennsylvanian" were originally used in a lithostratigraphic sense. The Mississippian System was named for rocks exposed along the Mississippi River Valley in Missouri, Iowa, and Illinois, whereas the Pennsylvanian System was named for the coal measures exposed in the state of Pennsylvania. The terms Mississippian and Pennsylvanian are now commonly used in both chronostratigraphic and lithostratigraphic senses. In this study, the terms Mississippian and Pennsylvanian are used entirely in a chronostratigraphic sense. Figure 3 illustrates the correlation of North American and European Carboniferous chronostratigraphic units. A detailed discussion of stratigraphic usage and the history of Carboniferous (Mississippian and Pennsylvanian) units is found in Rice and others (1979) for Kentucky, Milici and others (1979) for Tennessee, Collins (1979) for Ohio, Arkle and others (1979) for West Virginia, and Englund (1979) for Virginia.

Rocks of Pennsylvanian age are difficult to correlate regionally, because lithologies that comprise the coal-bearing units (for example, the Breathitt Formation) are frequently repeated. Moreover, recurring beds commonly are indistinguishable except by either their tracing in the

**Table 1. Lithostratigraphic correlation chart of Carboniferous formations in the Central Appalachian basin.**

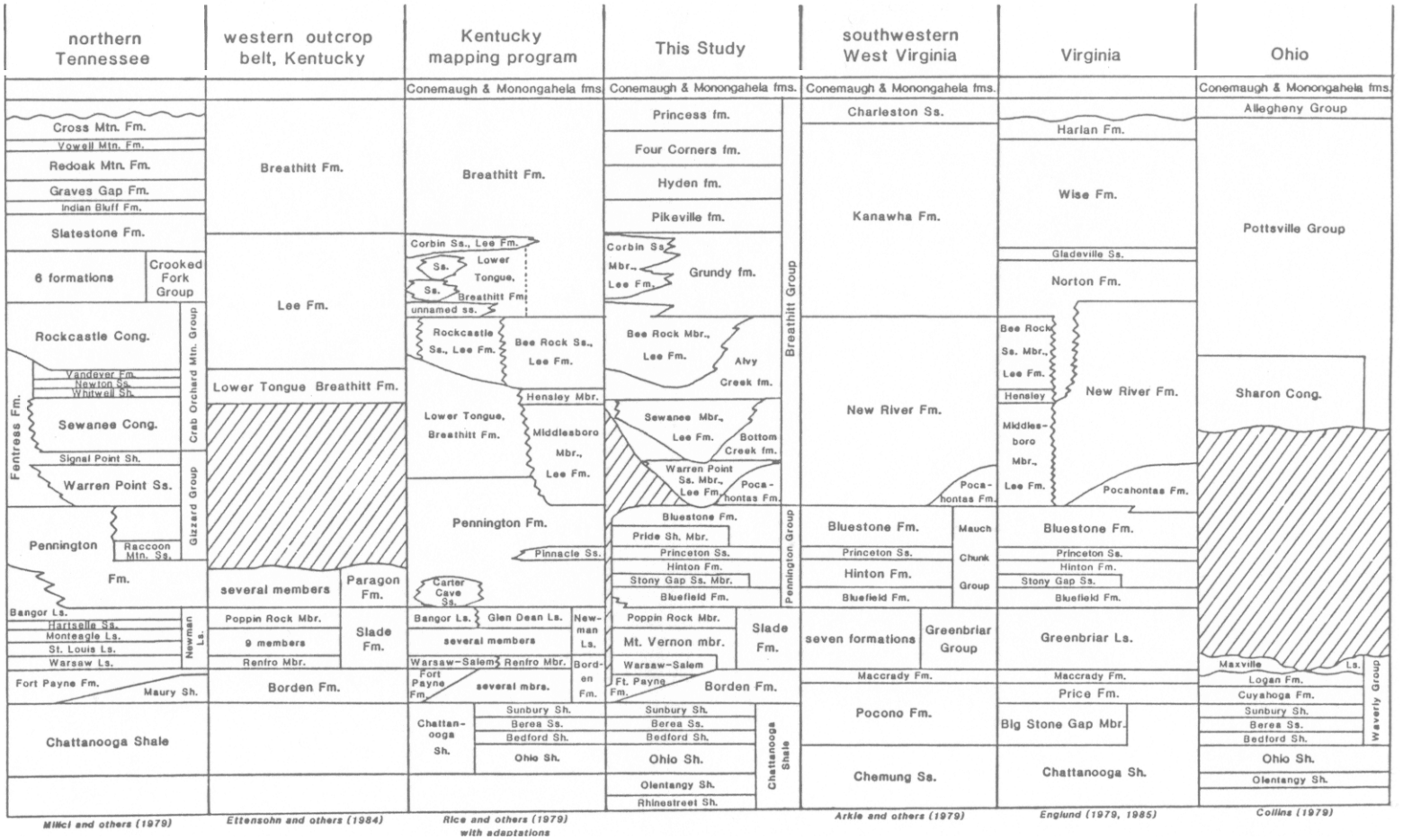
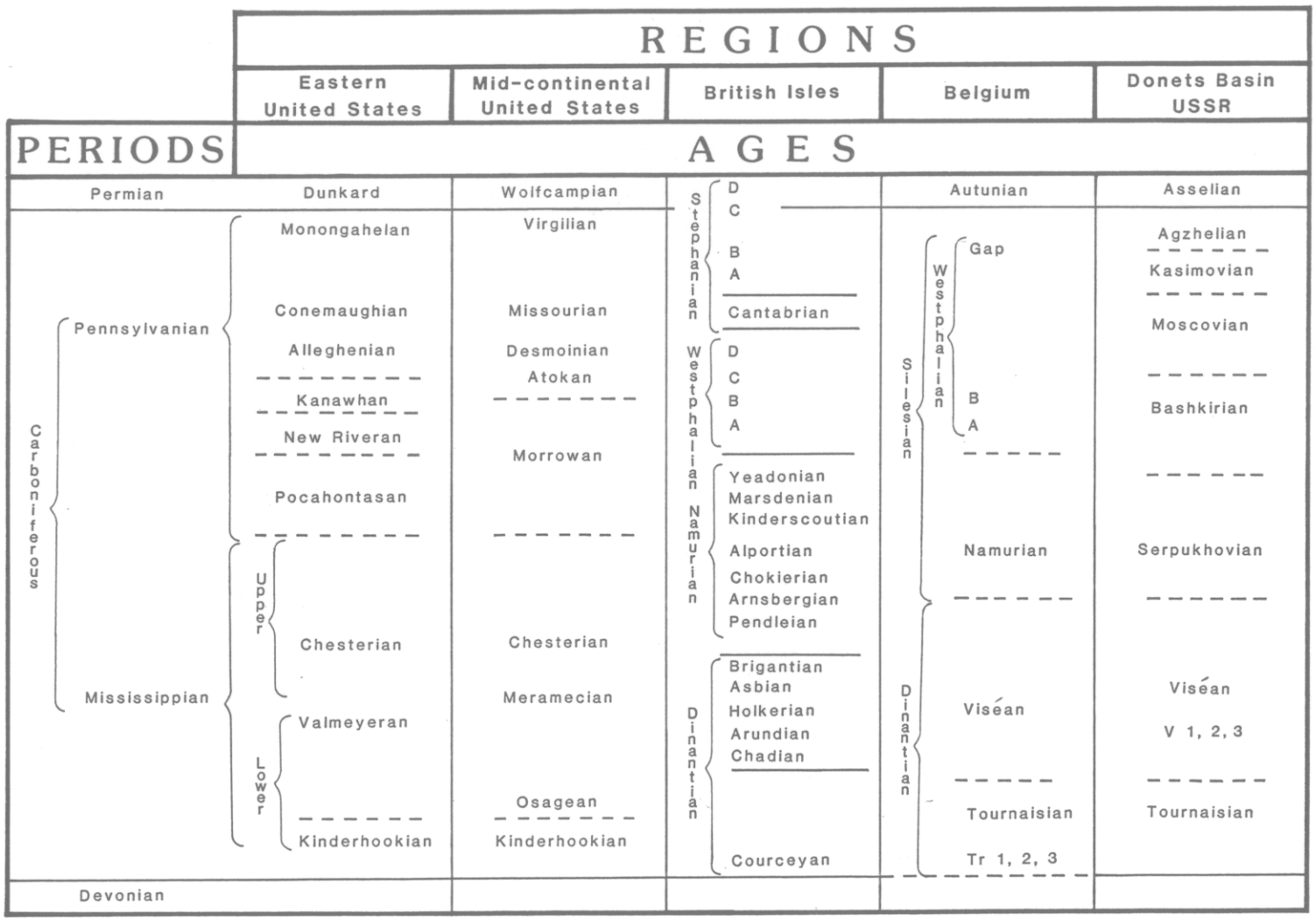

