

STATE OF ARKANSAS

Arkansas Geological Commission

Norman F. Williams, State Geologist

INFORMATION CIRCULAR 28 -- B

**STRATIGRAPHIC FRAMEWORK AND
DISTRIBUTION OF LIGNITE ON
CROWLEY'S RIDGE, ARKANSAS**

by

Charles R. Meissner, Jr., U. S. Geological Survey



**Little Rock, Arkansas
1984**

**Printed in cooperation with the
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Contents

Abstract	1
Introduction	1
Purpose of report	1
Location and size of area	2
Acknowledgements	2
Geologic Setting	2
Stratigraphy	3
Lithology and depositional environments of the Wilcox and Claiborne Groups	4
Wilcox Group	4
Claiborne Group	5
Near surface lignite exploration drilling	5
Cross section A—A' and area 1 (pls. 1 and 3)	5
Cross section B—B' and area 2 (pls. 1 and 4)	6
Cross section C—C' (pls. 1 and 5)	6
Cross section D—D' and area 3 (pls. 1 and 6)	7
Cross section E—E' (pls. 1 and 7)	7
Cross section F—F' and area 4 (north) (pls. 1 and 8)	7
Cross section G—G' and area 4 (north and south) (pls. 1 and 9)	9
Summary of significant lignite deposits on Crowley's Ridge	9
Chemical composition of Crowley's Ridge lignite	10
Utilization of Crowley's Ridge lignite and recommendation for further work	10
References	13
Appendix	14

Illustrations

Plates in Appendix

1. Map of Crowley's Ridge, Arkansas, showing lignite exploration drill hole sites, lines of cross sections A -A' to G-G', and areas containing lignite 2.5 feet or more thick.
2. Regional geologic cross section along and adjacent to Crowley's Ridge, Arkansas.
3. Crowley's Ridge cross section A-A' lignite exploration drilling, Clay County, Arkansas.
4. Crowley's Ridge cross section B-B' lignite exploration drilling, Greene County, Arkansas.
5. Crowley's Ridge cross section C-C' lignite exploration drilling, Greene County, Arkansas.
6. Crowley's Ridge cross section D-D' lignite exploration drilling, Craighead County, Arkansas.
7. Crowley's Ridge cross section E-E' lignite exploration drilling, Craighead County, Arkansas.
8. Crowley's Ridge cross section F-F' lignite exploration drilling, Poinsett County, Arkansas.
9. Crowley's Ridge cross section G-G' lignite exploration drilling, Poinsett and Cross Counties, Arkansas.

Figures

1.	Composite stratigraphic column showing approximate positions of lignite zones and beds, Crowley's Ridge Arkansas	8
2.	Index Map -- Location of lignite samples	11

Tables

1.	Areas containing significant lignite on Crowley's Ridge, Arkansas	10
2.	Summary of the proximate and ultimate analyses of the 8 lignite samples (range and average as received)	12
3.	Averages of major oxide compositions on the 8 lignite samples (laboratory ash)	12
4.	Potentially toxic elements -- number of samples averaged in parenthesis (whole coal-parts per million)	12

STRATIGRAPHIC FRAMEWORK AND DISTRIBUTION OF LIGNITE

ON CROWLEY'S RIDGE, ARKANSAS

ABSTRACT

This report establishes a stratigraphic framework for the lignite and associated strata in the Crowley's Ridge area of northeastern Arkansas. Crowley's Ridge is a north to south trending physiographic feature that resulted from erosion by the Mississippi River and its tributaries. Lignite exploration drill hole data provided by the Arkansas Geological Commission and oil and gas test holes were used in the synthesis and interpretation. Areas containing lignite of potential commercial value are also delineated.

A regional cross section was constructed from geophysical and lithologic logs of selected oil and gas test holes along or adjacent to the ridge for a distance of about 115 miles. The cross section shows that the lignite-bearing Tertiary formations dip gently southward. The strata of the Eocene age Wilcox Group are the bedrock in the northern part of the ridge and successively younger bedrocks of the Eocene age Claiborne and Jackson Groups are present in the central and southern part of the ridge. The Eocene rocks of Crowley's Ridge are unconformably overlain by sand and gravel of Pliocene age and alluvium and loess of Quaternary age. The thickness of lignite-bearing strata ranges from 830 feet in the north to 2,480 feet in the south. The Wilcox, Claiborne, and Jackson Groups of Eocene age are believed to have been deposited on a fluvio-deltaic coastal plain.

The detailed vertical and horizontal stratigraphic characteristics and distribution of lignite in the sediments were determined by constructing seven cross sections from lignite exploration lithologic and geophysical drill hole logs. Correlations and interpretations of the strata reveal ten potentially important lignite beds. These beds are as much as 9.5 feet thick and are assigned to stratigraphic intervals that are designated as zones 1 through 7. Zone 1 is near the middle of the Wilcox Group and zone 7 is near the middle of the overlying Claiborne Group. The thicker lignite beds can be correlated over distances as much as 30 miles, but the thinner beds disappear within short distances. Four areas are delineated on Crowley's Ridge that contain one or more lignite beds 2.5 feet or more thick. Lignite exploration holes were drilled to 300 feet or less.

Analyses of eight lignite samples collected from the Crowley's Ridge area are on record with the U. S. Geological Survey's National Coal Resources Data System. Two of the samples are from lignite beds in the Wilcox Group, and six are from lignite beds in the Claiborne Group. The specific lignite beds from which the samples were taken are not known. However, the analyses are believed to be representative of the lignite beds within the lignite-bearing sequence.

Lignite is not currently mined on Crowley's Ridge. It has potential for use as a fuel for boilers to generate electricity and for gasification and liquefaction to produce fuel oil. More drilling and analyses are needed to define the quantity and quality of lignite beds within the four significant areas of resource potential and to determine the extent of lignite beds 2.5 feet or more thick that occur in several isolated areas.

INTRODUCTION

Purpose of Report

This report is a synthesis of the drill-hole data gathered by the Arkansas Geological Commission during a lignite exploration project on Crowley's Ridge in northeastern

Arkansas in 1975 and 1976, and from private company drill-hole data acquired by the Commission. These data were used to interpret and correlate a stratigraphic framework for the lignite and associated rock units. A map was constructed to show areas underlain by one or more lignite beds 2.5 feet or more thick. These areas have economic potential.

A drilling program was designed to test the resource of shallow lignite beds, and drilling was limited to 300 feet. The Commission drilled 116 holes on Crowley's Ridge. The location, elevation, and lithologic description of the rock cuttings and core of each of the drill holes has been published in Clardy (1979) and Holbrook (1980). Drill hole location maps in these reports also show the locations of 133 drill holes from lignite investigations by private companies whose records are on file with the Arkansas Geological Commission.

Regional geologic characteristics of Crowley's Ridge have been described and interpreted by Call (1891), Hosman and others (1968), Murray (1961), Spooner (1935), Stephenson and Crider (1916), and Renfroe (1949).

Location and Size of Area

Crowley's Ridge is located in northeastern Arkansas within lat. 34° 30' to 36° 30' N and long. 90° 10' to 90° 49' W (index map, plate 1). It is an elongate, irregular and slightly arcuate ridge that extends from the north border of Arkansas southward about 145 miles to the Mississippi River and is 1 to more than 12 miles in width.

The area discussed in this report is limited to the part of Crowley's Ridge that extends from the north border of Arkansas southward to the south border of Cross County, Arkansas, at about lat. 35° 09' N. This part of the ridge has a length of approximately 100 miles and is within townships 6 to 21 north and ranges 2 to 8 east (plate 1). This area includes the published lignite investigations for Crowley's Ridge (Clardy, 1979; Holbrook, 1980).

Acknowledgments

The Arkansas Geological Commission, Little Rock, Arkansas, is gratefully acknowledged for supplying the basic data regarding lignite exploration on Crowley's Ridge. I am thankful to Bettie Hackman for completing the numerous stratigraphic forms of the lignite drill hole data for entry into the National Coal

Resources Data System. Her work enables the retrieval of computerized lithologic strip logs, used for stratigraphic correlation, that otherwise would have required laborious hand plotting. Entry and retrieval of data would not have been possible without support from the National Coal Resources Data System group.