northern Tennessee
western outcrop belt, Kentucky
Kentucky mapping program
This Study
southwestern West Virginia
Virginia
Ohio
Conemaugh & Monongahela fms.
Cross Mtn. Fm.
Vowell Mtn. Fm.
Redoak Mtn. Fm.
Graves Gap Fm.
Indian Bluff Fm.
Slatestone Fm.
6 formations
Crooked Fork Group
Rockcastle Cong.
Crab Orchard Mtn. Group
Vandever Fm.
Newton Ss.
Whitwell Sh.
Fentress Fm.
Sewanee Cong.
Signal Point Sh.
Warren Point Ss.
Gizzard Group
Pennington Fm.
Raccoon Mtn. Ss.
Bangor Ls.
Hartselle Ss.
Monteagle Ls.
St. Louis Ls.
Warsaw Ls.
Newman Ls.
Fort Payne Fm.
Maury Sh.
Chattanooga Shale
Breathitt Fm.
Lee Fm.
Lower Tongue Breathitt Fm.
several members
Paragon Fm.
Poppin Rock Mbr.
9 members
Renfro Mbr.
Slade Fm.
Borden Fm.
Corbin Ss., Lee Fm.
Ss.
Lower Tongue, Breathitt Fm
unnamed ss.
Rockcastle Ss., Lee Fm.
Bee Rock Ss., Lee Fm.
Hensley Mbr.
Lower Tongue, Breathitt Fm.
Middlesboro Mbr., Lee Fm.
Pennington Fm.
Carter Cave Ss.
Bangor Ls.
Glen Dean Ls.
several members
Warsaw-Salem
Renfro Mbr.
several mbrs.
Newman Ls.
Borden Fm.
Chattanooga Sh.
Sunbury Sh.
Berea Ss.
Bedford Sh.
Ohio Sh.
Princess fm.
Four Corners fm.
Hyden fm.
Pikeville fm.
Corbin Ss Mbr., Lee Fm.
Grundy fm.
Bee Rock Mbr., Lee Fm.
Alvy Creek fm.
Breathitt Group
Sewanee Mbr., Lee Fm.
Bottom Creek fm.
Warren Point Ss. Mbr., Lee Fm.
Pocahontas Fm.
Bluestone Fm.
Pride Sh. Mbr.
Princeton Ss.
Hinton Fm.
Stony Gap Ss. Mbr.
Bluefield Fm.
Pennington Group
Poppin Rock Mbr.
Mt. Vernon mbr.
Warsaw-Salem
Ft. Payne Fm.
Slade Fm.
Borden Fm.
Sunbury Sh.
Berea Ss.
Bedford Sh.
Ohio Sh.
Olentangy Sh.
Rhinestreet Sh.
Chattanooga Shale
Charleston Ss.
Kanawha Fm.
New River Fm.
Pocahontas Fm.
Bluestone Fm.
Princeton Ss.
Hinton Fm.
Bluefield Fm.
Mauch Chunk Group
seven formations
Greenbriar Group
Maccrady Fm.
Pocono Fm.
Chemung Ss.
Harlan Fm.
Wise Fm.
Gladeville Ss.
Norton Fm.
Bee Rock Ss. Mbr., Lee Fm.
Hensley
Middlesboro Mbr., Lee Fm.
New River Fm.
Pocahontas Fm.
Bluestone Fm.
Princeton Ss.
Hinton Fm.
Stony Gap Ss.
Bluefield Fm.
Greenbriar Ls.
Maccrady Fm.
Price Fm.
Big Stone Gap Mbr.
Chattanooga Sh.
Allegheny Group
Pottsville Group
Sharon Cong.
Maxville Ls.
Logan Fm.
Cuyahoga Fm.
Sunbury Sh.
Berea Ss.
Bedford Sh.
Waverly Group
Ohio Sh.
Olentangy Sh.
Millici and others (1979)
Ettensohn and others (1984)
Rice and others (1979) with adaptations
Arkle and others (1979)
England (1979, 1985)
Collins (1979)

**Figure 3. Chronostratigraphy of the European and American Carboniferous, adapted with major revisions of the North American part from Rast (1983).**