GEOLOGIC SETTING

Crowley's Ridge is an erosional remnant in the Gulf Coastal Plain of northeastern Arkansas that stands from 100 to 250 feet above the alluvial plains to the east and west, and is separated from these plains by slopes of varying degrees of steepness. The ridge is thought to have resulted from erosion by the Mississippi River and its tributaries which occupy large drainages east and west of the ridge (Call, 1889; Spooner, 1935; Stephenson and Crider, 1916). Modern drainage continually erodes the ridge, especially tributaries of the Mississippi River which lie very close to its east flank. The ridge is capped in many places by alluvium and loess of Quaternary age, and by sand and gravel beds of Pliocene age which creep down the slopes and mantle much of the underlying bedrock. The boundary slopes and tributaries are shown on the Geologic Map of Arkansas (Haley and others, 1976) and the geologic map of the Gulf Coastal Plain of Northeastern Arkansas (Stephenson and Crider, 1916).

Crowley's Ridge is in the northwestern part of the Mississippi Embayment, which is a geosynclinal feature whose axis trends approximately in the direction of the modern Mississippi River. The Mississippi Embayment Geosyncline plunges southward and opens into the Gulf of Mexico. Structural dip of the bedrock in the vicinity of Crowley's Ridge ranges from 35 to 75 feet per mile in a southeast to east by southeast direction towards the axis of the geosyncline.

Numerous publications are available that describe the Gulf Coastal Plain and the Mississippi Embayment. Two references are especially useful in reviewing the geologic setting of Crowley's Ridge: One is the "Geology of the

Atlantic and Gulf Coastal Province of North America' by Grover E. Murray (1961); and the other is "Tertiary Aquifers in the Mississippi Embayment" by Hosman and others (1968). The latter report contains a set of stratigraphic cross sections derived from electric logs, which cover much of the embayment.

STRATIGRAPHY

A geologic cross section, which includes the lignite bearing rocks of the Tertiary age Midway, Wilcox, Claiborne, and Jackson Groups (plate 2), was constructed along and adjacent to Crowley's Ridge from oil and gas drill hole data. The drill hole data are contained in Renfro (1949) and included data on the following holes; a north to south distance of about 115 miles:

U-Tex Oil Company drill hole no. 1, located in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ of section 26, T. 20 N., R. 7 E., Clay County, Arkansas (plates 1 & 2).

Volcanic Oil and Gas Company drill hole no. 1 located in section 16, T. 16 N., R. 5 E., Greene County, Arkansas (plates 1 & 2).

J. F. Scott, Trustee well no. 2-A located in section 12, T. 11 N., R. 3 E., Poinsett County, Arkansas (plates 1 & 2).

Ronnie Smith and Cockburn Oil Company drill hole no. 1, located 285 feet from northline, 420 feet from eastline of the NW $\frac{1}{4}$ NW $\frac{1}{4}$, section 14, T. 2 N., R. 1 E., Lee County, Arkansas (plate 2, and off the limits of plate 1).

These drill holes penetrated strata of Cretaceous age; however, only those parts of the section down to the base of the Tertiary age rocks were plotted. The U-Tex drill hole in Clay County penetrated about 45 feet of post-Eocene gravels which lie unconformably on Eocene sediments of the Wilcox Group. The oldest post-Eocene sediments are possibly

Pliocene in age (Spooner, 1935, Hosman and others, 1968). The Wilcox Group is about 560 feet thick in this hole, but the complete stratigraphic section is not present because of erosion prior to the deposition of the overlying gravels. The Midway Group, underlying the Wilcox, is about 270 feet thick and includes 10 feet of the Clayton Formation at the base of the Midway rocks. Thus, the total Wilcox and Midway section in the U-Tex drill hole, near the northern end of Crowley's Ridge, is about 830 feet thick.

The Volcanic drill hole in the southern part of Greene County is about 27 miles southwest of the U-Tex hole. The line of the section is just off the northeast-southwest structural strike so that the apparent dip of the formations is southward about 3 to 6 feet per mile. The Volcanic hole penetrated about 210 feet of post-Eocene sediments which lie unconformably on the Wilcox Group. (Note: there can be large variations in the thickness of post-Eocene sediments from place to place because of variations in erosion.) The surface profile is not shown on the regional cross section. The Wilcox Group in the Volcanic hole is about 480 feet thick, which is thinner than at the U-Tex drill hole locality, probably because of differential erosion at the unconformity after uplift at the close of Eocene time. The Midway Group, underlying the Wilcox, is 355 feet thick in the Volcanic hole. The Clayton Formation at the base of the Midway is not recognized in this hole. The Midway is thicker in the Volcanic test than it is in the U-Tex hole and demonstrates the gradual thickening of the formation from north to south. The combined thickness of the Wilcox and Midway is 835 feet.

The J. F. Scott drill hole in Poinsett County is about 30 miles south-southwest of the Volcanic hole. The line of section between the two holes is diagonally across strike and the dip is 17 to 20 feet per mile southward. The J. S. Scott hole possibly penetrated as much as 210 feet of post-Eocene sediments. These sediments unconformably overlie an estimated 180 feet of the Claiborne Group. As shown on the regional cross section the contact between the Wilcox and overlying Claiborne is between

the Volcanic and J. F. Scott drill holes. The Claiborne Group has been truncated by uplift and erosion after the close of Eocene time, and only the basal part of the Claiborne is represented in the S. F. Scott hole. The underlying Wilcox Group is about 780 feet thick. The Midway Group underlying the Wilcox is 440 feet thick, which is thicker than it is in the Volcanic hole, and again illustrates thickening to the south. Total thickness of the Claiborne, Wilcox, and Midway Groups in the S. F. Scott hole is about 1400 feet.

The Ronnie Smith drill hole in Lee County is located west of Crowley's Ridge, but probably represents closely the stratigraphic intervals in the ridge. This location is about 58 miles south-southwest of the J. F. Scott hole, and the strata dips 17 to 20 feet per mile southward between the two holes. The Ronnie Smith hole contains an estimated 250 feet of post-Eocene sediments. These sediments unconformably overlie 490 feet of the Jackson Group, whose basal contact with the Claiborne is in the southern part of Cross County. The truncated updip edge of the Claiborne extends for about 28 miles from the J. F. Scott drill hole towards the Ronnie Smith hole before these sediments dip under the Jackson Group (plate 2). The total stratigraphic thickness of the Claiborne Group is about 690 feet in this area. The Wilcox underlying the Claiborne is 775 feet or about the same as in the J. F. Scott drill hole. The Midway Group under the Wilcox is 525 feet thick and includes 80 feet of the Clayton Formation at the base of Midway. Total Paleocene-Eocene sediments in the Ronnie Smith Hole is about 2,480 feet.

The regional geologic cross section (plate 2) shows the intervals of lignite-bearing strata of Paleocene-Eocene age thicken southward from about 830 feet in the U-Tex drill hole near the north end of the ridge to about 2,480 feet in the Ronnie Smith drill hole. This increase is due mostly to the addition of younger sediments that were deposited downdip and have not been eroded during uplift at the end of Eocene time. Thus, strata, covered by the

post-Eocene deposits that mantle the surface of Crowley's Ridge, become younger from north to south. The partially eroded Wilcox Group is the bedrock surface in Clay, Greene, and part of Craighead County. The base of the Claiborne Group is the bedrock surface in southern Craighead County and becomes progressively younger southward through Poinsett County, to near the south border of Cross County where the top of the formation is in contact with the base of the Jackson Group.

LITHOLOGY AND DEPOSITIONAL ENVIRONMENT OF THE WILCOX AND CLAIBORNE GROUPS

Wilcox Group

The Eocene age Wilcox Group of northeastern Arkansas is composed of continental to deltaic deposits. These deposits consist of interbedded clays, silts, and sands that are commonly lignitic or carbonaceous, and beds of lignite (Murray, 1955, 1961). Spooner (1935) describes the Wilcox as a series of sands, clays and sandy clays, with beds of carbonaceous clay and lignite. Marked lateral variations are common. Stephenson and Crider (1916) describe the Wilcox as irregularly bedded sands, sandstones and quartzites, and irregularly bedded variegated clays interbedded with lignite. Caplan (1954) described the Wilcox as consisting of brown shale, gray micaceous shale, gray and gray-green siltstones and clays, and thick sand beds. Lignite and iron carbonate layers occur frequently in the Wilcox.

Studies of the Wilcox Formation in east Texas by Kaiser, and others (1980) and in northern Mississippi by Cleaves (1980) have shown that the sediments were deposited in a fluvio-deltaic environment. The lignite was formed in swamps between channels of a dendritic fluvial system or smaller interdistributary basins on the delta plain. The sedimentary models of east Texas and northern Mississippi

could well apply to the Crowley's Ridge area, and to the distribution of lignite in the Wilcox Group as described later in this report.

Claiborne Group

The boundary between the Wilcox and Claiborne Groups is placed at the contact between the clay, silt, and sand sequence at the top of the Wilcox, and the predominantly sand sequence at the base of the Claiborne. This change has been identified in the Ronnie Smith drill hole and is plotted on plate 2, and shown on the Geologic Map of Arkansas. The Wilcox-Claiborne contact could not be clearly identified from the near-surface lignite exploration drilling so the contact was determined on the basis of subsurface projection and the Geologic Map of Arkansas. The contact between the Wilcox and Claiborne is also the contact between the Lower and Middle Eocene as determined by palynomorphs identified by Frederiksen and others (1982) from the New Madrid test well of southeast Missouri, about 30 miles to the east of Crowley's Ridge. The New Madrid test well samples are considered by Frederiksen (1982), as the "laboratory" for the lithology of the northern Mississippi Embayment, especially where the Tertiary sediments are continental to near-shore in origin. The Claiborne Group consists of white to light-gray quartzose sands, and light to dark colored micaceous sands, interbedded with silts, silty clays and sandy clays containing thin beds of lignite. The sands are fine to very fine-grained and the clays are massive to thinly laminated with fine-grained, micaceous sand partings. In places clays contain iron carbonate concretions.

NEAR SURFACE LIGNITE EXPLORATION DRILLING

Drilling for lignite on Crowley's Ridge was done mostly along roadways and the holes were spaced from less than a mile to more than two miles apart depending on availability of unobstructed locations. The drilling depth

did not exceed 300 feet, which means that the holes just "skimmed" the surface of the Wilcox and Claiborne Groups after penetrating post-Eocene alluvium, loess, and gravel. The irregularly eroded post-Eocene deposits range from zero to more than 200 feet in thickness; and, because of the 300 foot drilling depth, the thickness of Wilcox and Claiborne penetrated varied according to the thickness of the covering material. Variations in thickness of the rock units also are controlled by the irregularly eroded Paleocene-Eocene bedrock surface upon which post-Eocene sediments were deposited.

To illustrate the vertical and horizontal characteristics of the lignite beds a series of seven consecutive cross sections (designated A-A' to G-G'; plates 3 through 9) were constructed from this drill hole data. The cross sections were drawn from north to south with cross section A-A' the most northerly, and G-G' in the southern part of the study area (plate 1). A description of each of these cross sections, including significant lignite-bearing areas, are reported as follows:

Cross section A-A' and area 1 (plate 1 and 3).

This cross section was prepared from the interpretation of seven geophysical logs which contain density and resistivity curves. The line of section trends southwestward in the middle of Clay County for a distance of about 9 miles. The alluvium, loess, and sand and gravel beds of Quaternary age range in thickness from 30 to 100 feet, and the thickness of Wilcox penetrated ranges from approximately 130 to 200 feet in the holes along this line of section. Two lignite beds were penetrated in these holes, designated beds 1 and 2 in zone 1. Bed 1, the uppermost, is from 1.5 to 4 feet thick excluding a parting, and occurs at a depth of from 100 to 170 feet. The bed is discontinuous along section, and is apparently absent in hole 214 (Arkansas Geological Commission number; Holbrook 1980); however, it extends without a break for possibly 2 miles in two different segments. Bed 2, about 20 feet below Bed 1, is from 1 to 5 feet thick

(excluding a clay split) and is apparently continuous along the line of section for a distance of almost 6 miles. Bed 2 has a resource thickness of 2.5 feet or more in holes 214, 230, and 231 at the south end of the cross section. (Drill holes with one, or more beds of lignite that are each 2.5 feet or more thick are shown as open circles on map (plate 1); the holes in which lignite beds are less than 2.5 feet thick, or absent, are shown by solid dots.)

Area 1 with lignite bed 1 and 2, zone 1 has been estimated from the locations of holes 214, 230, and 231 of cross section A-A': The beds are 2.5 to 5 feet thick excluding shale partings as indicated in cross section A-A', and cover an area of about 2 square miles. Area 1 is stratigraphically the lowest of four areas designated and lies near the middle of the Wilcox Group.

Cross section B-B' and area 2 (plates 1 and 4).

This cross section was constructed from data interpreted from 13 geophysical logs similar to those in cross section A-A'. The line of section trends roughly southward with a sharp jog to the east, and is within the northern to central part of Greene County. The section is about 15 miles long. Surficial post-Eocene alluvium, loess, and gravel range from a few feet to nearly 200 feet thick, and the thickness of Wilcox Group penetrated is from about 60 to 290 feet along the line of cross section. Three lignite beds were penetrated in these holes, designated beds 1, 2, and 3 in zone 2. Bed 1, the uppermost of zone 2, ranges from 1.5 to 6 feet thick, and occurs at a depth from 40 to 280 feet. The bed is probably continuous along the line of section, but is faulted up between holes 256 and 243, and 224 and 200, respectively. Offset of bed 1 by the fault between holes 256 and 243 is about 90 feet, and between holes 224 and 200 is about 60 feet. Bed 2, which lies from a few feet to 20 feet below bed 1, ranges from 0 to 4 feet thick. Bed 2 appears continuous, although faulted, between holes 247 and 200, a distance of about 3 miles. The bed is a few inches thick in hole 197, about 4 miles south of hole 200. Bed 3 of zone 2 lies from a few feet to 15 feet

below bed 2 and ranges in thickness from 2 to 3 feet. It is continuous along the same holes as bed 2.

Area 2 designates two separate areas in Greene County that contain one or more lignite beds that are more than 2.5 feet thick but are separated by lignite less than 1.5 feet thick in hole 245. The size of both parts of area 2, north and south, is determined by the location of drill holes that contain one or more lignite beds at least 2.5 feet thick, as well as other holes in the vicinity of the line of cross section which are believed to contain these same beds. Area 2 also includes two holes that are part of the north end of cross section C-C' to be described below. The north part of area 2 contains one lignite bed from 3 to more than 4 feet thick and occupies about 6 square miles. The south part of area 2 includes at least one hole (247) with 3 lignite beds, each 2.5 feet or more thick, whereas the remainder of the area contains at least 1 or 2 beds, each 2.5 feet or more thick (see cross section B-B'). The south part of area 2, is irregular and covers at least 12 square miles. The lignite beds of zone 2, are believed to be stratigraphically higher than those in zone 1 of area 1, and are in the upper third of the Wilcox Group. Because of the shallow exploration drilling it has not been entirely possible to relate lignite beds to specific stratigraphic horizons within the Wilcox and Claiborne Groups.

Cross section C-C' (plates 1 and 5).

This cross section has been prepared from data interpreted from logs of 12 drill holes. Five of the logs are geophysical and seven are lithologic logs. From near the center of Greene County the line of section trends about 15 miles to the south. Surficial post-Eocene deposits are from 10 to 160 feet thick and the Wilcox drilled ranges from 0 to 300 feet. The northern two holes of the cross section encountered a lignite that is correlated to bed 3 of zone 2 as seen in cross section B-B'. Bed 3 penetrated by these two holes is a part of area 2 and is 4 to 4.5 feet thick. Bed 3 also was found in holes 12 and 15 near the middle part of the cross section, where it is 1 to 2

feet thick and again at the southernmost hole, where it is 3 feet thick. The correlation of bed 3, zone 2, along the 15 miles of cross section C-C' shows a southerly dip of about 10 feet per mile which is reasonable in view of regional dips estimated for this part of Crowley's Ridge (plate 2).