REGIONS
Eastern United States
Mid-continental United States
British Isles
Belgium
Donets Basin USSR
PERIODS
AGES
Permian
Carboniferous
Pennsylvanian
Mississippian
Upper
Lower
Dunkard
Monongahelan
Conemaughian
Alleghenian
Kanawhan
New Riveran
Pocahontasan
Chesterian
Valmeyeran
Kinderhookian
Wolfcampian
Virgilian
Missourian
Desmoinian
Atokan
Morrowan
Chesterian
Meramecian
Osagean
Kinderhookian
Stephanian
Westphalian
Namurian
Dinantian
D
C
B
A
Cantabrian
Yeadonian
Marsdenian
Kinderscoutian
Alportian
Chokierian
Arnsbergian
Pendleian
Brigantian
Asbian
Holkerian
Arundian
Chadian
Courceyan
Autunian
Siliesian
Westphalian
Dinantian
Gap
Namurian
Viséan
Tournaisian
Tr 1, 2, 3
Asselian
Agzhelian
Kasimovian
Moscovian
Bashkirian
Serpukhovian
Viséan
V 1, 2, 3
Tournaisian
Devonian

field or by correlating distinctive sequences in closely spaced boreholes. In the past, various regional correlation schemes for coal beds, and rarely other lithologies, have been devised including those by Wanless (1939, 1946), McFarlan (1943), Gallagher (1949?), Pocahontas Land Company (1971), Coal Age (1975), Harned (1979), Rice and Smith (1980), and Bayer (1982). Of the above listed correlation schemes, only that of Rice and Smith (1980) for Kentucky is based on detailed geologic mapping. Moreover, most of the schemes deal only with the names of coal beds at different localities, and all disagree in detail.

The existing correlation schemes offer little or no information on the shape, size, stratigraphic relationships, or the structure of lithologic units or of the basin. To date, several cross sections have been published, which are used to represent the stratigraphic framework, and in some cases the structures of this basin. These include sections by Stearns and Mitchum (1962, p. 78-79, fig. 4), Ferm and Cavoroc (1969; also figured in Ferm and Horne, 1979, p. 4, fig. 4), Horne and others (1971; also figured in Ferm and Horne, 1979, p. 260, fig. 2), Ferm and others (1972, fig. 3), Milici and others (1979, figs. 7-15), Presley (1979, plate 1), Rice and others (1979, fig. 10), and Englund and others (1985, fig. 29). Those by Stearns and Mitchum, Presley, Rice and others, and Englund and others are typical

lithostratigraphic sections which show lateral continuity for some beds. The remaining sections differ in showing time-transgressive facies and lateral discontinuity of all lithologic units.

Of the existing sections one most frequently cited is that by Ferm and Cavaroc (1969), shown in Figure 4. It also appears in compendia on coal geology (Ferm and Horne, 1979, p. 4, fig. 4; Rahmani and Flores, 1985, p. 273, fig. 3), and in texts such as those by Galloway and Hobday (1983, p. 295, fig. 12-35) and Ward (1984, p. 173, fig. 5.21). The major contribution of Ferm and Cavaroc is their interpretation of the relationship between the major Carboniferous units which had traditionally been interpreted to reflect a "layer-cake" or tabular geometry. The "layer-cake'' reconstruction was thought by some to mean that lithologic units were one at a time deposited over a large area (Ferm, 1971, p. 1). Ferm and Cavaroc, however, suggested major regional time-transgressive facies relationships between all adjacent units. The extent and significance of their interpretation (Fig. 5) is reflected in their depositional model (Ferm, 1979, figs. 1-2, p. 4). In this model, they equated all units between the base of the Conemaugh (Fig. 2), traditionally considered to be Late Pennsylvanian in age, and the Borden Formation (Fig. 2), traditionally considered to be Early to Middle Mississippian in age, on a regional

**Figure 4. Facies-interpreted cross section of Late Mississippian and Pennsylvanian-age rocks of part of the Central and Northern Appalachian basins (after Ferm and Cavaroc, 1969).**