Cross section D-D' and area 3 (plates 1 and 6)

This cross section was constructed from geophysical and lithologic logs of 11 drill hole logs. The line of section trends nearly south for about 14 miles from the south end of Greene County, towards the southern part of Craighead County. Surficial sediments are from 0 to 160 feet thick, and the Wilcox Group penetrated ranges from about 20 to 230 feet thick. The northernmost hole of cross section D-D' is common with the southernmost hole of C-C', which means the two sections are continuous with each other. Bed 3, zone 2, has been correlated in cross section D-D', but it is discontinuous, similar to section C-C'. Bed 3, in section D-D' is from 2 to 5 feet thick. Bed 2 of zone 2, first seen in cross section B-B', also occurs in this section in one hole (169) and lies about 15 feet above bed 3; however, it is only 1 foot thick. Cross section D-D' contains three additional lignite beds stratigraphically higher than zone 2. These beds are included in zones that are designated, from older to younger, 3, 4, and 5. The designation zone for these single beds is used to allow for additional beds which may be discovered in subsequent drilling. Zone 3 lies about 50 feet above bed 3, zone 2, and is separated by a sandstone unit in several of the drill holes. Zone 3 lignite is first seen in hole 258 and then again in two holes about six miles south, near the south end of the section, within area 3. Zone 4 lignite bed within area 3 is 60 to 80 feet above zone 3 and is from 2 to 6 feet thick. Zone 5 lignite was identified in a single hole about 80 feet above zone 4 and is 4 feet thick. Zone 5 lignite is within area 3. Therefore area 3, as seen in cross section D-D', contains 4 lignite zones, and each hole contains one or two beds 2.5 feet or more thick. The depth to the lignite ranges from about 70 to 270 feet. The size and shape

of area 3 was determined from data from the holes in cross section D-D' and other holes in the same area which contain one or more lignite beds in zones 2 to 5. Lignite identified in these holes is as much as 9.5 feet thick, and the size of the area is estimated to be 7 to 8 square miles. The stratigraphic position of lignite beds in area 3 is in the upper part of the Wilcox Group.

Cross section E-E' (plates 1 and 7)

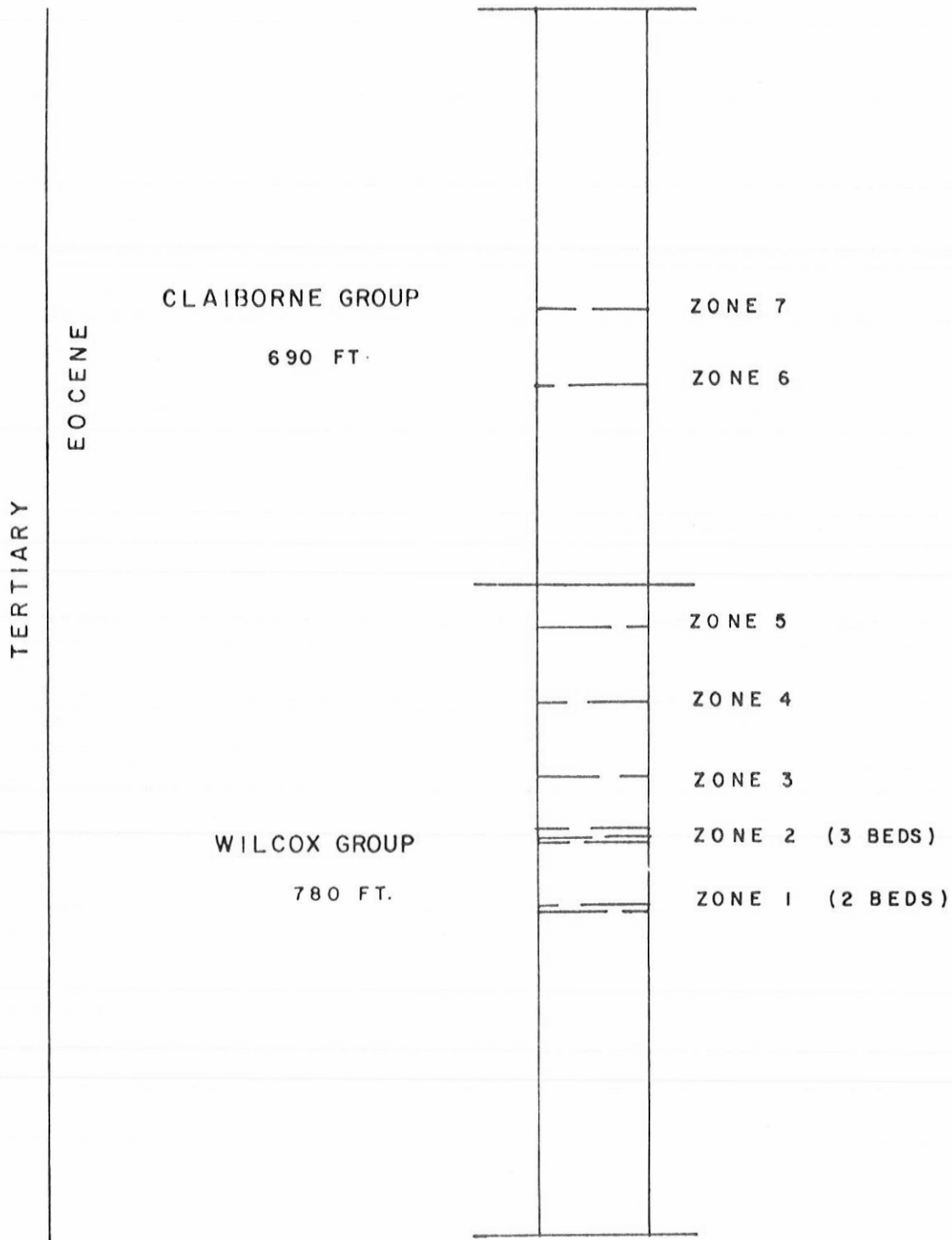
This cross section has been constructed using data from geophysical and lithologic logs of 9 drill holes. The northernmost hole is the same as the southernmost hole of section D-D'. The line of cross section trends east by southeast and is about 12 miles long, ending near the south border of Craighead County. Post-Eocene deposits that overlie the unconformity range from 10 feet to about 280 feet. The cross section crosses the contact between the Wilcox and Claiborne Groups as shown in plate 2. The cross section includes bed 3, zone 2 (hole 188), described in the section above, and is part of area 3, hole 72 adjacent to the south, encountered zone 4 lignite which is only 1 foot thick. The southernmost hole (62) contains a lignite bed believed to be stratigraphically higher than zone 5 and is designated zone 6. This bed is split by a shale parting with the upper bench 5 feet thick, and the lower bench 1 foot thick.

Upon reviewing cross sections A-A' to E-E' it can be seen that lignite beds in zones 1 to 5, are located stratigraphically from about the middle to the top of the Wilcox Group, and subsequent zones are in the overlying Claiborne Group (Fig. 1).

Cross section F-F' and area 4 (plates 1 and 8).

Cross section F-F' has been constructed from data interpreted from geophysical and lithologic logs of 9 drill holes. The northernmost hole of the the section is common to the southernmost hole of cross section E-E'. The line of cross section trends southward for about 12 miles, starting at the south end of Craighead County, and ending in the middle

FIGURE 1
 COMPOSITE STRATIGRAPHIC COLUMN SHOWING APPROXIMATE
 POSITIONS OF LIGNITE ZONES AND BEDS
 CROWLEYS RIDGE, ARKANSAS



of Poinsett County. The surficial deposits are relatively thin along this cross section and range from 0 to 60 feet thick. The thickness of the Claiborne drilled ranges from about 100 to 300 feet. The lignite bed, about 5 feet thick, of zone 6 (hole 62) at the north end of the cross section is absent in the next four holes, but has been recognized in the southernmost four holes. These last four holes penetrated lignite that ranges from 2 (excluding split) to 4 feet thick and is up to 7 feet thick in other holes off setting the cross section. The last three holes are located in the north part of area 4. Area 4 consists of two parts (north and south) that contain a discontinuous lignite bed. Hole 123 at the south end of the cross section contains a lignite bed that is stratigraphically higher designated as zone 7. It is the youngest lignite bed described in this report. The lignite of zone 7 is about 300 feet above the base of the Claiborne Group (Fig. 1). The lignite and associated strata in hole 123 is thought to have been down-faulted to the south about 50 feet with respect to hole 122 causing a steepening of the dip between the two holes.

The north part of area 4 contains at least one lignite bed 2.5 feet or more thick and underlies an area of about four square miles as determined from data from 12 test holes.

Cross section G—G' and area 4 (plates 1 and 9).

This cross section has been constructed from data interpreted from geophysical and lithologic logs of eight drill holes. The northernmost hole of the section is the same as the southernmost hole in cross section F—F'. Cross section G—G' trends southward for about 13 miles, starting in the middle of Poinsett County on Crowley's Ridge and ending in the north part of Cross County. The surficial deposits above the unconformity are as much as 90 feet thick. The Claiborne strata penetrated in the holes along the cross section range from 0 to 300 feet and include lignite beds assigned

to zone 6 and zone 7. The northern part of the cross section is in the north part of area 4. Hole 166 and 156 are included in the southern part of area 4. Area 4 south is separated from area 4 north by the absence or thinning of lignite. The southern area is estimated to cover about 3 square miles.

SUMMARY OF SIGNIFICANT LIGNITE DEPOSITS ON CROWLEY'S RIDGE

The areas that contain one or more lignite beds that are at least 2.5 feet thick have been delineated from lignite exploration holes. Cross sections constructed from geophysical and lithologic logs have been used to determine the number, extent, and stratigraphic sequence of lignite beds discovered on Crowley's Ridge.

The ten lignite beds, each 2.5 feet or more thick, have been divided into seven zones. Zone 1 is stratigraphically the lowest and oldest and zone 7 the highest and youngest (Fig. 1). Zone 1 occurs near the middle of the Wilcox Group. The strata dip gently southward and subsequent zones are progressively higher stratigraphically from north to south. Zone 7 near the middle of the Claiborne Group is present in the southern part of the area of this report. The total stratigraphic interval included in zone 1 through zone 7 is estimated to be 700 feet and the area investigated extended for a distance of about 70 miles along Crowley's Ridge. Drilling was limited to depths of 300 feet or less. Zone 1 contains two lignite beds, zone 2 contains three lignite beds, and zones 3 through 7 contain one lignite bed each. The zone designation is used in the case of single beds because later drilling may reveal more than one lignite bed in each of the zones. Four areas have been outlined that contain one or more lignite beds that are 2.5 feet or more thick and are less than 300 feet deep. The description of these areas is shown in Table 1.

CHEMICAL COMPOSITION OF LIGNITE OF CROWLEY'S RIDGE

Analyses of eight lignite samples from Crowley's Ridge are on record in the U. S. Geological Survey's National Coal Resources Data System. Two samples are from the Wilcox Group and six are from the Claiborne Group. The identity and specific stratigraphic position of the lignite beds sampled are not known but the samples may be representative of the lignite in the general area. The two Wilcox samples (from same drill hole) come from near area 3 and the six Claiborne samples are from in or near the north part of area 4 (Fig. 2). Summaries of the proximate and ultimate, and major and minor oxide analyses of the eight samples are shown in Tables 2 and 3.

The lignite on a "whole-coal" basis, was analyzed for 61 trace elements, 29 of which had sufficient values to average. None of the

average values were anomalously high. Potentially toxic elements in the lignite samples are listed in Table 4.

UTILIZATION OF CROWLEY'S RIDGE LIGNITE AND RECOMMENDATIONS FOR FURTHER WORK

Lignite is not presently mined on Crowley's Ridge, but it has resource potential and could be used in boilers to generate electricity. The lignite could be used for conversion to synthetic fuels and it has potential for gasification and for liquifaction.

It is recommended that more drilling be conducted to better define the quantity and quality of lignite beds within significant areas 1, 2, 3, and 4, and to determine the extent of lignite 2.5 feet or more thick found in several single, isolated, drill holes on Crowley's Ridge as shown in Plate 1.

TABLE 1

AREAS CONTAINING SIGNIFICANT LIGNITE ON CROWLEY'S RIDGE, ARKANSAS							
Area No.	Location	Size of Area in Sq. Mi.	Number of lignite beds and thickness	Depth range to lignite beds (ft.)	Strati-graphic Group	Strati-graphic zone of the lignite beds	Remarks
1	T. 20 N., R. 7 E. Clay County	4	2 beds 2.5 to 5 feet	100-190	Wilcox	1	
2	T. 17 - 19 N., R. 4 - 5 E. Greene County	north part 6 south part 12	north part 1 bed 3 - 4 ft. south part 3 beds 2.5-6 ft.	40-240	Wilcox	2	Area 2 is in two parts; a north and south part. The area apparently contains two faults.
3	T. 14 N., R. 2-3 E. Craighead County	7 - 8	4 beds 2.5 - 9.5 ft.	80-290	Wilcox	2 to 5	
4	T. 10 - 11 N., R. 4 E. Poinsett County	north part 4 south part 3	north part 2 beds 2.5-7 ft. south part 1 bed 2.5 - 3.5 ft.	20-160	Claiborne	6 and 7	Area 4 is in parts, north and south. The north part apparently contains a fault.

FIGURE 2
INDEX MAP

LOCATION OF LIGNITE SAMPLES

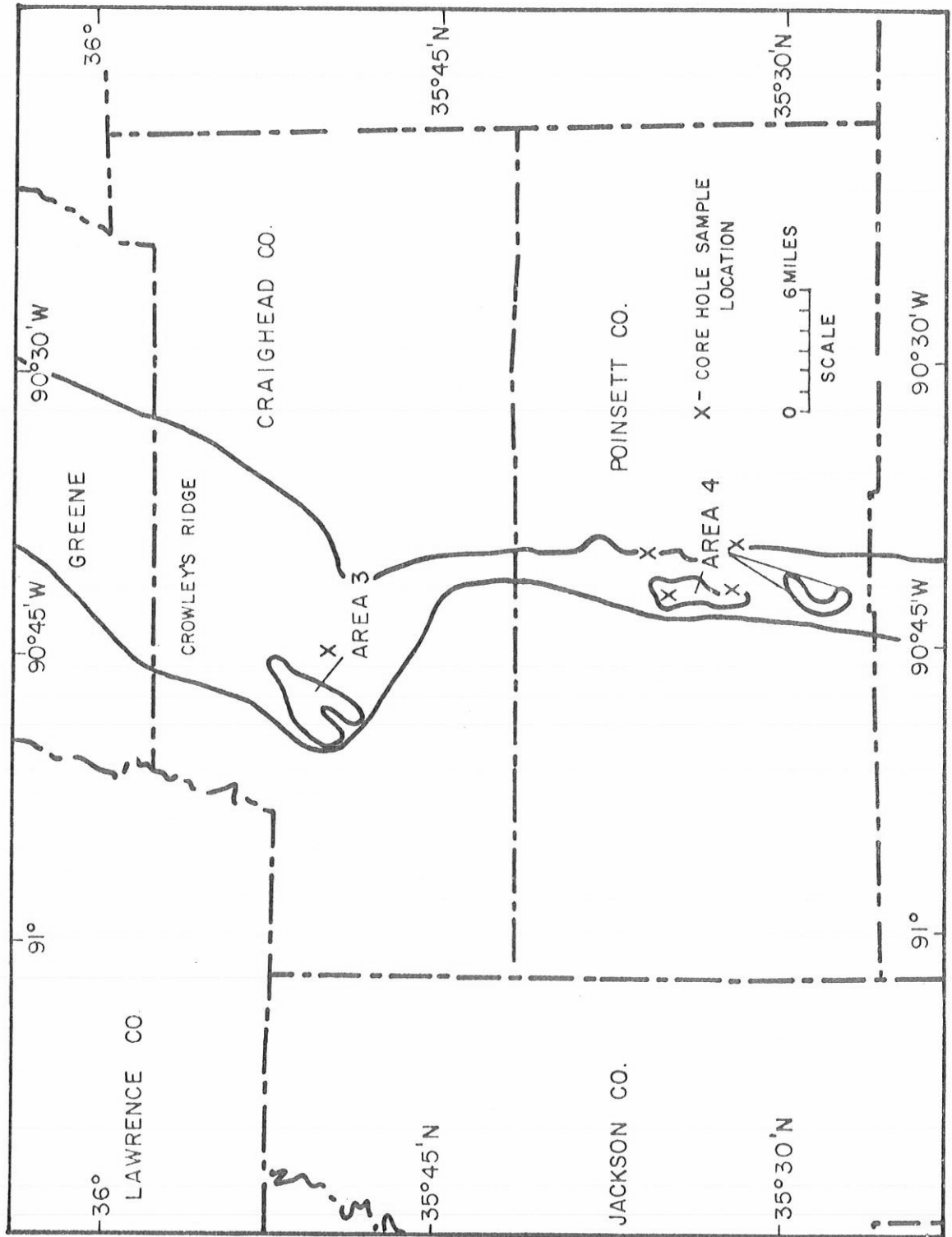


TABLE 2

Summary of the proximate and ultimate analyses of the 8 lignite samples
(range and average as received)