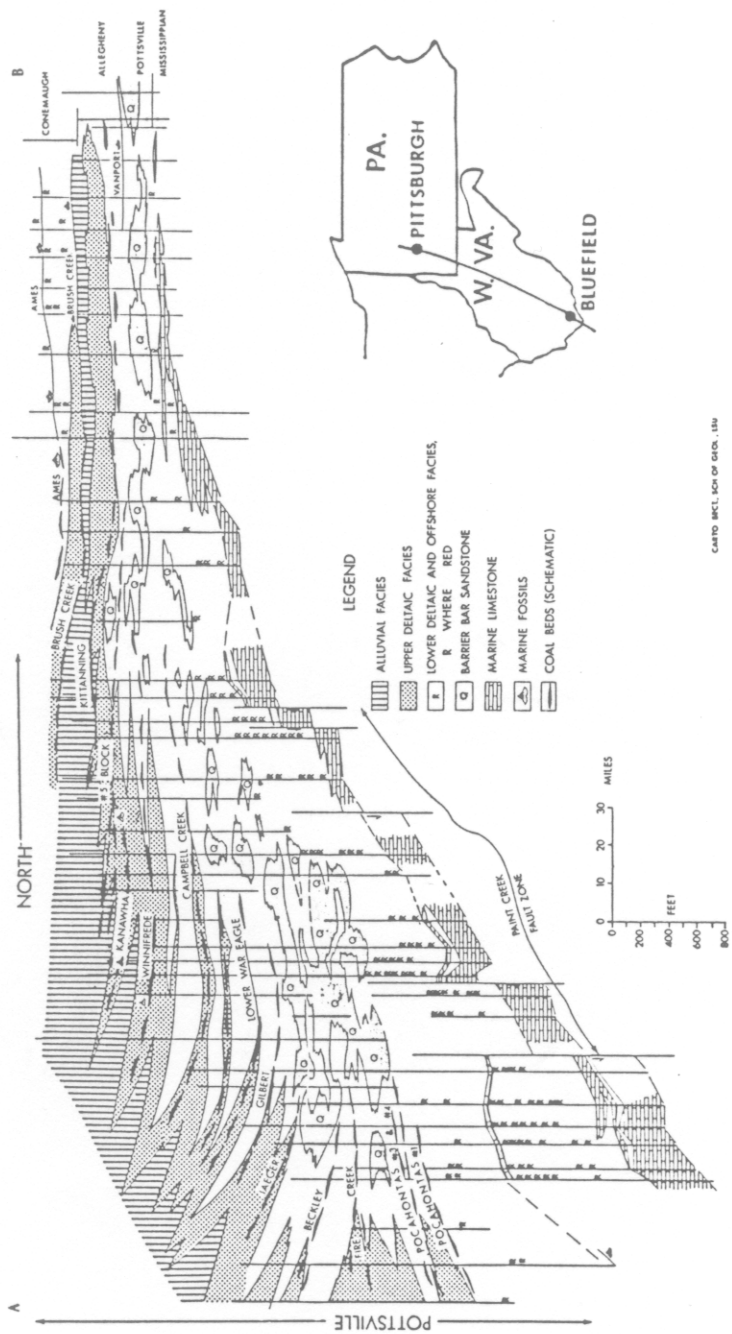
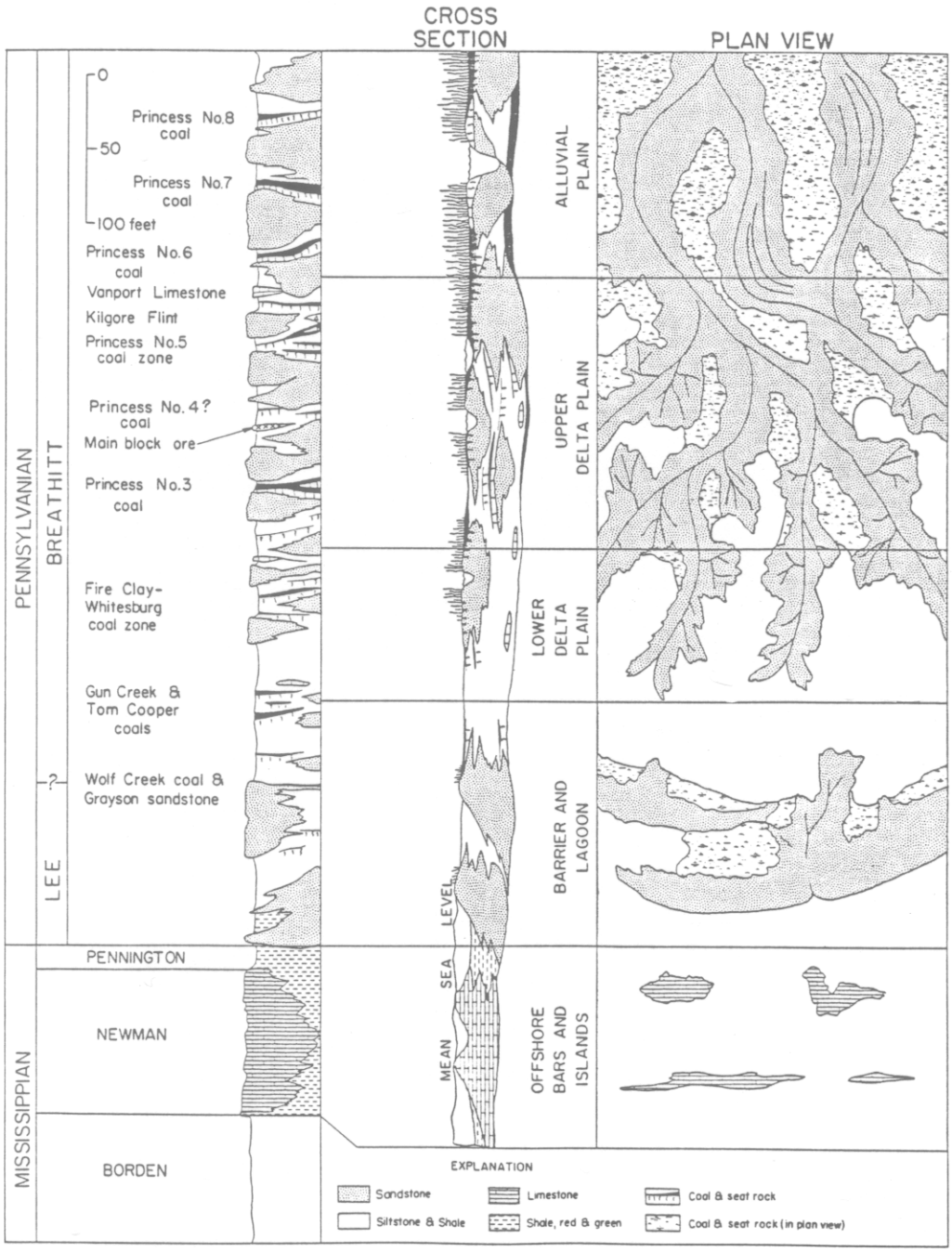