Group	Moisture %	Ash % (USBM @ 750°C?)	Sulfur %	Btu/lb
Wilcox Group (2 samples)	36.3 – 40.1	20.5 – 30.4	0.3 – 1.0	3910 – 4590 ¹ 6138 – 7663 ²
Claiborne Group (6 samples)	34.7 – 44.2	11.9 – 28.2	0.3 – 3.0	3400 – 5160 ¹ 5822 – 9448 ²
Averages	39.90	22.54	0.79	4368 ¹ 7305 ²

¹ as received

² moisture free

TABLE 3

Averages of major oxide compositions of the 8 lignite samples
(laboratory ash)

Ash % (USGS @ 525°C)	S ₁ O ₂ %	Al ₂ O ₃ %	CaO %	Fe ₂ O ₃ %	SO ₃ %	MgO, Na ₂ O, K ₂ O TiO ₂ and P ₂ O ₅ %
36.33	60.75	15.23	6.96	6.65	5.64	4.77

TABLE 4

Potentially toxic elements — number of samples averaged shown in parenthesis
(whole coal — parts per million)

Ag	Al	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se
43(1)	2.99(8)	2.96(6)	5.33(2)	33.76(8)	31.52(8)	0.30(8)	9.70(8)	14.39(8)	0.89(7)	3.27(6)

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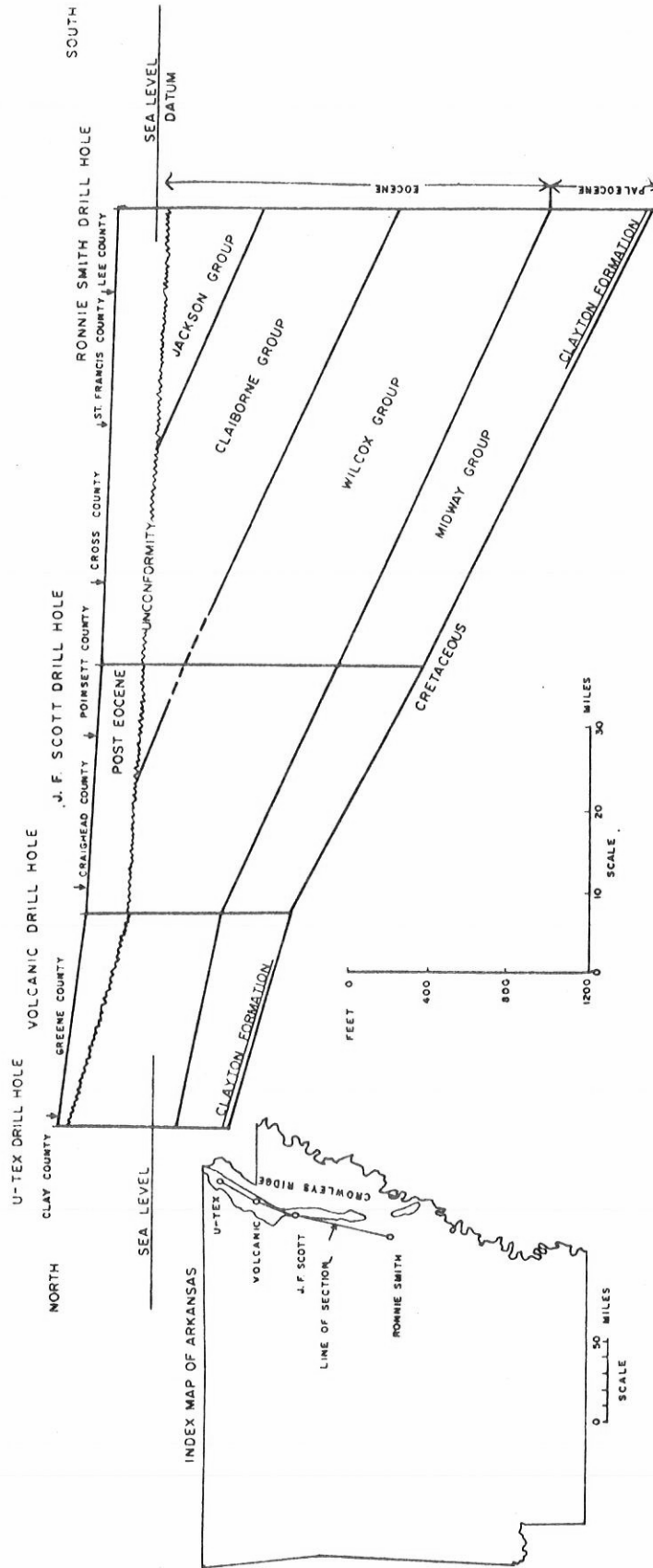
APPENDIX

ARKANSAS GEOLOGICAL COMMISSION
 IN COOPERATION WITH THE
 DEPARTMENT OF THE INTERIOR
 UNITED STATES GEOLOGICAL SURVEY

INFORMATION CIRCULAR 28-B
 PLATE 2 OF 9

PLATE 2

REGIONAL GEOLOGIC CROSS SECTION ALONG AND ADJACENT TO CROWLEYS RIDGE, ARKANSAS



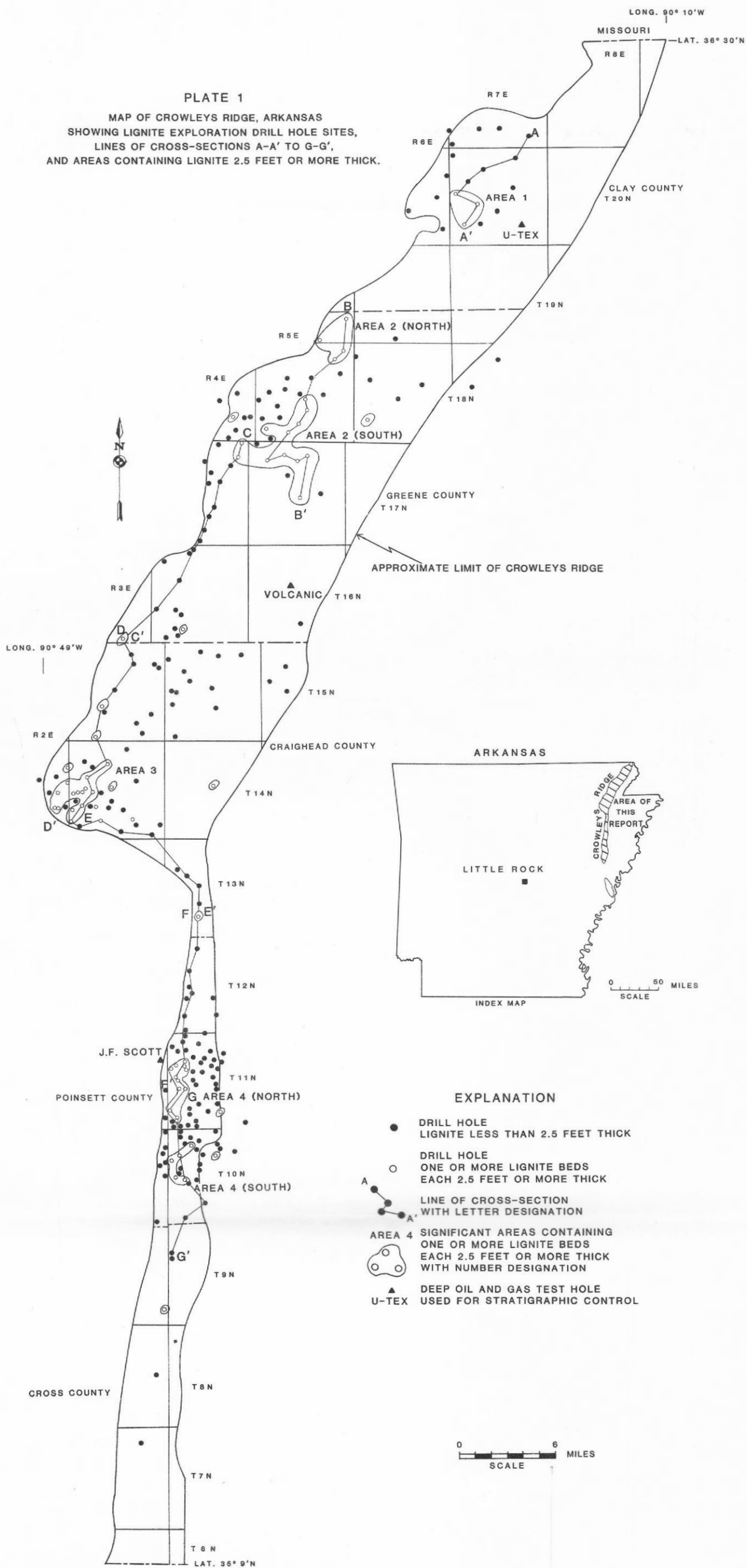


PLATE 3
CROWLEYS RIDGE CROSS-SECTION A-A'
LIGNITE EXPLORATION DRILLING
CLAY COUNTY, ARKANSAS

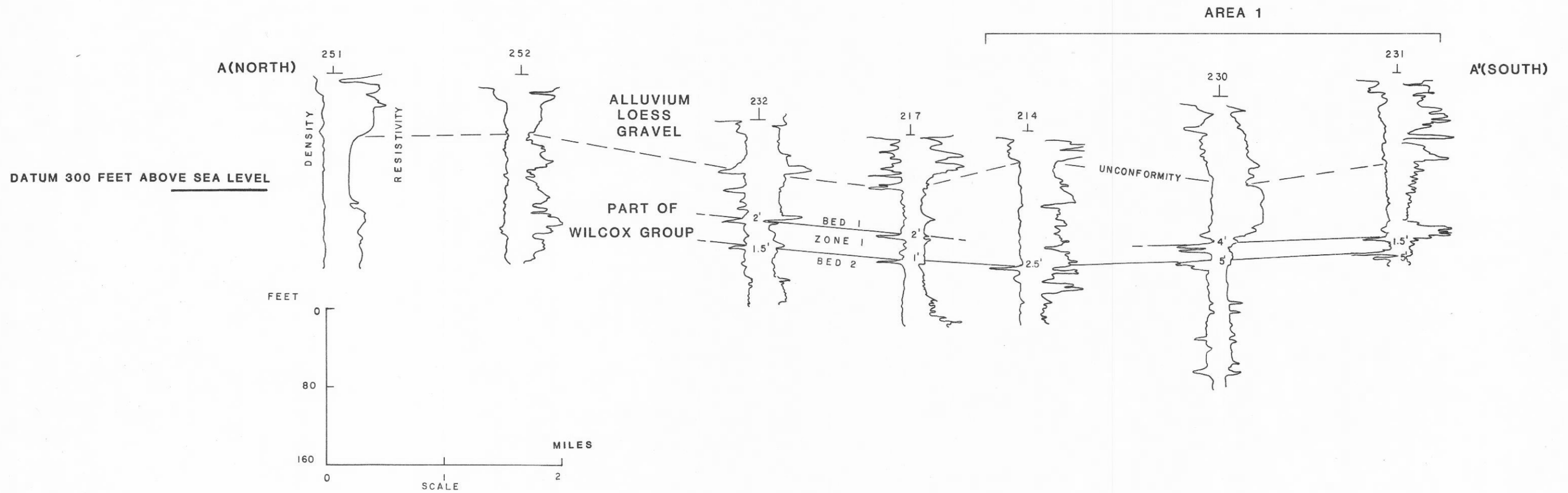


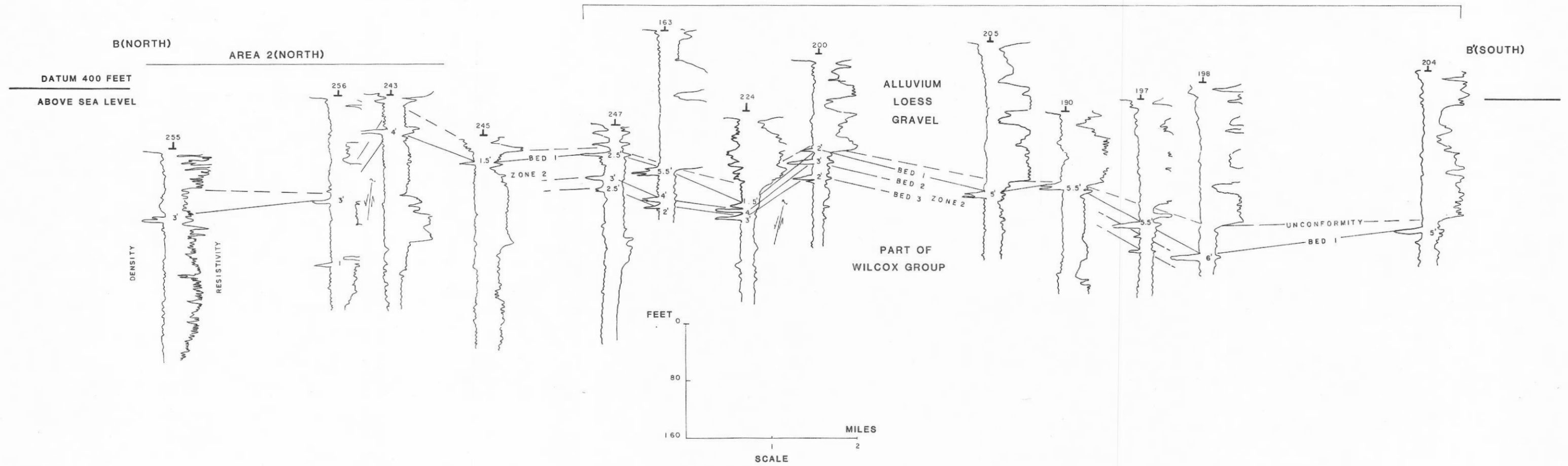
PLATE 4

CROWLEYS RIDGE CROSS-SECTION B-B'

LIGNITE EXPLORATION DRILLING

GREEN COUNTY, ARKANSAS

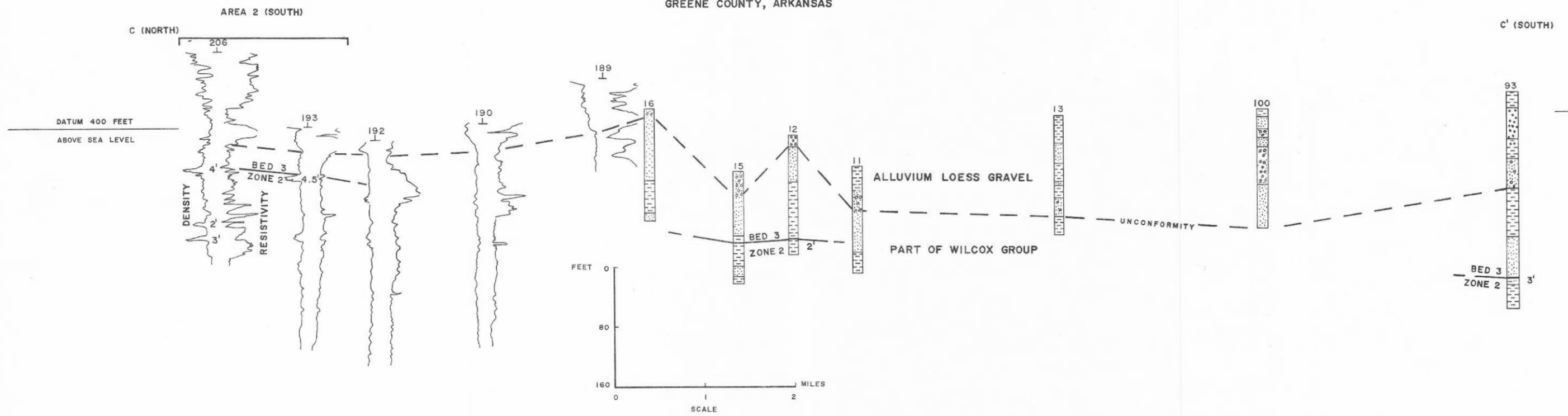
AREA 2(SOUTH)