A
B
NORTH
POTTSVILLE
MISSISSIPPIAN
POTTSVILLE
ALLEGHENY
CONEMAUGH
VANPORT
BRUSH CREEK
AMES
KITTANNING
BROCK
KANAWHA
WINIFREDE
CAMPBELL CREEK
LOWER WAR EAGLE
CHILTON
BECKLEY
POCAHONTAS
PAINT CREEK FAULT ZONE
PA.
PITTSBURGH
W. VA.
BLUEFIELD
LEGEND
ALLUVIAL FACIES
UPPER DELTAIC FACIES
LOWER DELTAIC AND OFFSHORE FACIES, R WHERE RED
BARRIER BAR SANDSTONE
MARINE LIMESTONE
MARINE FOSSILS
COAL BEDS (SCHEMATIC)
MILES
FEET

**Figure 5. Stratigraphic section and interpretations of depositional environments of the Lee-Newman Barrier-Shoreline model (from Ferm, 1971).**


CROSS SECTION
PLAN VIEW
PENNSYLVANIAN
MISSISSIPPIAN
BREATHITT
LEE
PENNINGTON
NEWMAN
BORDEN
0
50
100 feet
Princess No.8 coal
Princess No.7 coal
Princess No.6 coal
Vanport Limestone
Kilgore Flint
Princess No.5 coal zone
Princess No.4? coal
Main block ore
Princess No.3 coal
Fire Clay-Whitesburg coal zone
Gun Creek & Tom Cooper coals
Wolf Creek coal & Grayson sandstone
?
ALLUVIAL PLAIN
UPPER DELTA PLAIN
LOWER DELTA PLAIN
BARRIER AND LAGOON
OFFSHORE BARS AND ISLANDS
MEAN SEA LEVEL
EXPLANATION
Sandstone
Siltstone & Shale
Limestone
Shale, red & green
Coal & seat rock
Coal & seat rock (in plan view)