ARKANSAS GEOLOGICAL COMMISSION
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UNITED STATES GEOLOGICAL SURVEY

PLATE 5
CROWLEYS RIDGE CROSS-SECTION C-C'
LIGNITE EXPLORATION DRILLING
GREENE COUNTY, ARKANSAS

INFORMATION CIRCULAR 28-B
PLATE 5 OF 9



ARKANSAS GEOLOGICAL COMMISSION
IN COOPERATION WITH THE DEPT. OF
INTERIOR UNITED STATES GEOLOGICAL SURVEY

PLATE 6
CROWLEYS RIDGE CROSS SECTION D-D
LIGNITE EXPLORATION DRILLING
CRAIGHEAD, ARKANSAS

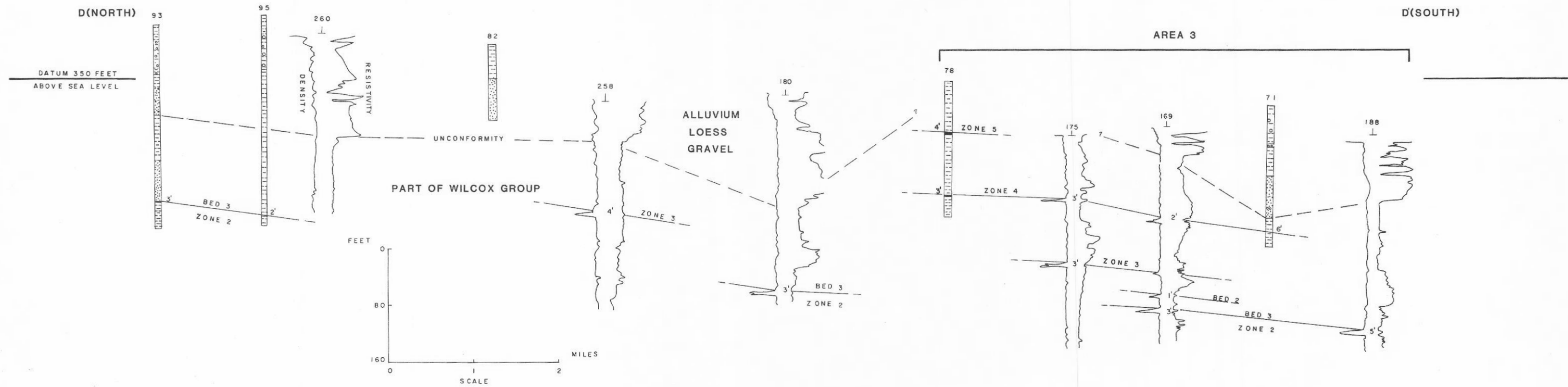


PLATE 7

CROWLEYS RIDGE CROSS-SECTION E-E'
LIGNITE EXPLORATION DRILLING
CRAIGHEAD COUNTY, ARKANSAS

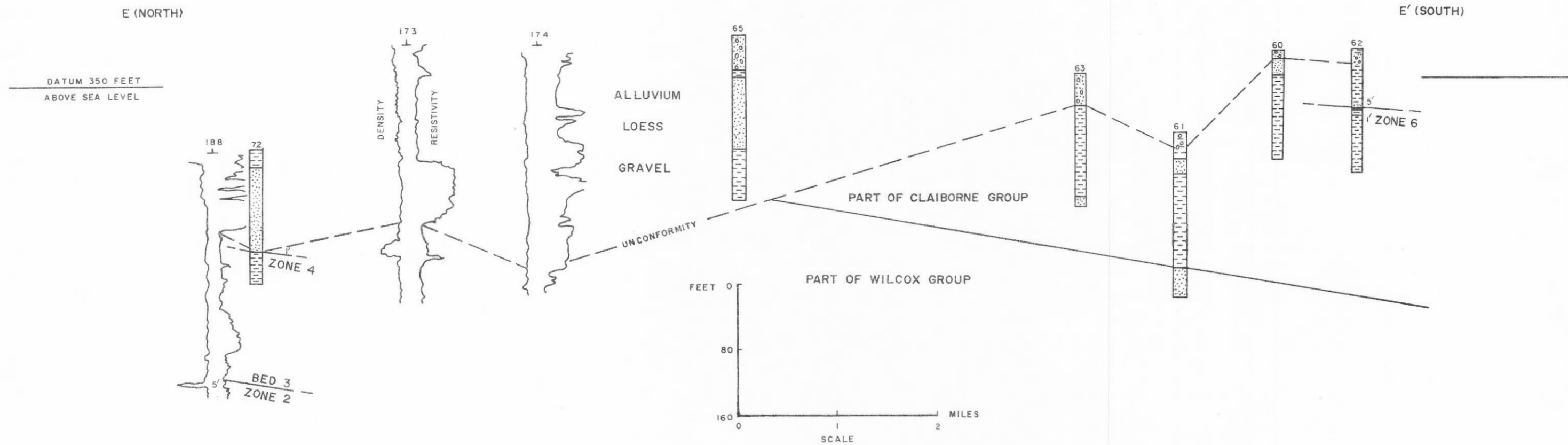


PLATE 8
CROWLEYS RIDGE CROSS-SECTION F-F'
LIGNITE EXPLORATION DRILLING
POINSETT COUNTY, ARKANSAS

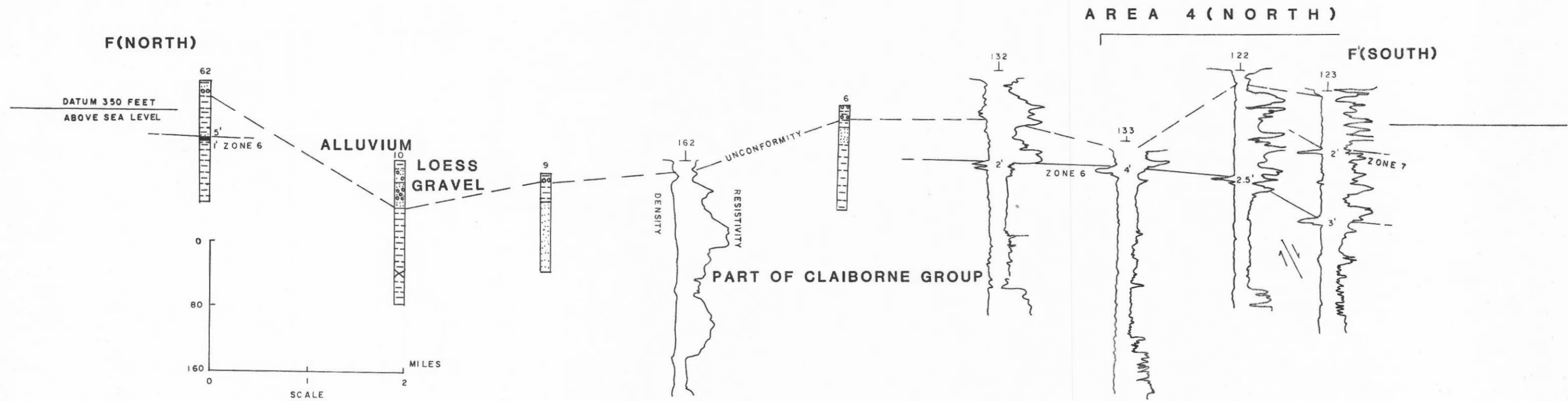


PLATE 9
CROWLEYS RIDGE CROSS-SECTION G-G'
LIGNITE EXPLORATION DRILLING
POINSETT AND CROSS COUNTIES, ARKANSAS

